

**INTERMEDIATE STUDENTS AT-RISK IN MATHEMATICS:
CASE STUDIES OF TEACHERS AND STUDENTS**

by

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ABSTRACT

Although there have been changes made to Ontario's mathematics curriculum within the last decade to ensure student success, a significant number of students in Ontario schools have been achieving at or below a level 1 and labeled 'at-risk' by the Ministry of Education's At-Risk Working Group (Expert Panel on Student Success in Ontario, 2004). This study explores intermediate students in a Northern Ontario city who are at-risk in mathematics. The purpose of the study is to investigate the various factors that inhibit student success in mathematics and to determine what students need in order to succeed. Since teachers are in a position to enhance and facilitate student success, the roles of teachers as well as student attitudes and dispositions in mathematics classrooms need clarification. The central questions guiding this study are: What types of strategies and practices do mathematics teachers use in their classrooms for all students and for those who they believe to be at-risk in mathematics? What are the observable behaviors of the students identified as at-risk as they interact in the classroom environment? What personal and mathematics-related learning characteristics can be observed in the at-risk students? The data collection process involved a collective case study of six students and three teachers, who were studied to provide an in-depth understanding of how mathematics teachers and their students interacted in mathematics classrooms. The data was mainly collected through participant observation, student work records and discussions with students and teachers. The findings indicate that the students in this study appear to be inhibited by many personal and behavioral issues. Some have been impacted by multiple school transfers and some have poor attendance. Most expressed a lack of confidence in their ability to succeed in mathematics, and some have a negative

attitude toward the subject matter. Each student case is unique as their individuality and experiences play a role in their beliefs, attitude toward the subject matter, and desire to achieve. This study also consistently showed that the teachers tended to fall back on traditional practices when working with students at-risk in mathematics, and seemed particularly reluctant to adopt reform-based teaching methodologies with these students.

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CHAPTER 1 - INTRODUCTION

Introduction to the Study

Students are at-risk in school for a number of reasons (Levin, 1990). Research suggests that students at-risk in school are more susceptible to a future unhappy lifestyle or the extreme cases of poverty and crime (Hannula, 2006). Students may find themselves at-risk within a number of subject areas or with school in general. However, as Fuchs and Fuchs (2001) report, there are pressing issues with students who are at-risk in mathematics regarding both means of prevention and intervention. The purpose of this study is to explore the many issues affecting intermediate students at-risk in mathematics in particular.

Within the last decade, Ontario's new mathematics curriculum has changed to one which is much more conceptually based with a focus on problem solving and relevant applications (The Ontario Curriculum, Grades, 9-10 Mathematics, 2005). The curriculum was designed with intentions of giving all students the opportunity to achieve success in mathematics and to develop their knowledge so that they can be productive within society. However, a significant number of Ontario's students have been labeled at-risk by the Ministry of Education's At-Risk Working Group (Expert Panel on Student Success in Ontario, 2004). The current study further investigates the classroom experiences and needs of selected intermediate students deemed 'at-risk' as determined by their classroom teacher.

Recently, the Ontario Ministry of Education published a report which recognizes the need to assist students at-risk, particularly those who are not developing mathematical

literacy and subsequently not earning an Ontario Secondary School Diploma (Expert Panel on Student Success in Ontario, 2004). The Expert Panel on Student Success in Ontario (2004) classifies 'students at-risk' in elementary school as those that are performing at or below level 1. Secondary school students are classified as at-risk if they are considerably below the provincial standard (level 3) with marks of low 60s and 50s (Expert Panel on Student Success in Ontario, 2004).

The EQAO (Education Quality and Accountability Office) results in Figure 1 suggest that a significant number of grade nine students are falling into the risk category (Education Quality and Accountability Office, 2006, p.5). As well, students who seem to be disengaged from mathematics and who do not regularly attend school have been categorized as at-risk by the Ministry of Education. Figure 1 indicates that the most recent Grade 9 Applied Mathematics EQAO assessment results from 2005-2006 show that only 35% of students were at or above the provincial standard (level 3) and that 21% of students were performing at or below level 1 (Education Quality and Accountability Office, 2006, p.5). The Ministry of Education has recognized a need to concentrate on students at-risk in mathematical development to ensure their effective participation in society.¹

According to the EQAO, the 8 percentage point increase in students who are achieving a Level 3 or above may have resulted from recent changes to The Ontario Curriculum in 2005, which were initiated partly because of the low EQAO scores and rarity of level 4's. Improvements have been noticed since this change and Figure 1

¹ From Education Quality and Accountability Office 2006, Results At A Glance: Grade 9 applied mathematics. Retrieved February 15, 2007, from <http://www.eqao.com>. Copyright 2006 by Queen's Printer for Ontario.

illustrates an increase in students achieving at a Level 4 as well as an increase over time in students' achievement at a Level 3 or above¹. However, these changes are relative to the previous year's EQAO testing. The goal is to have as many students as possible achieving at or above the provincial standard.

Although the Ministry has set out specific criteria to categorize students who are at-risk for mathematical literacy, the exact needs of students at-risk are not clearly defined (McFeetors & Mason, 2005). While there is existing research relating to the level of implementation of reform based programs in schools (Balfanz, MacLiver, & Bynres, 2006) there is a dearth of literature pertaining to the special needs of students at-risk in Northwestern Ontario.

The EQAO data indicates that a significant number of students are not successful in mathematics. However, the reasons why students are falling behind and failing to achieve should be the focus for this particular issue. There are multiple factors which contribute to perpetuating poor performance in mathematics. One major concern in this study is the possibility that some students, particularly those of different cultures and belief systems, may find challenges adjusting to teaching strategies deemed as "best practices" for mathematics instruction (Ontario Ministry of Education, 2007; Kajander, 2003). The conceptual framework to follow will help to look beyond the numbers and get to the source of what may be the major issues surrounding students who fail to achieve in mathematics.

Figure 1. EQAO Grade 9 Assessment Results

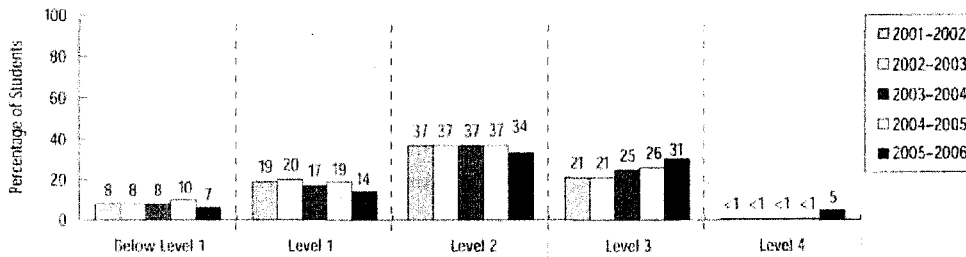
		2001-2002 # = 47 220	2002-2003 # = 48 426	2003-2004 # = 50 430	2004-2005 # = 51 155	2005-2006 [†] # = 50 667
Percentage of Students	Level 4	<1%	<1%	<1%	<1%	5%
	Level 3	21%	21%	25%	26%	31%
	Level 2	37%	37%	37%	37%	34%
	Level 1	19%	20%	17%	19%	14%
	Below Level 1	8%	8%	8%	10%	7%
	NEIS [‡]	6%	4%	5%	N/A [‡]	N/A [‡]
	No Data	7%	8%	6%	6%	8%
	Exempt	2%	2%	1%	1%	2%
	At or Above the Provincial Standard[§]	21%	21%	26%	27%	35%

[†] Changes in student performance from 2004-2005 to 2005-2006 must be interpreted within the context of significant revisions to applied program courses in *The Ontario Curriculum, Grades 9 and 10: Mathematics* (revised 2005).

[‡] See Explanation of Terms.

[§] The NEIS (Not Enough Information to Score) category was eliminated in 2004-2005. As students are now assigned a level based on the work they completed, comparisons with previous years should be made with caution.

[¶] These percentages are based on the actual number of students and cannot be calculated simply by adding the (rounded) percentages of students at Levels 3 and 4.



Note: Because percentages in tables are rounded, and as these bar graphs do not show the exempt, no data and NEIS categories, percentages will not add up to 100.

[†] From Education Quality and Accountability Office 2006, Results At A Glance: Grade 9 applied mathematics. Retrieved February 15,

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Conceptual Framework

This study is theoretically grounded in the concept of cultural capital. Cultural capital, as suggested by theorist Pierre Bourdieu, is the notion that knowledge is passed on through generations and contributes to the person one becomes (Brimi, 2005). In the context of this study, the world is to be viewed as a place where inequality is a reality and a result of the existing power and freedom held by a dominant culture (McLaren, 2003). "Dominant culture refers to social practices and representations that affirm the central values, interests, and concerns of the social class in control of the material and symbolic wealth of society" (McLaren, 2007, p. 201). Generally in Canada, [and in Northwestern Ontario specifically] the White Anglo-Saxon population is the dominant culture (McLaren 2007). A major concept of this cultural capital framework, is that values are centered around the culture in which one lives and that culture's associated social, cultural and economic capital. One's actions and means of socializing are also a product of his or her culture and are inherited through such (McLaren, 2003). Although many would argue an individual is free to make decisions and choices, culture greatly influences the behavior of individuals (McLaren, 2003).

Bourdieu views the educational system as one in which the values and beliefs of the dominant culture do not allow for a minority group's belief systems to exist (Brimi, 2005). Schools often omit the diversity of cultural capital, and may negatively repress it by bestowing the dominant cultural capital upon students (McLaren, 2003). Students whose life experiences are different from what is accepted and dominant within the educational system in terms of culture may simply be trying to hold onto moral and

political values which are previously instilled by preceding generations. In other words, defiance may be merely a product of feeling as though ones' identity is at stake.

Race, class and gender can be examined in the context of cultural capital and the educational system as a whole (McLaren, 2003). Students may feel that they need to give up their belief systems and conform to the dominant culture if they are to achieve within a school setting and ultimately society. Students either drop out because they cannot adjust to the culture of the classroom or they choose to live miserably under conditions that require them to act as though they are a part of the dominant cultural capital (McLaren, 2003). As Stone (2004) reports, Pierre Bourdieu theorizes that cultural capital is also 'institutionalized' meaning that status and order in society's rankings of class come from academic achievements (as cited in Brimi, 2005). Willis (1977) supports this notion in his description of the educational system as a microcosm of the class rankings and order which are evident in society (as cited in McLaren, 2003).

The form of critical pedagogy associated with cultural capital requires an educator to have an open mind and one which understands that issues often have many affective factors (McLaren, 2003). An educator who keeps an open mind will look for answers among the successes as well as the problems associated with resistance, failure and ignorance. It is only then that McLaren feels changes can be made which will affect the overall well being of society in terms of power, freedom and equal opportunity for all.

This framework acknowledges that educational organizations and leaders often best support the achievements of students who fall within a dominant cultural capital (McLaren, 2003). The framework also applies to education and specifically mathematics, as students may be in at-risk situations within the subject because of cultural capital.

Students' experiences in mathematics will be unique and they are very likely the result of the combination of social interactions both at and away from the school as an institution. As the literature review will further discuss, the particular needs of a student who is at-risk in mathematics may be different from other students. Therefore, as McLaren recommends, the issue must be explored from as many angles as possible. A broad approach will help to look beyond the obvious low grade achievements and to begin to examine the other factors which contribute to those students who are at-risk for failure in mathematics.

Introduction to the Researcher

At the time of the study, I was a graduate student in the Faculty of Education. During my Bachelor of Education program, I took great interest in the junior/intermediate pre-service mathematics course taught by Dr. Ann Kajander. The ideas surrounding mathematics reform were those that I knew I wanted to incorporate as a classroom teacher. I had previously tutored friends throughout high school as well as high school students while completing my undergraduate degree. I had a great passion for assisting others in towards success in mathematics. The opportunity to further research student success in mathematics and factors affecting students at-risk for failure really piqued my curiosity. Over the course of my pre-service year, I expressed interest in ideas related to math reform and approached Dr. Kajander with regard to any research opportunities for potential graduate students. Dr. Kajander had funding from NOEL (Northern Ontario Education Leaders) for this very type of project and I was given the opportunity to further investigate the topic. Although I was not Aboriginal, the Northern Ontario community in which the research took place had a substantial population of students who were. The

needs of Aboriginal students were also becoming an interest of the school boards in this region.

Purpose of the Study

The purpose of this study is to investigate the issues which affect intermediate students who are at-risk for failure in mathematics in a Northern Ontario city and to investigate the needs of these particular students.

Research Questions

This exploration of intermediate students at-risk in mathematics aims to investigate a variety of questions which include:

1. What types of strategies and practices are the study teachers using in their classrooms for all students, and are there any other strategies used for the students who they believe to be at-risk in mathematics?
2. What are the observable behaviors of the students identified as at-risk in the study as they interact in the classroom environment?
3. What personal and mathematics-related learning characteristics can be observed in the case study students?

CHAPTER 2 – LITERATURE REVIEW

Introduction

Descriptions of characteristics of students at-risk in mathematics are multi-faceted (Levin, 1990). The topic involves many aspects and thus it is important to provide a holistic perspective. I will begin with an overview of relevant literature and the definition of a student at-risk.

Achievement in mathematics may be influenced by the developmental process of learning itself (Geary, 2000). In addition, other factors which may contribute to a student at-risk include motivation, attitude and students' confidence in their mathematical ability (Hannula, 2006; Augustyniak, Murphy, & Phillips, 2005). The teacher may also influence the level of success a student may attain with respect to mathematics (Balfanz et al., 2006). All of these factors will be described to follow.

One's 'cultural capital' may be interwoven among many, if not all, of the factors which affect the student at-risk in mathematics. As McLaren (2003) explains, the acceptance and retention of mathematical ideas and concepts have a great deal to do with the culture which a student has experienced or of which the student is presently a part. One possible reason for resistance to new mathematical knowledge may be the result of a student not belonging to the dominant culture on which the teacher is focusing.

The Student At-Risk

According to Schissel and Wotherspoon (2001), there are many current definitions of a student at-risk. Canada Parks and Recreation outlined that many at-risk students often come from less fortunate family situations, live in communities which have social issues, and have difficulty with peers and school (Schissel & Wotherspoon,

2001). In addition, the education of students at-risk may be affected by loneliness, boredom, health and their development early on in life (Schissel & Wotherspoon, 2001). Levin's (1990) description of the student at-risk includes typically low education levels for parents as well as non-English speaking families as potential reasons for lowered success among students. As such, the student at-risk can fall into many categories and it is important for educators to be able to identify these students in order to be able to assist them.

The issues for students at-risk relate not only to the quality of life for that particular student, but also the impact they have on the greater society. Human Resources Development Canada (1998) informs that society is becoming more competitive, and as a result certain skills should be possessed in order to succeed (as cited in Schissel & Wotherspoon, 2001). These skills include: oral communication, thinking skills, the ability to be a lifelong learner as well as knowledge regarding technology. Action should be taken to be of assistance as the effects and costs are detrimental to all (Levin, 1990). Factors reported by Levin include educational costs of holding students back a grade level, the cost associated with crime, welfare and unemployment can all be reduced by intervention programs and identification of students at-risk. An earlier study by Remierez and Robledo (1987) estimated that an intervention program for grade nine students would result in a difference of approximately \$16 billion Canadian dollars (as cited in Levin, 1990). As a further incentive, when the numbers of those students who are at-risk are lowered, the overall cost in taxes will decrease accordingly.

It is also important to recognize that student success has been found to be correlated to the resources that a school can provide (Greenwald, Hedges, & Laine,

1996). More specifically, the amount of money the education system can provide for students has been strongly linked to their achievement (Greenwald et al., 1996). These authors acknowledge other factors such as teacher knowledge and education as making contributions to student success.

The following main sections of the literature review are titled Classroom Practices, General Characteristics of Students At-Risk, and Mathematics-related Issues, and these are organized as such to connect the literature with the research questions. As previously stated, the research questions are:

1. What types of strategies and practices are the study teachers using in their classrooms for all students, and are there any other strategies used for the students who they believe to be at-risk in mathematics?
2. What are the observable behaviors of the students at-risk in the study as they interact in the classroom environment?
3. What personal and mathematics-related learning characteristics can be observed in the case study students?

Classroom Practices

The subsequent sections aim to connect the literature with the first research question regarding the strategies and practices mathematics teachers are using for all students and those whom they believe to be at-risk in mathematics. Ideas from the literature include: the role of the teacher, the curriculum, challenging students, knowledge and attitude of the teacher, accommodating the students at-risk and the needs of the teacher.

The Role of the Teacher

As previously stated, students may be at-risk in mathematics as a result of a number of different circumstances and factors. The degree to which certain issues influence students may be based on their individual and cultural experiences (McLaren, 2003). Since students spend the majority of their formal mathematics learning at school, the teacher can have an obvious effect on learning. Teachers and other adults in the lives of students who show support and genuine concern can make a difference in combination with a supportive community (Wang, 1996). In other words, much of what the teacher chooses to do (or not to do) can have a major impact on the success of a student.

The Curriculum

Many of the curriculum changes in Ontario which were intended to impact the way instruction was taking place were inspired by the National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics* document (NCTM, 2000). The 400-page standards document contains visions, as well as principles and standards for mathematics education (NCTM, 2000). There is a strong calling for the restructuring of the way mathematics is presented to students for a number of reasons. *Principles and Standards* aims to correct issues such as the level of commitment on the part of teachers and students and a curriculum that does not motivate students' participation. The purpose of the initial document released in 1989 was to help identify goals, provide quality mathematics education and to transform the previous curriculum (NCTM, 1989). The more recent document includes more detail about how this might be achieved at the classroom level.

The vision held by the National Council of Teachers of Mathematics is one which the NCTM (2000) admits is idealized in nature. The vision described by the NCTM is one in which all students have access to learning mathematics no matter what skills they possess. Teachers are to provide rich learning experiences for students, helping students work through mathematical problems with multiple perspectives. The main goal is that students will want to do mathematics because they will have developed a passion for it. Although *The Standards* do provide some specifics regarding content and process standards, the intentions are to guide teachers only. It is up to teachers to determine exactly what works best for their class but the document does not mandate that a particular curriculum be followed.

The success of a student who is in an at-risk situation in mathematics can be influenced by the teaching strategies and curriculum which are imposed. It is the job of the classroom teacher to decide what to expose their students to and he or she should direct these students through their experiences to help them make sense of it all (Dewey, 1929). The instructor needs to constantly illustrate the practicality and relevance of the subject to many of these students who can not make the connection on their own (Hannula, 2006).

The use of manipulatives is an excellent way to help an at-risk student grasp concepts which are often abstract, in order to make them concrete (Expert Panel on Student Success in Ontario, 2004). Manipulatives bring a hands-on experience to a subject which often utilizes only paper and pencil as ways to perform its many procedures (Expert Panel on Student Success in Ontario, 2004). However, the instructor needs to carefully link the manipulatives with the concept in order to make them fully

effective (Expert Panel on Student Success in Ontario, 2004). This connection can be a particular challenge for teachers and requires deep conceptual understanding on the part of the teacher (Expert Panel on Student Success in Ontario, 2004).

In the same way as this connection between the concrete and the general must be made, the teacher must also tie concepts in with the lives of students. Since many of these students may have had negative experiences with mathematics, they often do not see its relevance in their lives (Expert Panel on Student Success in Ontario, 2004). The content and associated practice work not only needs to be appealing and mathematically rich, but also must be connected with the student's real world to reach out to an at-risk learner (Expert Panel on Student Success in Ontario, 2004). Using recognizable names and situations in problems as well as having students create their own problems are excellent ways to help make the subject area relevant.

Ontario's curriculum (2005) and mathematics reform in general strive to follow the constructivist approach. This means that students are encouraged to develop critical thinking skills in an environment which fosters the development of knowledge primarily coming from the students (Ward, 2001). In addition, the teacher should value classroom communication as well as having a desire to understand the thought processes of the students in order to help guide them through discovery learning. According to Ward, the goal behind a constructivist approach is to have students generate their own solutions in order to foster deep understanding, to best retain new knowledge. Thus, the teacher plays a pivotal role in students' learning by supporting learning via problem solving, although ultimately the students should be responsible for their own construction of knowledge.

Challenging the Students

Many at-risk students could be threatened by the challenges and difficulties associated with problem solving in mathematics that Ontario's new curriculum often presents (Sullivan et al., 2006). These students may be satisfied and feel successful when they are given initial problems which can easily be resolved (Sullivan et al., 2006). One of the main misconceptions by teachers is that at-risk students require more time with basic fundamental skills (Woodward & Brown, 2006) before trying any problem solving. The result of slowing down a students' learning may further jeopardize an at-risk student and will even place a successful student at-risk (Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6, 2005). Specifically, at-risk students may find learning only basic fundamental skills to be boring and this will add to the negativity associated with the subject matter (Expert Panel on Student Success in Ontario, 2004). As well, students are more likely to practice incorrect methods with this type of rote learning especially if they are working individually (Woodward & Brown, 2006). Thus, more practice and volume alone does not necessitate success in mathematics. This principle may be contrary to the beliefs of some classroom teachers, as will be discussed further in this study.

Another reason students may be at-risk is that their learning capabilities have not been developed properly as a result of not being challenged (McFeetors & Mason, 2005). Instead, all students should face the stress associated with difficult tasks and do need the opportunity to solve rich and complex problems (Expert Panel on Student Success in Ontario, 2004; NCTM, 2000; Van de Walle & Folk, 2005). In fact, a student who is labeled at-risk needs an even more stimulating program than an average learner (Expert

Panel on Student Success in Ontario, 2004). Indeed, challenge will place the student in a stressful situation but the student is placed at an even greater risk if he or she is not being stimulated. A *Standards*-based math curriculum can be quite demanding as Woodward and Brown (2006) report. Middleton (2006) suggests that the situations in which students have to struggle can help them find methods to persevere (as cited in Woodward & Brown, 2006, p.158). Sutherland (2005) concludes that challenging students helps them learn how to develop intrinsic motivation and obtain mastery oriented goals. Therefore students at-risk need a balance in succeeding as well as struggling (Hannula, 2006). Such needs provide many challenges for the teacher.

Knowledge of the Teacher

The mathematical knowledge of the teacher has a considerable impact on the students (Ambrose, 2004; Ball, 2005). Specifically, those who teach the intermediate level need to have a very strong conceptual background (Expert Panel on Student Success in Ontario, 2004). This knowledge needs to go further than what was obtained in a particular teacher's high school education (Kajander & Zerpa, 2006; Ma, 1999). The success of the student depends on the strength of the teacher's background as well as how prepared the teacher is for daily lessons (Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6, 2005). Additionally, at-risk students show the most development when their teaching and learning deepen both procedural knowledge and conceptual understanding (Balfanz et al., 2006). Balfanz et al. (2006) feel that an instructor whose mathematical education goes beyond high school (e.g. math degree or math specialist) and whose teaching addresses

both technical and abstract concepts will have the greatest impact on the student who is at-risk.

Although it has been argued that it is important to have strong conceptual knowledge, Hill, Rowan and Ball (2005) claim that teachers' credentials and years of experience are in fact insignificant. Despite limitations to their study which may have affected their results, the authors found that possessing a mathematical knowledge for teaching was a factor strongly related to student success (Hill, et al., 2005). To say that a teacher has mathematical knowledge for teaching means that the teacher is able to explain concepts, interpret student solutions as well as explain algorithms and proofs to their students. In terms of social economic status, the teachers of higher poverty students have been found to have less such mathematical knowledge than other teachers (Ball et al., 2005). Perhaps this may be one of the reasons why these students are in an at-risk situation. Research has argued that having knowledgeable math teachers may even be a social justice issue, as it is in the best interest of the students in the classroom (Ball et al., 2005). In conclusion, the deep mathematical knowledge of the teacher plays an important role in the success and development of a student.

Attitude of the Teacher

The attitude of a math teacher is as important as his or her mathematical background knowledge (Sullivan & et al., 2006). It is crucial for the teacher to be positive and energetic when giving instructions and assistance (Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6, 2005). However, while it is important for the teacher to remain positive, Sullivan states that it is also important that the teacher does not over-praise student effort.

This over-praise jeopardizes an at-risk student and may even be hazardous to a student who is not at-risk. This type of exaggerated recognition tends to direct student goals to become performance-oriented and impacted only by external forces such as the teacher or even parents. Sullivan reports that it is equally dangerous to filter out all criticism to protect a student's confidence or ego. When all criticism is avoided and achievement is constantly exaggerated, the success of that student may also be compromised. The student is ultimately placed at-risk for the times when he or she does not experience this type of praise or filtering of criticism that may be construed as negative. Therefore, it is ideal that a teacher remains optimistic and criticizes in a constructive but not personal manner wherever possible for the benefit of an at-risk student. A recently proposed model for effective feedback to students includes identifying what was done well, stating in non-evaluative terms what needs improvement, and then concretely stating how the student might achieve this (Chappuis & Stiggins, 2002). It is also important that the feedback be timely; delayed feedback can be detrimental to self-confidence without supporting improved learning. Grading student work without positive feedback as to how to improve has in fact shown to do more harm than good (Chappuis & Stiggins, 2002). This feedback is more commonly referred to as formative assessment, should be ongoing and is also known as "assessment for learning" (Black & William, 1998; Chappuis & Stiggins, 2002).

Classroom teachers' attitudes are certainly important, and they also have a role in motivating students (Geary, 2000). Teachers need to provide their students with positive experiences in the subject of mathematics that will make them curious about the subject matter and want to learn more about it. Geary states that it should not be assumed that

students will just logically find subject areas in which they are interested. Thus, in their selection of lesson delivery and instructional methods, teachers can have a significant impact on the interest students will have in mathematics. According to Geary (2000), students may require the teacher to assist in motivation when the material does become challenging. Thus, the teacher's positive attitude toward the subject can be helpful in motivating students but a balance of praise and constructive criticism may best support student improvement.

Accommodating the Student At-Risk

To further probe how the curriculum and the teacher might impact a student at-risk, accommodations within a classroom setting must also be considered. While it is not necessary to provide every assignment in a simpler form for an at-risk student, some extra time may be required to finish assignments and examinations (Expert Panel on Student Success in Ontario, 2004). As well, at-risk students in particular may not be responsive to deadlines and as a result of strict time lines, an assignment may never be submitted.

A learner who has been classified as at-risk for mathematical development may be in this situation due to poor attendance (Kajander, 2002). Consequently the teacher should be prepared to be accommodating to these factors when considering the student at-risk in mathematics. Beekhoven & Dekkers (2005) explain a "Participation-Identification Model" designed by Finn (1990) for which participation both inside the classroom and through extracurricular activities impacts success in the classroom and ultimately leads to a sense of belonging. When a student is absent, they cannot be

engaging within the classroom environment, thus affecting their ability to succeed and ultimately see the benefit of being at school (Beekhoven & Dekkers, 2005).

Consequently, Natriello (1997) claims that as a result of poor attendance, a student's life may be impacted by job instability as well as future difficulty with life in general (as cited in Beekhoven & Dekkers, 2005). Some characteristics that may impact poor attendance include: individual personalities, family situations involving conflict, lack of or inconsistent parental discipline, difficulty socializing, and school related factors (Beekhoven & Dekkers, 2005; Corville-Smith, Ryan, Adams, & Dalicandro, 1998). Specifically, single parents and parents with a low socio-economic status often lack the education needed to help lead their children to succeed in the school setting (Beekhoven & Dekkers, 2005). In other words, poor attendance affects mathematical learning, and the cause for attendance issue may result from family issues which may be beyond the control of an intermediate student.

Some solutions toward rectifying attendance issues include: adhering to policies and their consequences, tackling the issue early in the elementary school years, increasing the levels of classroom engagement and rapport building among students and their parents, and recognizing the needs of different cultures (Railsback, 2004).

In addition to attendance issues, the methods of assessment are also relevant. The earliest works of theorist John Dewey (1929) support the notion that assessment should be used as a method to help students and teachers acknowledge weakness and to overall assist students in determining where they fall within society. More recent notions of assessment would include support of student learning (NCTM, 2000), not just for purposes of evaluation and reporting. Oral assessments are a great alternative to written

assessments when applicable (Expert Panel on Student Success in Ontario, 2004).

Alternatively, teachers may wish to consider using a performance assessment in place of a test as Kajander's (2002) study suggests, because these may have an overall positive effect on student attitudes and success. The Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6 (2005), recommend providing students at-risk with a variety of assessment styles and being flexible with due dates are ways to decrease pressure and anxiety and to promote a greater focus on the concepts which the teacher wishes the student to grasp.

Struggling students potentially benefit from additional contact from either a teacher, educational assistant or a peer helper (Sullivan et al., 2006). Extra assistance may also be necessary with terms and definitions, as mathematics has a language of its own (Expert Panel on Student Success in Ontario, 2004). It is recommended that students work with and learn from others and that that a teacher or assistant is present to guide students toward the knowledge they should receive from a task (Woodward & Brown, 2006). In general, at-risk students need instructional accommodations which will be as specific and unique as each student is different, in terms of their needs. The NCTM's Equity principle states that students should have many different experiences so they will have as much opportunity as possible to succeed in one area or another (NCTM, 2000). This is one of the most important principles laid out by the NCTM as it connects strongly with the vision that all students have the ability to succeed in mathematics and their success will be a result of the experiences students are presented with.

The Needs of the Teacher

The knowledge of the teacher, teaching methodology and teacher attitude are all very important aspects which are critical to meeting the needs of mathematics students, particularly those at-risk. However, teachers have needs as well and these needs deserve mention (Askey, 1999). Askey proposes that professional development is one way to help those teachers expand their mathematical knowledge and modify their teaching methodology if necessary. The professional development should be a meaningful experience for the teachers who should be able to apply the new knowledge they have obtained directly in their classrooms. As well, they need time allotted for this development as well as sufficient time to prepare meaningful lessons. Askey (1999) also recommends that this development should begin in pre-service education courses which may not be adequately preparing teachers. Therefore, teachers should be trying their best to fulfill the needs of their students, particularly those who are at-risk, but should also have their own needs met in order to better equip them to do so (Askey, 1999). The emotional draw on a teacher faced with many at-risk students is not well addressed in the literature.

General Characteristics of Students At-Risk

The following sections are intended to connect the literature with the second research question regarding the observable behaviors of students at-risk in mathematics as they interact in their classroom environment. Related topics from the literature include but are not limited to: success related to the at-risk learner's motivation and needs, self-views and belief in one's own ability, the overall culture of the classroom, as well as cultural and family-related issues which impact mathematics.

Success of the At-Risk Learner Linked to Motivation and Needs

While the exact needs of students at-risk are not clearly defined (McFeetors & Mason, 2005), the success of students at-risk can be linked to their motivation as well as their needs. Motivation has the potential to direct students' behaviour and thus it is beneficial for the teacher to understand students' motives if teachers are to fully understand the behaviour which students are expressing (Hannula, 2006). Motivation stems from the emotion control mechanisms, both influencing and directing the decisions that a student will make (Sullivan, Tobias, & McDonough, 2006). Many students at-risk appear unmotivated and do not have the drive to persist. This can be observed in their often lacking levels of participation. Consequently, as a result of a lack of motivation, the choices a student at-risk makes or chooses not to make are directed towards the student's needs (Sullivan et al., 2006).

The needs of a student can be explored to help understand what exactly is causing the behaviour of some students (Hannula, 2006). It is a common understanding that basic needs such as food and shelter are to be met before learning can take place. This in itself can be a challenge depending on the students' background and upbringing. Most students have the need for an identity, independence and social acceptance (Sullivan et al., 2006). Sullivan et al. (2006) suggested that schools have the potential to meet the needs of students but must do so carefully. They also acknowledged that students may choose to oppose the effort and assistance that educators and schools provide to fulfill their needs. For example, if the teaching methodology is one in which much routine and rote learning takes place, the need for independence cannot be met (Hannula, 2006). Likewise, in classrooms which do not foster communication and group activities, students cannot

fulfill a need for socialization or develop a sense of acceptance. A student must fulfill a need as a means to achieve a goal and thus, needs must be taken into consideration especially in the case of a student who is already in an at-risk situation (Sullivan et al., 2006). To be further discussed is the fact that such research may indicate that traditional, teacher directed mathematics classrooms may be particularly inappropriate for at-risk students.

A student's attitude towards mathematics relates to achievement in the same way that confidence, motivation and needs relate to their success in mathematics (Expert Panel on Student Success in Ontario, 2004). Many students who are unsuccessful in mathematics are aware that their success is dependent upon the amount of effort they put into the subject (Sullivan et al., 2006). The harsh reality of many students at-risk is that they are making an effort to achieve success but are hindered by a number of factors including personal experiences which require a great deal of resiliency to overcome.

The success of mathematics students can also be related to how much control they have over their own learning and the mathematical identity they are able to formulate (Sullivan et al., 2006). This is important since the attitudes of mathematics students are influential in determining whether or not they will succeed, and this is especially true for those who have been placed at-risk.

Another very important aspect related to motivation is the concept of the 'reluctant student' (Daniels & Arapostathis, 2005). Some students may feel as though school does not meet their needs as Hannula (2006) suggests. The behaviour expressed as a result of this perception is often the refusal to participate in the learning that the curriculum offers (Daniels & Arapostathis, 2005). As Marks (2000) shows, many of these

students figure out very early on in their schooling that they are uninterested, and decide to reject what they are being taught (as cited in Daniels & Arapostathis, 2005). The most frustrating part about students who are unwilling to participate in learning mathematics is that they often in fact have the ability to be successful students. The gaps between what schools are offering and what interests' students are far too large and thus many students become disconnected from learning. For the intermediate student in particular, Csikszentmihalyi (1990) proposes that elementary schools may have offered students a more social and relevant environment that they do not typically find in an academic achievement based intermediate secondary setting (Daniels & Arapostathis, 2005). These authors suggest a relevant curriculum with less focus on extrinsic rewards. They note that when students' needs are being met and they are happy to participate because they are engaged, the learning of mathematics can take place.

In summary, when students' needs are being met, the students will be more motivated, which will better enable goal attainment (Daniels & Arapostathis, 2005; Hannula, 2006; Sullivan et al., 2006). Consequently, behavior and negative attitudes should improve and better mathematics learning will be possible.

Effects of Self Confidence, Self Esteem and Belief in Ability

Confidence and self esteem are major factors which contribute to the success of a student who is at-risk, and being at-risk may in turn further decrease a student's self-image. When students are successful in mathematics, they have often gained conceptual knowledge and receive acknowledgement from their classmates and teachers (Butterworth, 1999). The author's position is that confidence will naturally increase and result from the positive cycle the student can be found in, which includes internal and

external encouragement as well as an overall enjoyment of mathematics (Butterworth, 1999). On the other hand, students at-risk often lack belief in their abilities to succeed in math and their opinions of themselves are often less than positive (Expert Panel on Student Success in Ontario, 2004). This low opinion may be reinforced by continued poor performance so the perception becomes self-sustaining. Low confidence and self esteem can hold students back from achieving in mathematics and further inhibit the learning of those students who are already in a high risk situation. Students who are placed at-risk for developing mathematically have most likely been subjected to negative schooling experiences, and such experiences are likely to affect their present and future learning of mathematics (McFeetors & Mason, 2005). As Marchesi (1998) has found, the negative experience has the potential to begin a cycle which is difficult to break. Teachers may direct less attention towards students who do not have an interest in the subject and give up on them. Students may also wrongfully interpret positive affirmation coming from a teacher because of poor treatment in the past (Expert Panel on Student Success in Ontario, 2004). Many of these at-risk students will find themselves in a dangerous cycle which makes success in mathematics an even greater challenge (Expert Panel on Student Success in Ontario, 2004). Hence, student confidence and self esteem appear to significantly contribute to potential lack of success in mathematics.

Emotions and student behavior associated with mathematics may also be the product or outcome of underlying values and beliefs (Phillips, 2005). Students who have difficulty approaching mathematical problems and who are easily frustrated and have a lack of motivation may tell a researcher that the problem is rooted in their beliefs. Mtetwa and Garofalo (1989) have found that students' beliefs about math may include the ideas

that it takes memory work to be successful, algorithms can always be applied to problems, there is only one right answer, and that those who are good at mathematics are far superior people (as cited in Mercer, Jordan, Millar, 1994). It is also possible that these beliefs may be reinforced via influential people in a student's life (e.g. parents, friends) and that these beliefs can become difficult to reverse (Phillips, 2005).

Classroom Culture

In addition to the importance of students' belief in their own mathematical ability, is the impact of the social setting of the classroom and interactions within this setting. A learner who is at-risk is in an even greater danger when placed in a social setting where classmates may become a distraction. There is a distinct connection between social interaction, cognitive development and the construction of knowledge (Wood, Williams, & McNeal, 2006). The authors believe that communicating and learning with others often helps students to surpass the learning and discoveries they can make as individuals. To achieve effective learning in this group environment, students need to have some common ground to refer to and must be able to relate to one another socially. This implies that the teacher should allow some time in the beginning of the school year for these types of social connections to be made, for example, through group activities and games. Acceptable ways of interaction and effective means to support or refute mathematical arguments must be developed and supported. Ensuring that all students are given the opportunity to answer questions and participate in class requires the teacher to give adequate response time before selecting a student who has raised their hand (Costa, 2008). Dr. Mary Budd first referred to this as "wait time", and it is recommended that teachers take at least three seconds before choosing a student to respond to a proposed

question or discussion (Costa, 2008). Students will have more time to breathe, which increases the flow of oxygen to the brain which ultimately leads to better decision-making and thinking. Consequently, confidence levels will likely rise, students will be less likely to hesitate to clarify concepts which ultimately will lead to success (Costa 2008).

In reform-based classroom environments, students are typically required to support their answers with an oral presentation defending the strategy they chose, which underscores the importance of being able to effectively interact in a social setting (Wood et al., 2006). Ignoring the development of such “social math norms” may seriously impact the success of a reform-based program. The development of such skills may take several months. Students are not able to switch back and forth between a student centered and teacher centered classroom; the transition to a student centered learning environment must be gradual and consistent (Huhn, Huhn & Lamb, 2006).

While the classroom environment should be a place where students ask questions, defend positions and generate mathematical discussions as recommended as best practices, these suggestions may not always be culturally sensitive (NCTM, 2000, Ontario Ministry of Education, 2007, Kajander 2003). The interaction and social engagement in the mathematics classroom can very much be argued to be culturally biased (Kajander, 2003). Such practices may cause Aboriginal students (or those who are from the non-dominant culture) to compromise their belief system. For example, if students have been encouraged to be calm, peaceful and not make ‘waves’ of any sort, participating in challenging discussions may feel uncomfortable (Kajander, 2003). Thus,

there may be some conflict between what is being described as best practices for all, and what might be more comfortable for Aboriginal students (Kajander, 2003).

Another problem faced by students is an environment which favours poor behaviour and the opposition to learning (Sullivan et al., 2006). In other words, peer pressure might support the resistance to success. Many students feel as though they should conform to a particular classroom setting to be socially accepted. Sullivan suggests that a negative environment which favours a lack of participation places those students who are at-risk at an even greater danger. It also challenges those students who are successful math students and have yet to develop a strong individualized sense of self. An environment which favours purposefully avoiding effort has also been termed as one which is “self-handicapping” (Dorman & Ferguson, 2004). Urdan, Midgley, & Anderman (1998) define self-handicapping as “a more esoteric psychological construct: proactive, avoidant behavior which is designed to manipulate other people’s perceptions of performance outcomes so that the student appears worthy to other people in the school” (as cited in Dorman & Ferguson, 2004, p.70). Urdan et al. (1998) also conclude that students with a low self esteem will utilize this technique but it is recognized in students with high self esteem as well (as cited in Dorman & Ferguson, 2004). The effect of a negative classroom culture places students in at-risk situations for learning mathematics and further jeopardizes those who are already labeled as such.

Cultural and Family Related Factors Affecting Mathematical Development

Culture as well as related family environment may have an impact on successful mathematical development and achievement (Hao & Bonstead-Bruns, 1998) just as the classroom environment does. Hao and Bonstead-Burns (1998) found that immigrant

Chinese parents in particular have high educational expectations for their children and frequently interact scholastically with them. Their study concludes that those students who can effectively communicate with their parents and have strong within-family as well as between family-and-social- institution capital will likely achieve within mathematics.

To contrast this, Amato and Keith (1991) report that factors such as divorce which are evidently higher in the American culture negatively affect academics (as cited in Geary, 1994). As well, Eccles et al (1993) have shown that American children as a whole value sport more than academics and this is due to cultural influences and the family environment (as cited in Geary, 1994). To summarize, parents and family who are supportive likely play a key role in the success of a student (Butterworth, 1999).

Language itself is a means through which culture may also influence mathematical development. Fuson and Kwon (1992b) describe that the Asian language supports the concept of the base 10 system whereas European language does not (as cited in Geary, 1994). Butterworth also discusses this idea, highlighting the fact that because the English language does not support the base-10 system and Chinese does, English children must use other strategies that would otherwise come naturally for Chinese children (Butterworth, 1999).

Overall, the family reflects cultural values and can be a determinant of a student's success in mathematics (Geary, 1994). It is important to recognize that there are factors which may inhibit mathematical success that can be traced back to culture and family life (Geary, 1994).

Culture is a very important aspect to examine regarding students at-risk, particularly any culture that differs from the dominant culture (McLaren, 2003). Hegemony refers to “the struggle in which the powerful win the consent of those who are oppressed, with the oppressed unknowingly participating in their own oppression” (McLaren, 2003, p.203). The process of hegemony often represses the non-dominant culture through ethics, politics and the economy (McLaren, 2003). Within the classroom setting, the practices of the teacher and the school community in general often reflect those of the dominant culture (Sleeter & McLaren, 1995). Students may feel that they need to give up their belief systems and conform to the dominant culture if they are to achieve within a school setting and ultimately society (McLaren, 2003). Whether intentional or not, sociologist Pierre Bourdieu views the educational system as one in which the values and beliefs of the dominant culture do not allow for minority group’s belief systems to exist (Brimi, 2005).

In the concept of McLaren’s (2003) hegemony, the moral and intellectual leadership of the dominant culture (i.e. teachers) over minority groups exercised through the school, the church, the media and political system actively restructures the culture and experiences of minority groups. Aboriginal students in particular are faced with a curriculum to which they have may difficulty relating (Agbo, 2005). They may have inherently different values and knowledge based upon tradition, which Ontario’s curriculum in particular is not addressing (Agbo, 2005). For example, Agbo states that their knowledge comes from the experiences of their people and is expressed orally and through art. Generally, the mathematics classroom does not incorporate such opportunities into its daily lessons. It is important that educators are aware of the

differences in culture and how they could perhaps be oppressing students by imposing a dominant culture whether they realize it or not (McLaren, 2003).

Educators need to be aware of the difference between high and low-context cultures in order to be able to communicate with all students (Lynch & Hanson, 1997). A low-context culture refers to that in which Anglo European Americans and Canadians are primarily classified. This culture differs from high-context cultures which rely less on verbal communication. Native Americans, African Americans, Asians and other cultures labeled high-context, may obtain knowledge from experiences both past and present and tend to focus less on interaction and eye contact. They rely on understanding through shared experience, history and implicit messages (Lynch and Hanson, 1997). These traits are very different, for example, from the precise, direct, logical verbal communication which low-context cultures often emit. The members of low context cultures may not process gestures, environmental clues and unarticulated moods that are central to effective communication in high context cultures (Lynch and Hanson, 1997). Therefore, as Lynch and Hanson (1997) describe, there are many inherent differences between the two classifications of cultures. The implication for the learning of mathematics is that if teachers from low-context cultures are unaware of the particular needs of high-context students, they may not be able to reach their students in the best possible way. This means that learning will not take place to its fullest potential because high-context students may become disengaged, uninterested or offended by the low-context teacher.

Aboriginal students in particular have the highest high school drop out rate and many do not attend University (Hull (1987, 2000) as cited in Sutherland, 2005). In addition, Sutherland describes that Aboriginal people are vastly underrepresented in

careers which are linked to science and mathematics. Their culture has survived because of a great deal of resilience dating back to residential schools. It was in the residential school where, although Aboriginal people were faced with losing their culture, they managed to rise above the injustice (Miller, 1996). Some students manage to succeed in our Western society's educational system and many are still very resistant. External factors such as poor family support and belief in education also may contribute to Aboriginal students being at-risk for failure (Sutherland, 2005). Nonetheless, this is one very prominent example of a non-Western culture which struggles with education within a Western European society and educational system.

There is a calling for a partnership between community members as well as members of the educational system in order to provide an inclusive educational experience for minority at-risk students (Agbo, 2002; Wang 1996). Without such a partnership, students who feel a threat towards their culture and way of knowing in the world may continue to reject schooling as is often the case (McLaren, 1995). Many aspects of a different culture should be considered, including language as well as cultural practices (Agbo, 2002). Agbo (2002) recommends that teachers develop cultural competence which means becoming familiar with the different cultural perspectives and integrating them into the curriculum so that students have equal opportunities to learn. This will come from learning about students' culture, educating oneself about other cultures and taking part in developing ways to have positive interactions with students (Lynch & Hanson, 1997).

Thus, there are implications regarding culture and the minority at-risk student. The teaching methods and culture within a school may be entirely oppositional and even

somewhat oppressive to a student who does not belong to the dominant culture (Agbo, 2002). Therefore, the notion of culture should be carefully considered when students become withdrawn from school and specifically the learning of mathematics. Such withdrawal could be a mechanism to hold onto ones own values and beliefs (Sleeter & McLaren, 1995). Perhaps even more alarming is that it could also be a means to refuse learning because the material simply has no relevance within that particular student's way of life (Agbo, 2002).

Mathematics and Personal Characteristics

The next seven sections aim to connect the literature with the third and final research question regarding the mathematics and personal-related learning characteristics of the case study students. Ideas from the literature include: the developmental process of learning mathematics, the role of representation, students' developmental needs, arithmetic development, problem solving, mathematical disabilities and special characteristics of at-risk learners.

The Developmental Process of Learning Mathematics

Brian Butterworth is a Professor of cognitive neuropsychology and provides insight into the developmental process of learning mathematics (Butterworth, 1999). His perspective and the basis for one of his books is that everyone has circuits in the brain which allow for some type of mathematical understanding to occur (Butterworth, 1999). He terms this the "Number Module" and believes that all other abilities and the progressions one makes with numeracy originate from it. He states that ability in mathematics is dependant upon our "innate core" as well as the knowledge acquired and available through culture. Thus, the development of our mathematical skill and

knowledge, according to Butterworth, depends on whether or not it is passed on or taught by someone who has a thorough grasp of the subject matter.

The process of learning mathematics is often referred to as two-fold. The first aspect is the informal process of learning and constructing mathematical knowledge which comes from the “quantitative environment” in which a child grows up (Ginsburg, 1997). The informal construction of knowledge begins before the child enters school and continues throughout life. Ginsburg (1997) reports that the process of learning for a child is generally based on intrinsic motivation and curiosity. He states that cross culturally, this holds true for any class or race. Thus, children generally enter school with an initial mathematical foundation and a keen interest to learn it.

However, formal mathematics, composed of defined material, often contrasts with the concept of informal mathematics. There are many factors which contribute to the negativity associated with formal mathematics and the way it possibly inhibits learning and places students at-risk. For one, the school environment may not be conducive to learning. Within the school environment, the following contributing factors might include: a lack of proper supplies for students, teachers who are giving poorly structured lessons, poor textbooks and/or a general environment which portrays negative attitudes and beliefs toward the subject matter (Ginsburg, 1997). Ginsburg (1997) concludes that the informal knowledge of the child may not be utilized to its greatest potential in the formal learning of mathematics.

Students need to be able to use their informal knowledge as the basis for the formal knowledge they are presented with (Ginsburg, 1997). When mathematical concepts are forced upon students and they are not able to construct and make meaning

out of new knowledge, Ginsburg believes the outcome is often a negative attitude towards mathematics. In addition, he claims that a lack of motivation may also be the result which is typically accompanied by poor grades or failure.

The Role of Representation in Mathematics

It is important to understand how external representations affect students' learning of mathematics by examining how they are interpreted internally. Even very young children are capable of developing systems of representations and these should be fostered even at a young age. External systems of representation are the formal aspects of mathematics such as number symbols, the base ten system and algebraic notation. The internal system of representation is the personal meaning that students associate with external system. Such internal systems need to be developed and when they are not, students often experience difficulty in mathematics. Goldin (1987, 1998) identified some of the internal cognitive representations which have been briefly defined (as cited in Goldin & Shteingold, 2001). The *verbal/syntactic systems* involve language and vocabulary. The *imagistic systems* are the visual and spatial images. *Formal notational* representations are how students visualize problem solving steps or manipulate numbers mentally. Finally, *strategic and heuristic* representations include developing and organizing strategies. It should also be mentioned that students do not realize they are utilizing these systems and may not be able to articulate they have done so if asked (Goldin & Shteingold, 2001). The recommendation from the authors is that teachers are knowledgeable regarding the external and internal systems and understand that beliefs and attitudes toward mathematics also play a role. Such deep knowledge would be a

challenge for teachers to absorb during, for example, a one-year teacher education program.

The process of understanding and learning about internal representations is very complex (Goldin & Shteingold, 2001). It is the responsibility of an educator to help students develop their systems of internal representation and this can be accomplished through their teaching methodology and understanding of representation. Teachers are to interpret the internal representations by their students the best they can, based on the external representations the student provides (e.g. drawings, explanations). It is through a students' conceptual knowledge and their own construction of knowledge that students will be able to take an external task, develop strong internal representations and be able to outwardly express their understanding. In order for students to be successful, Goldin and Shteingold suggest that teachers should be making an effort to support students' development of internal systems of representation by subjecting students to appropriate external representations. Recent developments in the understanding of mathematical learning support encouraging student-generated algorithms, and the encouragement of multiple solution methods, as ways to support such effective and developmentally-based learning (Van de Walle & Folk, 2005).

Developmental Needs of the Intermediate Student

The intermediate student in particular, is experiencing changing developmental and cognitive needs along with concerns about social acceptance and independence, among other things (Fleener, Westbrook, & Rogers, 1995). Such changes add pressure to learning situations. Students will benefit the most from hands on, active learning where they are free to explore and manipulate objects while problem solving (Fleener et al.;

1995; Van de Walle & Folk, 2005). As socialization has become very important to students, Fleener states that they need to learn in a social environment, communicating with other students about mathematics to proliferate their own learning. The intermediate student who is experiencing change should be learning mathematics in such a way that satisfies his/her social needs as well, and such needs can be met better in small group environments typical of the reform based approach.

Arithmetic Development

The most innate area of mathematics to be developed is arithmetic (Geary, 1994). In fact, Vandenberg (1966) reports that differences among one child to the next in terms of arithmetic ability can be related to genetic inheritance half of the time (as cited in Geary, 1994). Parent-child interactions at a young age with mathematics related material may also be beneficial to development. Arithmetic development is crucial and it, along with counting procedures, lays the foundation specifically for addition problem solving strategies (Geary, 1994). It should also be noted that when only drill and practice is concentrated on, this becomes problematic (Woodward & Brown, 2006). Nonetheless, arithmetic skills are important, and as Geary states, should not be discounted as a critical area in the developmental process of learning mathematics.

Problem Solving

Problem solving is fundamental to mathematics yet is an area which is often incorrectly overlooked until basic skills are mastered (Woodward & Brown, 2006). Leron and Hazzan (2006) have critically analyzed how cognitive psychology can be helpful to support the understanding of mathematics problems. One 'system' is very intuitive in nature and is described as "fast, automatic, effortless, unconscious and inflexible" and it

is this system that is responsible for either giving quick responses to problems or estimations (Leron & Hazzan, 2006, p.108). The other 'system' is analytical and within this system the person who is problem solving is cautious to analyze thought processes (Leron & Hazzan, 2006). The argument posed is that the systems are reliant upon one another and that teaching has always tried to develop the meta-cognitive system. The authors suggest that it is important to teach students that the two systems interact and that this interaction can be a very useful problem solving strategy on its own. This also has implications for understanding some of the reasons why students answer questions incorrectly. If the intuitive system is wrong on a particular occasion, and has taken over the analytical system, the incorrect answer generated may be due to a cognitive error (Leron & Hazzan, 2006). As well, there are times when both systems can be faulty and their interactions may produce an incorrect answer. Therefore, teachers should also take into account possible cognitive issues when determining why students may not have the ability to give them the correct answer. A simple example of this phenomenon might be a student with highly procedural knowledge without conceptual understanding who is unable to identify "obvious" calculation errors. Conceptual understanding often provides a means to check the apparent correctness of an answer that was generated quickly with a procedure.

Mathematical Disabilities

There are many outcomes which are the result of mathematical disabilities (Geary, 1994). Much of the research related to such disabilities is based on arithmetic and also includes a small amount pertaining to problem solving (Geary, 1994). Cognition, neuropsychology as well as reading disabilities are all components that may contribute to

mathematical disabilities. The idea that problem solving difficulties can be linked to both reading disabilities and mathematical disabilities implies that math and reading disabilities may coexist (Robinson, Menchetti, & Torgesen, 2002). There also exists a “two factor theory” which hypothesizes that students may have mathematical disabilities because they have reading difficulty, or “weak phonological processing” due to irregularity in the left hemisphere of the brain (Robinson, Menchetti, & Torgesen, 2002, Geary, 1994). The other of the two theories states that a weakly developed number sense might be the contributor to mathematical disability whereby students have difficulty grasping basic ideas about numbers and their significance (Robinson, Menchetti, & Torgesen, 2002). Thus, it is important to consider reading disabilities along with mathematical disabilities but also to realize that they may not always be linked. Also, to consider that mathematical disabilities stem from early ages where students do not mature as others may and employ certain techniques which postpone their mathematical growth and development (Geary, 1994).

Butterworth (1999) recognizes that there is an exception to the instinctive Number Module he believes everyone has, and that some children may have an irregular brain development which would have a negative effect on it. The result may be what has been technically termed Developmental Dyscalculia. Geary recognizes that this type of disability holds students back from using the strategies and skills they should normally use at a particular age group (as cited in Butterworth, 1999, p.271).

It is important that many steps be taken to identify a mathematical disability. Tests should be included so that math anxiety, teaching effectiveness and study habits can be ruled out as the major contributing factors to the difficulty (Strawser, 1997). As well,

medical history, social and academic information are also critical when determining mathematical disabilities. Therefore the recommendation by Strawser (1997) is that all aspects which may affect students' mathematical abilities need to be explored. These variables may range from neuropsychological damage to attitude toward the subject. Strawser also explains that many schools do not include neuropsychological testing as part of their assessment for a disability. Difficulty in mathematics can be a result of a deeper neuropsychological problem which needs to be examined to properly diagnose a student and ultimately give them the assistance they require (Strawser, 1997). It should be noted that this literature survey does not attempt to explore the topic of mathematical disabilities to an extensive degree.

Special Needs and Characteristics of At-risk Learners: Strategies for Improvement

While some teachers may feel that rote learning of procedures is crucial for students at-risk, there are many other strategies which can be employed by the teacher in order to help improve numerical skill development (Van de Walle & Folk, 2005). The teacher should constantly ask guiding questions, provide suggestions and encourage the students to give a response in order to help improve procedural as well as conceptual knowledge. Also, as at-risk learners may have difficulty with the vocabulary associated with mathematics, teaching to small groups as well as providing students with definitions (rather than asking them to memorize them) would be to their benefit (Augustyniak et al., 2005). According to Augustyniak et al., those students who have a mathematics disability (as well as other students) would benefit from instruction in non-traditional ways such as games both within the home and school setting.

Numerical skills development is only one type of difficulty which may be faced by a student who is at-risk for learning mathematics (Augustyniak et al., 2005). Visual and spatial deficits generally affect the alignment of numbers as well as work with decimals. These students also may have difficulty distinguishing similar letters, recording figures and interpreting graphs and charts (Augustyniak et al., 2005). The use of grid paper is recommended as well as creating worksheets for students so they do not make mistakes in rewriting out questions. Visual aids and manipulatives are both alternatives and complements to paper and pencil work, as reported by Augustyniak et al., and again these methods support good mathematical learning for all students, not just some.

Related to numerical, visual as well as spatial difficulties is cognitive skill development (Augustyniak et al., 2005). Augustyniak et al. (2005) states that such a deficit would be apparent in recollection and memory, the speed in which information is processed, attention span as well as the planning associated with problem solving. In order for a student to learn effectively he or she must learn to develop cognitive skills which help the student to be organized and allow past information to be connected to current learning (Augustyniak et al., 2005). To improve short term memory, students need help with procedural steps to solve problems. Long term memory can be improved by individual attention during practice. Also, having students look for patterns and themes among problems is a way to assist with long term memory storage and recollection. However, those students who have a visual or spatial deficit that is linked to an attention problem may need assistance while practicing, with a focus on a minimal number of questions to complete (Augustyniak et al., 2005).

There are many other techniques to improve the learning of at-risk students, some of which are more specific to certain disorders and difficulties than others (Wheland, Konet, & Butler, 2003). Having students create their own strategies rather than presenting them with one will help develop the procedural as well as conceptual knowledge in areas with which they may struggle (Wheland et al., 2003). At-risk students will need careful scaffolding by the teacher to support increased autonomy. Students need help in gaining mathematical independence overall and need assistance with defining problems, analyzing them and carrying out strategies to solve them. The teacher can also assist by reviewing quickly before a test in order to assist with memory recollection, and giving more time for students to complete tasks and tests. As discussed, other forms of assessment should be used in addition to tests.

As described earlier, many at-risk mathematics students tend to focus on failure or negativity from past experiences (Augustyniak et al., 2005). Students should be encouraged to assemble positive thoughts using any recent successes as the basis. Small mixed-ability group settings may help students to achieve the confidence they need and to feel as though they do not always need the teachers' affirmation (Van de Walle & Folk, 2005). The authors believe that the use of homogeneous groups at times can ensure even participation and support self confidence. Groupings of two to four students may help to create a safe social setting which is highly recommended for learning. Students will obtain a sense of independence while working within the group and therefore begin to associate mathematics with positive experiences (Augustyniak et al., 2005).

Summary of Best Practices

Unlike the traditional perception, students at-risk will not profit from rote learning or procedure practice alone (Fleener et al., 1995, Huhn et al., 2006, Van de Walle & Folk, 2005). Instead, their successful learning is dependant upon manipulating concrete objects, exploration and active problem solving (Fleener et al., 1995; NCTM, 2000). Best practices from a number of resources indicate that intermediate students in particular need to be actively involved in their learning, and be provided with many hands-on, relevant and engaging learning experiences to better support the development and retention of knowledge (NCTM, 2000; The Ontario Curriculum, Grades 1-8 Mathematics, 2005; Expert Panel on Student Success in Ontario, 2004). It would be fair to conclude that traditional practices are particularly damaging for students at-risk, while reform-based practices can be particularly beneficial. Hence professional development to support reform-based classroom environments is crucially important for the success of students at-risk.

Summary

The factors and needs related to students at-risk in mathematics require further exploration, as the literature describes. The varying needs of these students have been examined but many combinations of needs are also possible (McFeetors & Mason, 2005). The factors which place a student at-risk at school in general and specifically in mathematics include educational methodologies of teachers and guardians, a student's attitude, motivation and levels of self confidence, as well as his or her cultural background (Hannula, 2006; Woodward & Brown, 2006; McLaren, 2003; Butterworth, 1999). Other contributing factors include issues with disabilities and the developmental

processes associated with learning mathematics (Geary, 1994; Butterworth, 1999).

Teaching practices are particularly important for student success, and the literature is overwhelmingly in favour of a reform-based or *Standards*-based approach for students at-risk in particular.

Factors which affect a student's performance in mathematics do not always exist independently. There are relationships among the factors which make the concept of defining the student at-risk such a challenging task. For example, a student's culture may affect his or her attitude toward a particular teaching style, potentially inhibiting growth within the subject matter. The interrelationship among the factors may be complex in nature, signifying the importance of viewing this topic from as many angles as possible. The result of broadening one's perspective regarding the student at-risk in mathematics by considering the multiple factors which may place them at-risk, is a potentially deeper understanding of the underlying causes of student behavior. A better understanding of student behavior may give insight as to how to help that student become successful in mathematics. The following chapter describes how the qualitative research was designed in order to gather both student and teacher data regarding students at-risk in mathematics.

CHAPTER 3 – METHODOLOGY

Qualitative Study

As the review of literature has revealed, there are multiple factors which may contribute to a student at-risk in mathematics. The specific areas of interest were how the teachers responded to these particular students, what impact the classroom itself might have, as well as the effects of the students' personal experiences. Crotty (1998) suggests that knowledge is socially constructed and that behaviour can be studied by observing interactions among individuals themselves and with their surroundings (as cited in Golafshani, 2003). Thus, qualitative research was drawn upon to help answer some of these questions in the ever changing and dynamic classroom setting.

Initially, a scientific approach was taken, where the literature review was used to guide me to identify and describe what was considered important in terms of students at-risk in the mathematics classroom. The literature review helped me to gain some background knowledge into the key factors to be aware of when in the classroom setting. As the research continued, an emergent design also guided me in the decision making process as to what I would consider to be significant in terms of this study. The research design had to be very flexible as it was taking place in a dynamic environment.

The research can be classified as a collective case study as “multiple cases are described and compared to provide insight into an issue” (Creswell, 2005, p.589). It is a form of ethnographic research whereby different cases from a ‘culture-sharing group’ are described and interpreted based on emergent themes to be able to better describe an issue (Creswell 2005). Specific to this research project, the particular ‘culture-sharing group’ was the intermediate mathematics students. The issue of interest was the factors that affected their ability to succeed in mathematics, thus placing them at-risk for failure.

Research Design

During the 2005-2006 school year, grade seven to 10 teachers at an Ontario school board were invited to participate in voluntary Professional Learning Groups for mathematics, which met for a half-day a month (Kajander & Mason, 2007). During one of these meetings the topic of students at-risk arose, and teachers expressed the desire for a better understanding of the needs of such students. This teacher interest spearheaded the work on a Northern Ontario Education Leaders (NOEL) project for which I was the researcher, with the data collection for the study taking place during the 2006-2007 academic year. Thus, not only did the low EQAO results give merit to taking a deeper look into students at-risk in mathematics, but there was a local desire to obtain more information as well (Education Quality and Accountability Office, 2006; Kajander & Mason, 2007).

The teachers who were voluntarily recruited from the Professional Learning Groups chose students whom they felt were at-risk in mathematics. In turn, those recommended students who returned ethics forms signed by their guardians were selected for the research project (See Appendix A).

In this qualitative study of intermediate students at-risk in mathematics, I worked primarily one on one with at-risk students in grades seven through nine who had been selected by their teachers during their allocated math period and practice time. I did not wish to interrupt the natural daily classroom processes from occurring or deter the students from having access to the learning environment and opportunities their classmates had. All three teachers gave me the freedom to observe their lessons and participate with the students after the lesson was completed. They also allowed me to

remove students from the classroom if I so desired during a lesson to conduct research. During the delivery of the lesson, I observed the teachers and recorded observations in the form of field notes based on teaching methodologies. The aim was to become a regular participant with the students in assisting with assigned practice problems while recording relevant observations and anecdotes.

The participant approach was one in which observational roles moved from non-participant to participant. Marshall and Rossman (2006) list classroom studies as an example where a qualitative researcher may use observation in their approach. The researcher may first enter with a very wide perspective and be able to notice patterns which reoccur. The researcher can give many details or an overall description of the observations. Finally, Marshall and Rossman (2006) suggest that when the researcher acts as a participant, the researcher can engage in some of the same experiences as the subjects.

In each of the classroom settings, the first week or two was helpful to gain insight into classroom routines and to become familiar with the participants and the environment. The research took place for a total of 10 weeks' time and there were two to three visits per week in the grade eight and nine classrooms for a total of approximately 25 visits each. The grade eight visits took place in the morning and the grade nine visits took place after the lunch period. The grade seven class was added halfway through the project as another research project encouraged one more willing teacher to participate. There were 10 visits to the grade seven classroom in total.

Student data was collected from extensive field notes of the classroom visits as well as by obtaining other forms of information. Attendance records were collected, as

well as documents such as classroom notes, practice work, quizzes, tests and any other methods of assessment. In addition, teacher data was collected by observing teaching methodologies, for example, their adherence to guidelines of the revised Ontario curriculum, and particularly the learning process recommendations based on the NCTM *Standards*. Regular conversations with the students and teachers regarding the issues and circumstances they are faced with on day to day basis also became useable data.

I felt that the combination of a participant and non-participant approach taken allowed me to best answer the research questions. I was able to observe teacher-student interactions, concentrating specifically on those students designated by their classroom teachers as at-risk in the mathematics classroom. On each visit, I observed the lesson so that I could see the particular style of each teacher and the methodology they chose most frequently. In working one on one or in small groups with the students at-risk, I was able to build a rapport with them and they shared many personal life stories with me. Having a better understanding of their personal experiences and issues answered a very important research question. Thus, my selected methodology helped to uncover the factors which are affecting intermediate students at-risk in mathematics.

Field notes from each classroom visit were used to provide detailed descriptions of each classroom and teacher. Notes taken after individual conversations with students augmented the more formal classroom observations to provide deeper insight into each student's behaviour. Where appropriate, observations were organized into themes. Other data such as classroom artifacts and attendance records from each study student were used to support the observations. The results are presented as case studies of each particular student. Yin (2003) states that case studies are often used to describe "complex

social phenomena” and to give a broad perspective. In addition, themes emerged among the cases and these were reported on to give an overview of the needs of the intermediate students at-risk and the factors that affect them. These emergent themes which coincide with the research questions were then grouped into three different categories which included: strategies and practices used by the classroom teachers, observable behaviors of students at-risk, and personal and mathematics related learning characteristics. Many of the factors affecting students at-risk in mathematics which were found in the literature were confirmed through the research.

Research Site and Research Participants

In order use the term ‘intermediate’ in the study, it was important that different grade levels within that particular range were used. One grade seven, one grade eight and two grade nine applied classes (for non university mathematics or science-bound students) were used for this study. These choices were based on the willingness of those particular schools and respective teachers’ participation. Schools had been contacted to ensure there was little conflict within scheduled class times, making the research possible. Two different schools were used in order to provide variance among the selected sites. The area in which one school is situated might be classified as middle to low income in terms of economic status. The other location had a variety in terms of the socioeconomic status of the students who attended. In total, there were three teachers involved in the research project and six students.

The selection of students was based upon teacher recommendation of those students who were working at that particular grade level and who teachers felt were at-risk in terms of mathematical achievement. Henceforth in this work, when students are

referred to as at-risk during the course of the research, the designation has been strictly based on teacher identification². Over time, the participants were narrowed down to one student per classroom in order to provide an in-depth picture of each particular case. The exception was the grade eight class where three female students were studied. All three students voluntarily identified themselves as being Aboriginal and I felt that keeping all three students would help me to better explore minority students at-risk in mathematics as discussed in the literature.

Specifically, there was one grade seven teacher named Ms. Adams and the student of interest in her class of 25 was named Brian. Mr. Brown was the grade eight teacher who taught in a classroom of 24 students. The three Aboriginal students of interest in Mr. Brown's class were named Diane, Amber and Jessica. There was also one grade nine teacher named Ms. Chase and one student from each of her applied classes named Susan and Kelly who were involved in the research project. The class that Susan was in had 25 students and Kelly's class had 20 students. It was important that information regarding these teachers and students be presented in a manner which included anecdotes and examples. However, many themes emerged and will be discussed in the latter portion of this thesis. These themes were also drawn from the data from the other students who have participated in the research, but who are not described in detail in the provided cases. All teacher and student names used are pseudonyms. The cases were presented by describing the classroom environment and the teacher, followed by case study student observations for each grade level.

² From this point on in this thesis, the phrase "students at-risk" will be used to imply students that were identified by their classroom teachers as being at-risk.

In terms of purposeful sampling, the students and teachers who were selected helped me to gain insight into the characteristics of intermediate students who were at-risk in mathematics. The objective of the sampling was to explore as many angles as possible which pertained to students at-risk. Therefore, maximal variation sampling was one of the selected strategies (Creswell, 2005). The collection of students was considered to be a convenience sample as the students were available based upon recommendation by their teachers and returned ethical permission forms (Creswell, 2005). In terms of the research specifically, students were chosen primarily based on their risk status in terms of mathematics as identified by their teachers. The subjects were further differentiated based on attendance, work ethic, attitude, and levels of motivation as well as personal experiences which may have affected their learning.

This particular research not only helped describe students who were at-risk in mathematics, but it also potentially will help others to understand this central phenomenon (Creswell, 2005). My intention was also to assist others to identify and learn about intermediate students at-risk in mathematics and potentially provide recommendations pertaining to the issues.

Ethical Considerations

Ethical permission was obtained through Lakehead University (See Appendix C). Teachers, as well as the parents/guardians of students signed forms which insured them they were volunteering and could withdraw at anytime and also let them know that all information given would be strictly confidential. The students were especially reminded that any information would remain confidential. The students were not given the opportunity to review what was being written about them during the research but were

aware that they could access a web summary of the project upon the completion of the research, upon request. The students were aware that they were invited to participate because of their difficulties in mathematics as determined by their teachers, which was explained during the first research meeting in each classroom. There was no form of deception used during the course of the research. The students were informed that being a participant in the research would also provide them with some extra tutoring by the researcher. Once the students were able to develop trust in the research project, and build a rapport with the researcher, they opened up and this is apparent in the descriptive nature of the personal stories they told. Students were not initially invited to participate based on any cultural criteria. Any students who mentioned a particular cultural heritage did so voluntarily.

Ethical approval (as provided in the appendices) was granted to explore the factors contributing to student success. It should be noted that the phrase “student success” was a phrase used by the school boards in question when referring to students who might not be successful, i.e. students at-risk, and thus the phrase “student success” was used on the consent forms. In the rest of the thesis the more commonly used term, students at-risk, is used. To follow is a discussion regarding the observations made and data collected in both elementary and high school settings with regards to students at-risk in mathematics and those who teach them.

CHAPTER 4 – RESULTS

Classroom A – Ms. Adam’s Grade 7 Classroom

The Classroom Environment

Ms. Adam’s classroom was very organized and creatively decorated to create a very warm and welcoming environment for the students. When entering this room on the first day of research, it was very apparent that a great deal of time and effort was put into creating this type of atmosphere. The students were seated in groups of three or four, in which the desks were joined at the sides so that all the students faced the blackboard from where Ms. Adams frequently taught. Her desk was also at the front of the classroom, offset from the centre and facing the students. The classroom was arranged length-wise and from sitting at the back of the classroom, in many different seats, it seemed as though every student had a good view of the blackboard. School supplies and math manipulatives were readily available to the students in order to assist them with their learning if necessary. They could be found at the back of the classroom, neatly organized on shelves.

Teaching Methodologies

Ms. Adams spoke confidently about her teaching and had been teaching for over 30 years. Each of her mathematics lessons tended to follow a similar format. First, the students began by “reflecting”. For example, on one particular day, the students were to write down as many strategies as possible to find the area of irregular figures. Soft music played in the background and the students worked independently for approximately five minutes. Following the reflection, a discussion was held in which students shared their reflections, thus exposing many of the different strategies to the entire group. After the reflection homework questions were typically taken up with the class. When students

gave incorrect responses related to homework, their teacher often let them know they were incorrect by saying, “Does anyone have a better answer?” Errors did not appear to be used as opportunities for learning, and correct answers were emphasized.

Much of the ownership of the answer came from Ms. Adams although the attempt to share it with the students was occasionally evident. For example, when examining a word problem and looking for hints within it, she had the class focus on the word “excluding”. One student suggested that it means “not including”. Before consulting with any other students or probing further she told them that ‘excluding’ means they should be ‘subtracting’. [A more reform oriented classroom might involve the students determining the appropriate operation themselves rather than being told by the teacher]. It was observed that the time she allowed for student answers was very short in general. Her “wait time” was observed to be waiting for the first student to raise his or her hand and selecting them to answer. As previously discussed, waiting up to five seconds for responses can have many positive effects including increasing levels of student achievement (Costa 2008).

Ms. Adams was also observed to teach her “lesson” in different ways. In the majority of the observations, the students were asked to copy a short note from the board which was followed by examples and homework questions. However, they were given an assignment to work on independently on occasion. She also gave the students different activities such as creating and conducting their own survey to analyze. The students primarily worked independently and most often were told that if they needed assistance they had two options. They could ask the teacher one question and they were allowed to ask a friend for help, but again, only once.

Response to Students At-Risk

Ms. Adams' interactions with the male student (Brian) selected to take part in the research project illustrate her concern for his well being as a successful individual. The student in question demonstrated a minimal amount of organizational skill and appeared not to have made school a priority. Although the teacher had been overheard to say, "Brian, I believe in you," positive comments like this were sometimes overshadowed by her harsher approach at other times. If the student came to school without his supplies she took a stern approach to the situation, making comments such as, "We are going to have to call home right now about this." She then called home to speak to the guardian about the situation.

The way that Ms. Adams chose to deal with her students at-risk was particularly interesting. There were three students in the class who were struggling with the material at the grade seven level and receiving failing grades. She had placed them in a "foundations" curriculum where the students were to work at a grade five level. Her explanation was that they had too many gaps in their learning and that this would benefit them by filling in these gaps. The idea was that the students would move onto a "Life Skills" program in grade eight which would prepare them for grade nine essential math. According to Ms. Adams, the idea was to give the students the opportunity to succeed.

The students moved into the "Life Skills" program were given an independent work book with over 60 pages in it. For the most part, the at-risk students, including Brian, worked independently on the workbook questions while Ms. Adams taught the rest of the class. The students worked on their own at some lunch tables outside the classroom door. An Educational Assistant was occasionally with the students but she admitted that

she struggled with the material herself. I was working primarily with the “Life Skills” group of at-risk students at the time and did not to observe Ms. Adams interacting with the “Life Skills” students at any point while they worked. She told me that she would collect the workbooks periodically, mark them, and then hand them back to the students for corrections.

Brian, who seemed generally unmotivated, did not seem to either care or know how to express his feelings when asked to comment about this situation. When asked how he felt about the new program he was in, or about working in isolation from the classroom at a table in the back of the room or in the cafeteria area outside the room, he always responded, “I don’t know.” Ms. Adams regularly indicated to me that she was trying to do what was best for her students, including those who were at-risk.

Student Observations in Classroom A – Brian

Brian, who did not mention any particular cultural heritage, spoke English as his first language and was a very well behaved student in the classroom environment. He regularly attended school although he seemed easily distracted during mathematics class. The condition of his very messy binder, and his consistently forgetting to have the necessary materials and supplies, suggested that he was somewhat disorganized. As well, Brian did not seem to possess a great deal of self confidence and frequently suggested that he equated getting the right answer with being ‘smart’. For example, when working independently on a question during a lesson, he could be heard muttering under his breath, “Is that right? Am I smart?” The predominant factors which seemed to affect Brian’s success in mathematics included his lack of organization, focus and effort, a difficulty reading as well as choosing inefficient problem solving methods. The factors

which seemed to inhibit Brian's success in the mathematics classroom will now be described in more detail.

Difficulty Reading

From the time spent with Brian, it appeared that one of the greatest factors inhibiting his success in mathematics was his difficulty with reading. This was a major factor for Brian when he worked on word problems but also became an issue when he tried to read the instructions for other workbook questions as well.

For example, a question which began with, "A patio will be made with square stones ..." was read by Brian as, "A *potato* will be made with square stones..." When working with him it was easy to point out the reading error by saying the mispronounced or incorrect word out loud and having Brian repeat the question at least once. In the patio example, after meaning was made, the problem was discussed and this helped to create a visual image for him. Brian was then able to complete the problem with very few prompts.

Another example of Brian's reading difficulty and comprehension hindering his mathematics performance was in a ratio question which was assigned for homework, during a time when he was participating in the regular class. When Brian first attempted a particular problem on his own, he was unable to give any type of response. Once the question was read to him and he discussed what it was really saying, he drew a picture on his own and said, "This question is easy!" When asked why he could not complete it in the first place he said it was because he did not understand it.

Difficulty with Problem Solving

In addition to an apparent difficulty with the reading that was involved in problem solving, Brian often chose methods which were inefficient when dealing with mathematical problems. There were a number of occasions where a calculator was provided but he chose to attempt the math in his head. Although he was correct at times, it took a lot longer and was more stressful as observed from his physical reactions of placing his hands on his head and sighing. For example, in the study of equivalent ratios, when asked to create three additional equivalent ratios, Brian wrote the following:

$$5/3 = 10/6 = 20/12 = 40/24$$

As each ratio was calculated, it took longer for Brian to generate a response. He had seen many examples of multiplying the original fraction by two or three which kept the calculations much simpler. However, Brian chose the doubling method shown above.

During a particular 'unit rate' lesson [when Brian was participating in the regular class], he was not copying the note and was looking around the room. He had to be reminded to continue copying from the board as it would be soon erased. I also noticed that his writing was messy and hardly recognizable. Although a lesson pertaining to unit rate had just been taught, Brian remained unclear. When given assistance with his homework for the day, Brian expressed a unit rate answer as a ratio rather than a unit rate as follows:

"30 papers produced in 2 minutes"

I felt he needed reinforcement as he did not grasp the concept the first time. Once it was explained that unit rate means "How many in 1?", and that this question was asking, "how many papers could be produced in 1 minute?" he was certain of what he

was doing. The rest of the questions he completed correctly without assistance, and he seemed to understand what he was doing.

Difficulty Focusing

According to the teacher, Brian would not normally complete work on his own in the given amount of class time. He had also been observed to have difficulty staying focused as he was often concerned with what was going on around him. Alternatively, his observed reading difficulty may have presented frequent road blocks. However, with assistance and gentle reminders to stay on task, Brian was able to complete a mid-unit review even before many of his classmates in the regular classroom setting.

His lack of participation in his own learning was apparent as demonstrated by this lack of effort he directed toward assignments. Similarly, when sitting beside him in regular class time, it was noticed that he did not put his hand up voluntarily to give answers. However, when he was paying attention, he would say his answers quietly to himself.

Brian got into trouble on a daily basis primarily for his lack of organization. Comments from his teacher such as “you can’t do your work if you leave it at home” were frequent. I felt he badly needed some strategies to get organized. This data opens the question of whether these issues were profound in his other subjects. However, there was no access to this information as the research did not allow for any investigation outside of the mathematics classroom.

Classroom B – Mr. Brown’s Grade 8 Classroom

The Classroom Environment

In this classroom, the students’ desks were arranged in rows of pairs which faced the blackboard. The walls were also decorated with motivating posters. During one on one tutorial sessions with the students it was noticed that the three girls were often distracted by the noise level from the other classroom. There were two classrooms in an open concept setting, separated only by shelves and one movable blackboard. This type of environment was particularly disruptive if one class was trying to do a lesson and the other was participating in group work or had a supply teacher in the room often tending to make the classroom noisier.

Teaching Methodologies

The grade eight teacher, Mr. Brown, had been teaching for seven years. He showed compassion toward students as he tried to assist them in any way he could. The students were aware of what they needed for a particular lesson and were provided with the necessary supplies if they lacked them. He was well prepared for his lessons and, in turn, attempted to prepare the students as well.

Mr. Brown appeared to be a very organized teacher who made the effort to expose his students to a variety of methods to learn mathematics.³ He often started his lessons by welcoming the students and telling a math related anecdote. He attempted to use examples connected to student interest, such as the salary of a baseball player. This

³ In two other recent research projects in which Mr. Brown participated, he demonstrated strong awareness of and interest in reform style teaching. He was adept at manipulative use and was generally considered a system leader in mathematics. In fact, his knowledge and ability in teaching mathematics may well have played a role in his assignment to this particular classroom which contained a significant number of at-risk students.

introduction was followed by a short, concise black board note with relevant examples and then time for the students to practice their work was provided. He followed the Math Makes Sense 8 textbook and teacher guide. As well, Mr. Brown used manipulatives in his lessons to give the students a better visual understanding and to solidify concepts. For example, integer chips as well as snap cubes were used to assist with instruction. However, his current lessons remained relatively teacher directed.

In addition to well organized lesson plans, Mr. Brown used methods of assessment other than tests. During the course of the research, he used two culminating unit problem tasks, one which was worked on individually, and the other in groups.

The Impact of the Classroom Environment

Mr. Brown was dealing with a classroom with a significant number of extreme behaviour issues. In fact he seemed to be in a constant battle with student behaviour and had many students who appeared highly disinterested with the subject matter. It appeared difficult for him to collect assigned questions to correct and to draw information from the students as they were not very eager to work or participate. He constantly asked if the students had questions with the material and paused during his lessons to ensure that everyone was able to follow along. The students were very reluctant to ask questions or to speak when given the chance. Thus, it was very difficult for the teacher to have the students actively involved in his lessons.

Although many of the students were reluctant to participate, they certainly were not hesitant to speak out and disrupt the class during the lessons. He repeatedly used the phrases, "It's hard to do this when other people are talking" and "you can choose to do nothing but you cannot choose to disrupt this class". Eventually, misuse of manipulatives

resulted in the snap cube manipulatives being withheld. Students were making inappropriate objects (i.e. guns) with them as well as throwing them around the classroom.

In terms of math specifically, earlier in the fall he appeared to have every intention of assisting his class and using currently recommended teaching strategies which cater to reform-based and discovery learning. However, given the environment he was in this year, Mr. Brown appeared unable to implement these methodologies and stated that they were unrealistic in his current classroom, even though he was aware of the needs of students at-risk in terms of hands-on learning and manipulative use. This example illustrated an interesting case in that the classroom environment was seen to not only have a potentially debilitating effect on other students, but in fact on the teacher himself.

Student Observations in Classroom B – Diane, Amber, & Jessica

All three students studied in this class freely self-identified themselves as being of Aboriginal descent. Their pseudonyms are Diane, Amber and Jessica. These particular students exemplified many common themes which may provide some insight to the investigation pertaining to students at-risk in mathematics from non-dominant cultures . These issues include attitude towards mathematics, confidence in mathematical ability as well as classroom attendance and behavior.

Attendance

It was very difficult to collect data from the three girls in Classroom B, mainly due to attendance and behaviour related issues. Some underlying causes surfaced in the course of the research but others are as yet unknown. The reality was that from the period

of early September to the end of November, which is approximately 60 school days, there were many absentees or lates. To be specific, attendance records were obtained and are recorded in terms of half days. For example, a missed morning and afternoon would count as two absences. In the most extreme case, Amber was absent 38 times (four due to suspension for swearing) and late 12 times. Not counting the times late, this translates to being absent about one day in every three. Diane was not far behind in being absent 32 times (four also due to suspension) and late four times, while Jessica was absent 31 times and late 42. So for example, Jessica missed the equivalent of just over one day in four, and was late the equivalent of about once each full day attended. So essentially, each of the three students had missed approximately one third of time spent in school in a three month period.

In terms of attendance, school transfers could also pose as another risk factor and were observed in both Diane and Amber's cases. Diane attended school on a reserve about 300 kilometres away from her present school, from kindergarten to grade 3. She missed a lot of grade three because she was "visiting her sister". A new school was attended for grades three and four, followed by a move to another reserve for grades four to six. She cannot recall why but knows that she "missed a few months of school" in grade six. During grade six her family moved again and she has attended this school since. This means that Diane attended four different schools in less than nine years.

Similarly, Amber experienced many school transfers. Her recollection was living in Surrey, Vancouver, Winnipeg, Northwestern Ontario at her present school, Vancouver and finally back to Northwestern Ontario and her present school. She explained that many of the moves were due to drug treatment for her mother. According to Mr. Brown,

her most recent absentees were because she apparently was moving again. Similar to Diane, she experienced many school transfers and the likely difficult adjustments and learning gaps which are often associated with them. However, the third student in the class to be studied, Jessica, has attended this school since she was in kindergarten.

Student Attitudes Toward Mathematics

In the beginning of the study, I asked the girls to answer some informal questions regarding their attitude toward mathematics, which I used as an ice-breaker activity. The phrase “I hate math” was quite prominent and there appeared to be some common reasons for this. In their words, math made them feel “stupid, frustrated and dumb”. They could recall experiences only in primary level math where they enjoyed the use of manipulatives (blocks) as well as having positive experiences with teachers. Diane could remember achieving good marks in early grades and attributed this to a positive experience in math.

The outstanding emotion mentioned about mathematics by the girls was frustration. They explained that it was not often that they understood a concept immediately and their reaction to challenge was to often say “I don’t want to do this”. They also would often just stop doing a question and would not ask for help. They appeared to need someone sitting beside them to motivate and guide them. During the research observations, there were a countless number of times where the girls gave up and would not have made any effort unless they had assistance and guidance from someone through even some of the simplest problems.

The Assessment Focus (See Figure 2) was a difficult lesson in which Diane was easily frustrated. The educational assistant in the classroom was also struggling with the

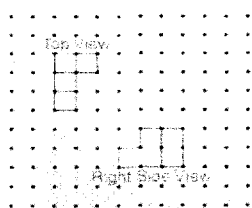
task as it was somewhat challenging. Diane built the top layer of the object independently but when she could no longer build any more of it, she put it down as she was visibly frustrated with it. After I explained to her that part of math is struggling with problems and that everything just does not come easily, she persevered with the question. It was this type of support, and the recognition that a lot of people were having a hard time with it that appeared to encourage Diane to continue to try the problem.

Figure 2. Assessment Focus from Math Makes Sense 8 Textbook

(Brown et al., 2006, p.105)

6. Assessment Focus

- a) Use these views to build an object.



- b) Sketch the object on isometric dot paper.
c) Draw the other views of the object.

While positive experiences and memories were associated in mathematics with some previous teacher interactions, the girls currently had many negative feelings toward mathematics. The girls could sense that past and present teachers were getting frustrated with them when they asked for help. As well, when I gave them assistance with particular questions, they all frequently commented that concepts were not explained to them well enough for them to understand. Jessica went so far to say that she “hated her teacher so much in grade seven that she did not do her math at all.” This is interesting because

during the study, her attitude toward Mr. Brown was quite similar and she showed some very hostile feelings toward him.

Confidence

A general feeling among the three girls was that they would not succeed in mathematics, a feeling that they had before they had attempted particular mathematics problems. With respect to their homework, they neither completed nor attempted their homework. Their reason for this was that they felt that they might not understand how to do it or might get questions wrong. As well, they did not feel prepared for tests and quizzes and tended to forget the procedures and concepts necessary to be successful. For example, even when Diane had completed a question correctly, she thought that it was wrong, further illustrating the fact that her level of confidence was low. The question involved solving for an unknown in a linear equation, using a balance analogy as an example and a visual model to follow. The students had to find the value of the unknown mass and Diane chose trial and error as her strategy. Although her answer was right, she thought that some type of procedure was needed in order to figure it out correctly so she was convinced she was wrong.

When I initially interviewed the girls about their lack of success on assessments, Diane mentioned that she did not pay attention in class and suggested that could be one reason. Anxiety was also expressed by Amber with respect to the number of questions on tests. Amber also had many negative feelings toward failure. Each of the girls felt as though they were predetermined to fail on any test, regardless of the situation.

The girls admitted that they did not always ask for help, but stated that when they did, they have to overcome feelings of shyness. For example, Amber would often be

stopped at the beginning or midway through a homework question. She said that she “feels stupid” and there was often nervous laughter when she was stuck or after she finally asked a question. Even these brief admissions indicate a certain level of built-up trust between the students and me during the course of the research.

In summary, the overall confidence levels among all three girls appeared to be consistently low. They felt as though past failures in mathematics meant a lack of success currently and in the future.

Behaviour Issues

In the beginning of the research project in September, during instruction periods, the girls were observed to be quite attentive to Mr. Brown. They also listened quite well to me during the assistance and tutoring after lessons occurred. However, after about three weeks' time, changes were noticed, specifically in Jessica. Her behaviour toward a supply teacher was considerably inappropriate, despite the fact this teacher had supplied in the classroom in the past. She was quite rude on a number of occasions, refusing to copy the lesson for that day or to do any of the assigned work. Jessica went so far as to make him a nametag calling him “Mr. Meathead” and presented it to him. She continuously was passing notes in class with a student who sat nearby and therefore was not attentive. In order to gain attention, she pounded her fists on her desk repeatedly, although the supply teacher chose to ignore this behaviour.

In response to poor behavior toward Mr. Brown, Jessica was sent to the principal's office which did not appear to result in any changes in her behaviour. Examples of Jessica's unacceptable behavior included speaking out during lessons, disrupting other students by passing notes or with loud outbursts, as well as refusing to do

her homework. Her poor behavior continued and she was placed in a 'transitions' room for students who had needs that could not be met in a regular classroom environment. Ultimately, it was decided by Jessica's principal that she choose which classes she wanted to attend and to place her in primary classes as a teacher's helper for the rest of the periods. The reasoning behind this decision was to at least keep Jessica in school, as it was feared that she would experience a further decline in attendance if some type of intervention did not occur.

Interestingly, the subjects Jessica chose to be exempt from were mathematics and physical education, that Mr. Brown taught her. When asked why she did not want to be in the math class, Jessica said that she "hated" Mr. Brown. It was quite difficult to extract information as to why she hated him so much, and was rude to him. She said that he raised his voice when disciplining the class, but admitted that perhaps some of it was warranted as the class overall was very disruptive. She had developed some type of strong dislike toward him, perhaps because he was intolerant of her behaviour.

From conversations with Mr. Brown and my field notes, it was evident that Jessica was experiencing a variety of differing discipline methods which could potentially be confusing. For example, the school secretary would let Jessica wander about the school office, sitting in her chair assisting with the attendance. These activities would seem like an unusual privilege to anyone looking in from the outside. This would be very confusing for her when contrasted to the more strict policy of Mr. Brown which she experienced in the classroom. Mr. Brown did not give her the flexibility to make her own decisions as to what type of learning she wanted to participate in as the office had. While the school administration gave her choices, as an attempt to keep her from quitting

school altogether, this practice was difficult for Mr. Brown to accommodate into his mathematics classroom. Administration had allowed Jessica choose not to attend Mr. Brown's class, but assist in a Kindergarten Physical Education class. This could potentially have been the result of the strong negative feelings she was expressing toward him.

The following example illustrates a typical day with Jessica. It should be mentioned that in the beginning of the research, she was very eager to learn and also relatively easy to interact with. Over the course of the research she became particularly disengaged with mathematics and her classroom behavior seemed to progressively worsen. One observation from my field note is as follows:

Today Jessica is passing notes and not paying attention. She does not have a book in front of her, and is without a pencil and calculator. She says that she "doesn't want to do her math" but is easily coaxed into doing it. Once she is told 'here is the question and this is what you have to do', and with my presence there, Jessica starts doing her work.

When she comes to a problem she does not understand she turned to her notes to look at an example from the previous day's work. However, when she begins a question which requires the use of manipulatives to solve, she is frustrated as the students are no longer allowed to use the linking cubes. Mr. Brown took them away because the class was misbehaving with them and using them inappropriately by throwing them and making guns out of them. Jessica's frustration leads her to throw paper across the room toward the garbage, a procedure not valued by her teacher. She is quite loud and demanding, banging her fists on her desk. When she finally calms down and gets the dot paper she needs to complete a question she begins to work independently. This lasts for

only a few minutes when she is distracted and begins drawing in her textbook. Soon after she looks up at me and says: [S = student, R= researcher]

S: Oh I am hungry

R: Did you eat breakfast?

S: No. I was busy showering and doing my hair

Finally, the class leaves the room to move to their next period, but I have the opportunity to work independently with Jessica. She is working quietly and independently for about 10 minutes. The environment is somewhat distracting as I can hear the lesson in the next room loud and clear. Jessica is distracted by this too as I see her turning her head to listen to what the other teacher is saying. All of a sudden, Jessica appears to be frustrated and abruptly gets up and lets me know she is going to the bathroom. When I ask her what is wrong she says nothing but it is very unconvincing.

Upon her return she announces [to me], "I am bored and I don't want to do it."

This notation portrayed a typical day with Jessica. However, it was almost a delight just to have her at school at all. Nevertheless, the student was not interested in mathematics.

During the research, Diane was observed to have behavior difficulties as well. Over time, it was noticed that Diane was giving answers which were unconnected to the mathematical questions being asked. On one occasion, I asked if they had models (manipulatives) of prisms and pyramids in the classroom. Diane was having difficulty with drawing 'nets' for the geometry and measurement unit and I thought that it would be helpful for her to be able to physically see the object as a whole. Diane brought back a hollow half cylinder which I felt Diane knew was incorrect. I felt that Diane was being

purposely disrespectful and silly. Her response was not appreciated by me and yet she carried on with inappropriate and provoking responses. On another occasion, when working on perimeter and area questions, she gave answers which were tens of thousands (numerically) away from what was actually correct. When asked why she gave those answers, she said it was just because she felt like it.

Jessica and Diane were examples of students whose family lives may have been significantly inhibiting their school experiences. Whether they could have been engaged by even the most exemplary mathematics teaching without sorting out their other issues is unclear.

Class C – Ms. Chase’s Grade 9 Applied

The Classroom Environment

The grade nine applied classroom was arranged with the desks in long rows of single desks with as many as seven desks in one row. The room was quite plain, with a few math posters scattered around but otherwise quite dull in appearance. The desks and chairs appeared to be used for many years as the markings and scratches on them indicated. The other classroom had desks arranged in groups of four, where many students were able to sit with their friends. The room was slightly brighter than Ms. Chase’s other classroom (where the desks were in rows) and was a much more decorative and aesthetically pleasing room to work in as it was adorned with more colourful posters and brighter lighting.

Teaching Methodologies

Ms. Chase appeared to be a young, very compassionate, and patient teacher in a class which was observed to contain many inattentive and disruptive students. She had been teaching for three years at this particular high school.

Typically, Ms. Chase's lessons involved providing the students with a note to be copied from the blackboard, followed by examples which were at times worked on by the entire class. When the students had the opportunity to give answers and contribute to the lesson, the response time given was generally only as long as it took for the first student to raise a hand and participate. As well, in the examples, the students were presented with solutions to most of the types of problems that they would encounter in their assigned homework questions. This did not allow the students to engage in self directed learning to any degree.

In addition to the lack of problem solving opportunity resulting from providing the relevant methods in the examples, Ms. Chase gave many step-wise procedures to the students. For example, to expand a polynomial, she had the students record in their notes that they should first remove the brackets, and then collect the like terms. Other topics for which similar step by step procedures were given included solving equations, 'reducing' ratios and finding equivalent fractions. The students themselves did not have the chance to investigate or develop these procedures independently and may have had to rely on memorizing them if they did not conceptually understand them. Homework practice also tended to be mostly procedural practice, and few contexts were evident.

In addition, her lessons often involved asking leading questions in an attempt to draw answers from the students who were not always eager to participate. In her

blackboard work, Ms. Chase used charts, pictures and diagrams to help the students take organized notes. She also explained symbols to the students such as the 90 degree angle square indicator, as well as parallel line and equal length markings on figures.

The teacher directed portion of the lessons were often very lengthy, with her talking at the students for a period of 40 or even 60 minutes out of a 75 minute class. The students most often were not attentive throughout the lengthy lesson as they were observed talking to other students and not copying the note as they were instructed.

Following the formal lesson, homework was assigned. The students usually had an ample amount of class time to complete it, although they did not always use this time to do so. It seemed as though many were just waiting for the lesson to be over so they could ask to leave to use the washroom even though they just had a whole period off for lunch. In fact the homework questions were never taken up in class and it was questionable as to the reasons behind assigning them to the students. Homework checks did not take place to keep the students accountable, and the students were responsible for completing it on their own (or not) and asking for help if needed. In my three months with the class, I did not ever hear a student ask the teacher about a homework question which they could not figure out. In reality, many of them were simply not doing the homework at all.

In terms of classroom communication, the vocabulary used by Ms. Chase was usually the proper mathematical terminology. However, students were frequently allowed to use improper terms such as “minused” or “times” to imply subtraction and multiplication. Ms. Chase was occasionally heard to use the terms ‘number’ and ‘letter’ when talking about ‘coefficients’ and ‘variables’, respectively.

The students demonstrated difficulty in verbally expressing the questions. In turn, Ms. Chase was not always able to understand what the students meant and often could not properly answer the students. At times during the lesson, by the time Ms. Chase figured out what a student was really asking, the student would become quite frustrated. An example of this communication difficulty comes from a lesson on grouping like terms when working with polynomials.

S: What do you do with the x's?

[Ms. Chase thinks she is talking about the exponent rules for multiplication and begins to explain them]

S: Nevermind, don't worry about it

Finally, Ms. Chase guessed that the student was talking about collecting like terms. She was able to give her an analogy of thinking of the 'x's like apples and that you wanted to group apples with apples. By the time she could determine what the issue was, the student was showing signs of frustration and not even paying attention to the explanation. Ms. Chase recognized that many of these students had trouble expressing their questions or answers and had difficulties with communication in general. To address this issue, she suggested to students that they write down all of their thoughts when answering a question and subsequently organize them.

In terms of methods for summative assessment, all quizzes and tests were in an open book format, the majority coming from the Pearson Math 9 applied textbook (Cooke et al., 2007). Before one particular test, Ms. Chase reviewed all of the formulas they had been using over the course of the unit and gave an overview of some of the

concepts. The EQAO testing this year served also as her final exam. She also collected assignments and review work to be graded.

Ms. Chase attempted once to try a group task from an exemplar lesson. She was very dissatisfied with the lesson as many students were off task, did not complete it, and misused the manipulatives. This was the first time she had used geoboards or in fact any type of manipulative with the class. After that experience, she did not use any form of manipulative again, and assignments thereafter involved working with a partner rather than a small group.

It was rare in all of the case study observations in this project to see attempts to link mathematics to the real world. However, Ms. Chase attempted this at times, for example, when explaining the concepts of area and perimeter. Ms. Chase related perimeter to home improvement, like measuring baseboards, and area concepts were used for discussing painting walls and knowing how much carpet to lay. On this particular day, the classroom behavior was observed to be much better than any other. Perhaps this was not coincidental and that there was a link between the relevance in the lesson and at least somewhat improved behaviour.

Response to Students At-Risk

In terms of the attitude she conveyed in her classroom, Ms. Chase took into consideration students' individual behavioural issues and was very tolerant of less than perfect behaviour on many occasions. As well, she volunteered to meet with students during lunch periods to provide them with extra assistance. She attempted to stay positive and to keep the students in good spirits despite the fact that many of them were struggling with the material. She was often heard reminding the students that each new unit meant a

fresh start. In general, she appeared to remain optimistic in an environment that was difficult to teach and often contained students who were opposed to learning.

However, there did not seem to be a great deal of personal interaction between the teacher and the students, such as getting to know them as individuals and making personal connections. Nonetheless, Ms. Chase was able to tell me a lot about their family backgrounds and personal histories, but much of this information came from confidential documents to which she had access, and not from speaking with the students directly.

During the time that involved the research project, an educational assistant was in the classroom, working with students who had individualized education plans (I.E.P.'s). Those students deemed at-risk by the classroom teacher received the exact same lesson and questions as every other student did. The teacher often circulated the classroom following her lessons to provide assistance to all of the students, including those at-risk. She was very open to the idea of students receiving help with their homework from me. Thus, there was little difference in terms of Ms. Chase's response to her students at-risk as compared to the other students in the classroom.

Two case studies from these classes will be provided in the next immediate section. These students did not self-identify as being of any particular race or ethnic background, nor did it appear that English was not their first language.

Student Observations in Classroom C - Susan

Susan was chosen as a case study student because she exemplified a number of typical issues observed with several other students. Susan appeared to me in fact not to be lacking in mathematical ability. Nevertheless she was identified by the teacher as at-risk. Emergent themes in Susan's case include low grades yet multiple demonstrations of her

potential, lack of focus and effort in the mathematics classroom when not prompted, and personal issues which possibly contributed to her being at-risk in mathematics.

A typical day with Susan was as follows: [from my field notes]

Susan is in the hallway as soon as class begins, just minutes after the bell has rung at 1:00 pm, and is apparently going to the washroom. The lesson continues and Susan comes back to class at 1:25 pm. She leaves again for whatever reason and returns about 10 minutes later. Upon her third arrival to the class, she is not paying attention as the lesson goes on and she continues to make conversation with the students around her. Susan frequently displayed a similar desire to avoid class.

Issues Outside of the Classroom

Susan was comfortable sharing some of her personal history. She had many challenging experiences at quite a young age, and there are many issues with which she said she currently struggled with. She attended kindergarten through grade six in Toronto and also lived in New York in a dangerous area for a portion of grade six. She talked about two gangs in particular, and told stories of violence involving children in the streets. In grade seven she moved to a very small town in Ontario and began grade eight there. Eventually she moved to the present location to complete grade eight. She came to this high school this year for grade nine.

Lack of Motivation to Be Successful

When the subject of math was brought into the conversation, Susan said that she did not see the point and did not understand why the students needed to go through all of this “stuff”. She said that you should just learn what you needed for a particular job and that would be sufficient. The topic of mathematics and the relevance to society led to the

discussion of future aspirations. Susan said she did not want to go to college or university and also said that she did not care if she was ever employed. Her solution was that she would collect unemployment insurance. She said she was charged with assault when she was in grade eight and this experience was her explanation for having such low expectations for herself. She expressed feeling as though she would not be able to secure a job as a result of these charges despite the fact that she was told that any charges would likely not be on her record past 18 years of age.

Assessment Results

Cumulative grades from September 6th until November 22 indicated that Susan had an overall average of 40% at that point in the grade nine applied course. Susan did achieve three marks of 100 percent as well as six “zero’s” which indicated that the assessment was not turned in. There were other marks between the range of zero and 100%, however, 14 of these marks were at or below 60%.

When analyzing Susan’s tests, quizzes and assignments, it appeared as though she lost many marks for not showing her work and she frequently generated incorrect answers. There were sub-questions on assessments and even entire assessments on which Susan demonstrated ability, such as the perimeter and area quiz on which she received 100%. On the other hand, sometimes questions and even full pages on assessments were left blank with no effort put forth. In the case of one particular review assignment, she was off to a great start but was discouraged by the length of it. The last few pages were completely blank and she said that was what she did not complete in class.

While Susan appeared not to have been initially successful according to standard course grades, it is important to recognize that there were many instances where she

demonstrated ability as well as potential. I saw evidence that Susan demonstrated the capacity to complete mathematics at the grade nine applied level. At times, she went above and beyond what was expected and demonstrated a very deep conceptual understanding of the subject matter. An example of this was a question for which Susan had to find the area of a given triangle.

Instead of using the formula sheet, which was previously referred to within the same section of homework, she intuitively came up with the formula for the area of a triangle. She used the knowledge from the area of a rectangle and recognized that two of the triangles made a rectangle. By dividing the area of a rectangle by two she was able find the area of the triangle. The scenario is as follows:

[S= Student, R= Researcher]

R: What did you do here?

S: I made the triangle a square

[She draws a rectangle]

S: You get your answer for what it would be as a rectangle

R: Ok. You are right. Show me what the formula for the area of a triangle is

S: [looks at the book] $A = \frac{1}{2} bh$

Oh. See I did the same thing but just more complicated

It appeared that Susan understood the derivation of the triangle area formula, since she reconstructed it in front of me. There were also other examples of the demonstration of conceptual understanding and strategies which she employed. For example, Susan was rarely prepared for class with the required supplies, but, not having a calculator one day prompted her to find her own strategy for dividing. Instead of dividing

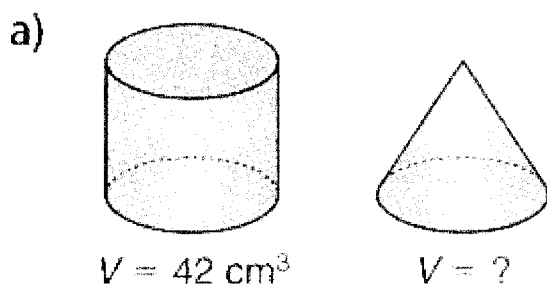
by 4 when given the perimeter of a square and asked to find the dimensions, Susan divided by 2, twice. She realized this was the same thing and although inefficient, was correct. Again, a deep understanding was apparent.

When prompted to check over a question carefully, Susan was often able to find the incorrect portion and correct it. For example, when she used the diameter instead of the radius, I asked her to check her answer carefully and she was quickly able to find her mistake. Other careless errors and mistakes also accounted for lost marks on tests as in the case of signage errors when expanding polynomials.

Although she frequently demonstrated to me that she could conceptually understand formulas, she often did not refer to the formula sheet although it was provided for her. In the triangle example she was able to construct the area herself without the formula, however, in other examples this reluctance to use the formula sheet worked against her. For example, when working with the formula for the volume of a cone Susan was presented with the question part of which is shown in Figure 3.

Figure 3. Practice Question from Pearson Math 9 Textbook (Cooke et al., 2007, p. 31)

*The cylinder and cone in each pair have the same base and height.
The volume of each cylinder is given. Determine the volume of each cone.*



Susan did not read the question first and guessed that the answer was 42. No strategy was implied by Susan, suggesting a lack of motivation to attempt to apply the concepts from previous math lessons to the work. I asked her repeated questions to help her reconstruct or recall the generalization that the volume of a cone is one third of that of a cylinder. Owing to the fact that she was running out of time and the solutions were due, I finally made the connection for her by telling her that a cone is one third of a cylinder's volume. The relationship was explained three times until Susan said she understood.

At this point, Susan still seemed distracted and made a careless error.

S: Ok so I take 42 and divide by 4.

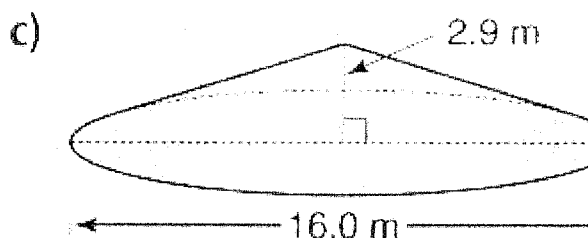
Once it was pointed out that she should have divided by 3 she was baffled and could not explain why she said 4 previously. Susan then said she realized it should be divided by 3. As this example illustrates she often appeared unfocused.

Need for Guidance and Encouragement in the Classroom

Susan frequently seemed distracted, often telling stories which were completely unrelated, and was often seen to be looking around. Without prompts to get focused and begin her work, she was often very slow to get started. For example, as shown in the question in Figure 4, she seemed to need a lot of prompting.

Figure 4. Susan's Math Practice Question from Pearson Math 9 Textbook

Determine the volume of the cone (Cooke et al, 2007, p. 31)



I gave her assistance starting the problem by writing the formula down, referring her to the formula page. I wrote:

$$V = \frac{1}{3} \pi r^2 h$$

She was then able to substitute the numbers for the variables and she wrote the next line:

$$= \frac{1}{3} (3.14) \times 8^2 \times 2.9$$

S: Now what?

She was not sure what to do first so I reminded her of the order of operations. Susan was not sure where to write down the result of each calculation and had to be told to write down everything before and after the part she was calculating in the current step.

Subsequently Susan wrote:

$$= \frac{1}{3} \times 3.14 \times 64 \times 2.9$$

This issue (of not knowing how to record intermediate steps) came up with other students in the research as well. I reminded them of what the acronym BEDMAS stands for, and they were also unsure about how to record their answers. For example, in this case, Susan knew that she was supposed to solve the exponent first and did so. However,

she did not know what to do with the numbers before and after 8^2 . She did not know how to properly write the question out in a continuous manner without help. In this case of course, since all of the operations were multiplication, any order of calculation would have worked fine as long as the student squared only the 8.

When working one on one with me discussing concepts and guiding her to the formula sheets, Susan was able to correctly complete the questions. The appropriate formula was selected with the few errors being the omission of units. Thus, having the extra support and guidance provided by having me in the classroom appeared beneficial for Susan. A very telling example of this situation occurred the day she had to write a test and was in the room with another student. She began by announcing that she did not want to write the test. All that I had to tell her was that in about half an hour she would be done and that she would have support to clarify questions if she had any. These minimal words of encouragement and support were all that were necessary and within moments Susan was completing her test quietly.

In summary, Susan repeatedly demonstrated the ability but appeared to lack the dedication and focus necessary to be successful. As well, for multiple reasons, Susan failed to see the value in mathematics or in education in general. The classroom teacher later reported that Susan did manage to pass the course, and felt that this would not have been possible without my support for such a substantial period of time.

Student Observations in Classroom C- Kelly

Kelly was another female student in grade nine applied mathematics. One of the greatest factors inhibiting Kelly as a successful math student was that she appeared to have difficulty communicating and did not always ask for help when she needed it. Other

factors which might have contributed to Kelly being at-risk in mathematics may have included her low self esteem, lack of focus during instruction and lack of conceptual knowledge.

Communication in the Mathematics Classroom

During general classroom observations, Kelly did not normally ask Ms. Chase for assistance. When I worked one on one with her, she became more comfortable as time went on with asking me for help when she could not complete a question. However, it was often difficult to interpret exactly what she was asking when she was inquiring about a specific portion of the problem. Her ability to convey specifics regarding problems was quite weak, thus making it difficult to give her a concise and relevant answer. She mixed in phrases like “or something” and “like” repetitively, which broke up her sentences and made it very hard to follow. Nonetheless, as a rapport was built, she did become much more comfortable approaching me when she needed assistance. The fact that somebody was sitting beside her and available for individual help during seatwork was possibly a boost to her confidence.

The phrase selection which made communication difficult may point to issues with confidence and self esteem. Kelly’s use of language conveyed a great deal of uncertainty and underscored the observation that her confidence was quite low. Kelly continuously asked me if she was on the right track with assigned questions. For example, when she figured out a problem on her own and I asked if she was successful in solving it, she said she thought she was wrong. After checking over the question, all of her methods led her to the correct answer. It seemed that there were some issues with confidence which affected her performance in math.

Self Esteem

Outside of the math classroom, Kelly belonged to a girls' self esteem group. She reported that she was recommended to the program by another teacher at the school. It involved a support group of girls who got together periodically during the lunch hour to discuss the issues which were affecting them as well as other students their age. Kelly's issue with confidence was one which appeared to impact her schoolwork generally.

Classroom Behavior and Focus

Her classroom behaviour was not unlike many other grade nine female students who occasionally communicated with other students while instruction was taking place. I saw her both passing and reading notes on a number of occasions which took her away from the intended learning outcomes of Ms. Chase's lessons. This was particularly a problem because she already had difficulty with mathematics and she was missing portions of the lesson when preoccupied with the notes. Ms. Chase did not realize this was happening as it was always done in a very discrete manner.

Assessment Results

Not surprisingly, Kelly's distraction and difficulty with mathematics was reflected initially in her achievement level. She failed the first two tests. However, as of the middle of December, Kelly had an average of 67% which came from assessments including tests, tasks and quizzes, as shown on Figure 5. Analysis of the student grade reports shows a trend in which it is her test scores which are the cause for a lowered average. Tests had been weighed almost double the value of any quiz or task that was given and Kelly's five test scores were 29%, 43%, 56%, 60% and 68%. The tasks show three marks of 100% and other marks which were higher than the test scores, except one task in which Kelly

received a mark of zero. Interestingly however, the test scores were showing a steady improvement, and one can not help but speculate again on the support generated by having my presence in many classes for help. Ms. Chase in fact stated emphatically that she believed that neither Susan nor Kelly would have passed the course without my presence.

Figure 5. Grade Nine Applied Math Mark Printout

STUDENT REPORT APPLIED		Unit: [ALL] Category: [ALL]			Class Avg.: 60% Median: 67%			67% Wt. Average NoMark: 1 Zero!: 1		
VFMI P101 - 2006/2007 - Nov. 22, 2009									Page 1 of 1	
ENTRY TITLES	Date	Unit	Category	Weight Factor	Mark %	Class Avg. %	± Class Avg. %			
1. Questionaire	Sep. 6	1	Tasks	4.0	100	94	6			
2. Add Sub Integers	Sep. 7	1	Tasks	4.0	74	64	10			
3. Integers	Sep. 11	1	Tasks	4.0	100	69	31			
4. Collecting Like Terms	Sep. 12	1	Tasks	4.0	64	65	-1			
5. Like Terms	Sep. 15	1	Quiz	4.8	70	66	4			
6. Expanding	Sep. 21	1	Quiz	4.8	88	61	27			
7. Chapter 1 Test	Sep. 25	1	Tests	7.1	68	59	9			
8. Solving Equations	Oct. 2	1	Quiz	4.8	63	65	-2			
9. Pyth/Area/Perim	Oct. 4	1	Tasks	4.0	Zero!	44	-44			
10. Take Home Test	Oct. 11	1	Tests	7.1	43	55	12			
11. Buddy Quiz Volume	Oct. 17	1	Quiz	4.8	92	77	15			
12. Volume Review	Oct. 17	1	Tasks	4.0	86	60	26			
13. Volume Test	Oct. 20	1	Tests	7.1	56	67	-11			
15. Min Max Area/Per Quiz	Oct. 26	1	Quiz	4.8	95	63	32			
16. Down By The Bay	Oct. 26	1	Tasks	4.0	57	42	15			
17. max min per/are Review	Oct. 30	1	Tasks	4.0	100	48	52			
18. Max Min Per/Area TEST	Oct. 31	1	Tests	7.1	60	48	12			
19. Angles Assignment	Nov. 7	1	Tasks	---	---	---	---			
20. Angles Quiz	Nov. 8	1	Quiz	4.8	39	64	-25			
21. Angles Review	Nov. 10	1	Tasks	4.0	100	50	50			
22. Angles Test	Nov. 13	1	Tests	7.1	29	53	-24			

NOTE: NoMark entries are NOT included in mark calculations - CALCULATION METHOD: Average - Category Weight

Verbal and Mathematics Related Skills

Kelly's difficulty with mathematics had many dimensions as was seen with other students at-risk studied in this project. She made a lot of careless errors, for example, forgetting to divide by two when applying the area of a triangle formula. This error, like many of the other minor errors, resulted in lost marks, perhaps lost confidence, and may have been due to the fact that Kelly was rushing or failed to check over answers, and was

most likely working only procedurally. In addition to this, Kelly did not readily use the resources which were available to her. Formula sheets, given homework answers at the back of the book as well as a calculator were accessible and often on her desk, although she would often take a great deal of time trying to recall formulas or facts from memory. Most of the time she was unable to remember the formulas from memory and showed signs of frustration by hanging her head and becoming quiet, not unlike the earlier behaviour and response of Brian.

Conceptual Knowledge

The application question in Figure 6 was difficult for Kelly. Previous assessments and homework questions demonstrated her success at computing unit rates as well as creating equivalent ratios. However, the problem solving nature of this question appeared to make it difficult for Kelly to be able to complete it, and again provides evidence that she was working procedurally and without deep understanding. There was an attempt at the top right of the page to make an equivalent fraction but she was not able to successfully do so.

Figure 6 shows an example of Kelly's work (in white boxes and the rough work to the right).

Figure 6. Results from A Ratio Problem Solving Assessment

1. Lemonade is made with water and concentrate.
 Mary uses 3 parts of concentrate and 2 parts of water.
 Jenny uses 4 parts of concentrate and 3 parts of water.
 Whose will have the stronger lemonade taste? Explain

1/6

"MARY WILL HAVE THE STRONGER TASTE BECAUSE USES LESS PARTS OF WATER"

2. Kevin and Steven rode their bikes to school.
 Kevin rode 7 km in 20 minutes.
 Steven rode 13 km in 29 minutes.
 Who rode faster? Explain.

0/0

"KEVIN RODE FASTER BECAUSE HE HAD A LOWER SPEED BUT HE GOT THERE IN LESSER TIME"

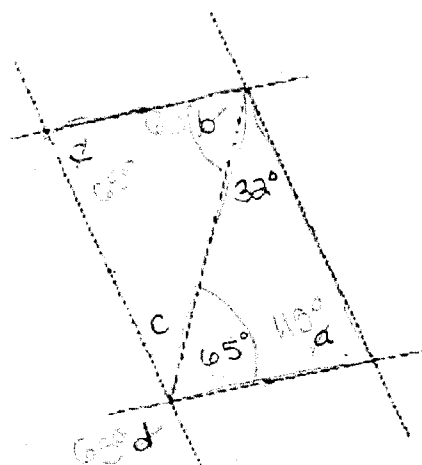
Handwritten notes and diagrams include:
 - Ratios: 3:2, 4:3, 9:6, 8:6
 - A diagram showing two circles representing lemonade mixtures with arrows pointing to 'C' (concentrate) and 'W' (water).
 - Time conversions: 7:20, 13:29, 14:40, 13:48
 - A note: "change both sides"

The following is yet another example in which Kelly could not apply a concept. Again, she did not appear to have the conceptual knowledge of that particular concept and therefore was unsuccessful. In question one of Figure 7, the student was supposed to figure out the unknown angles by using the "Z pattern, F pattern, and C pattern" for parallel lines.

Figure 7. Angle Theorem Assessment Question

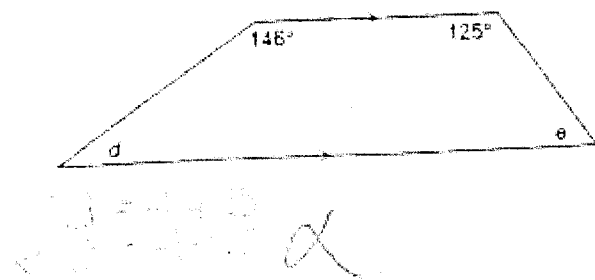
Determine the angle measure indicated by each letter. (Remember your Proofs!)

Handwritten solution:
 A = 110° X (C pattern)
 e = 65° X (F pattern)
 d = 65° X (opp angles)
 c = 60° X (F pattern)



It was assumed by the teacher that the student understood that the pairs of lines were parallel although the diagram is inconclusive. Kelly seemed to have an incomplete idea of the patterns. For example, she made an attempt to determine angle a on the bottom right possibly from the idea that it would be the supplement of 65 degrees. In fact the "C" pattern refers to angles enclosed by parallel lines (i.e. angle c + 65 degrees + angle a must add to 180 degrees). The student appears to have a partial understanding in that she chose the angles enclosed by the right side and the diagonal, rather than enclosed by the parallel lines. In the very next question (Figure 8), students were given another example in the form of a quadrilateral and were supposed to apply the concepts and proofs to determine the angles. As shown to follow, Kelly made an attempt at an answer but it was not correct and her reasoning was unclear. It is not surprising that she was unsuccessful with this question after seeing her work on the previous question.

Figure 8. Angle Assessment Question



One can not help but remark on the abstract and uninteresting nature of these questions for students in the applied level. Hands-on or concrete materials were not used to convey the ideas, and the real world connections were not apparent. Put simply, the questions were highly decontextualized and lacking in engagement.

In addition to application questions, recalling definitions (as was mentioned in the literature) was also a problem for Kelly. This was true for both test situations as well as

when completing seatwork and in discussions. The following dialogue provides an example to illustrate this:

(The question was one regarding maximizing area with a given perimeter)

R: What can we say about the dimensions?

[Does not respond as she likely does not know what is meant by the term “dimensions”]

S: Oh are those what makes it up? ...Like the area...?

[Still not able to give a response]

R: Yes. So what are the dimensions?

[She is very quiet. Seems to not know what the term means]

R: Area equals blank times blank... [offered as a hint]

S: Oh! Length times width!!

R: So the dimensions are....?

S: length times width

During the study, there was little evidence of Kelly’s conceptual understanding of the concept of area, and details pertaining to the specific term “dimension” were also missing. There were also many instances on the tests where she was unable to provide answers for definition questions. She could not define terms like binomial and variable, yet the majority of test questions involved such terms and used them repeatedly. The teacher was requiring definitions which were very important in doing the other test questions. However, the fact that Kelly was unaware of many of these crucial definitions, but was attempting to work with the concepts associated with them is unsettling. She did not have the entire concept and most likely was carrying out procedures which would not be retained for a long period of time. I felt that the conceptual foundation was not being

grasped, and math was to her a mysterious set of rules and procedures and terms to be memorized. Kelly's work in Figure 9 illustrates another example of this crucial learning issue.

Figure 9. Definition Portion of Grade Nine Applied Assessment

1. Group the terms into appropriate "like terms" groups.

-4	$8x$	$16x^2$	m^2	98	$-x^2$	$-15x$
$12x$	$-63m^2$	-9	x	$-19x^2$	4	$-x$

2. Write an example of a binomial.

3. What is a variable?

4. Solve.

a) $(-8) + (-3) + (-1) =$
 $-8 - 3 - 1 = -12$

b) $(8) + (-5) + (-2) + (-4) =$
 $8 - 5 - 2 - 4 = -3$

c) $10 - 4 - 2 + 3 =$
 $10 - 4 = 6$
 $6 - 2 = 4$
 $4 + 3 = 7$

d) $(58 - 5) =$
 $58 - 5 = 53$

e) $1 - 100 - 63 =$
 $1 - 100 = -99$
 $-99 - 63 = -162$

f) $\frac{-15}{-3} =$
 5

g) $\frac{1000}{100} =$
 10

h) $-4 + 4 =$
 0

i) $12 - 5 =$
 7

Figure 9 shows highly procedural and definition oriented questions which were typical of the homework. To reiterate, such tasks ignore many of the elements of best practices as described in the framework such as the use of manipulatives, real world examples, or contextual and motivating problems.

Kelly's lack of conceptual knowledge is further illustrated in a particular homework problem on maximizing area. It was one of five assigned homework questions with respect to maximum perimeter and area. The question given was very similar to the

thirty minute lesson the teacher had just provided. Kelly was very unsure of what the question was asking her.

(S= student, R= researcher)

Homework Question: A farmer had 80 m of fencing. What is the largest possible area that could be enclosed?

S- Do I have to draw this out?

R- Read the question. What is it asking? Keep in mind it is VERY SIMILAR to the examples

(S is still very confused at this time)

R- Ok, well tell me what 80m represents as it is the total amount of fence to go AROUND the yard

S- 80 is the perimeter

R- correct

(S proceeds with the question and writes an attempt to take the square root of 80 which would be the proper procedure if given the area and asked to find the dimensions of the square. However, she also writes down

$P = 20 + 20 + 20 + 20.$

(The student appears to be confused about the role of perimeter versus area in the question.)

R- You are correct in saying this [pointing to the square root of 80], but why did you write down $P = 20 + 20 + 20 + 20$?

S- I know that 80 divided by 2 is 40 so I decided to take half of that again and got 20

R- What is the shape that gives us the MAXIMUM AREA?

S- A rectangle or a square (pause) rectangle! (pause) square!

(R reinforces the fact that the square shape gives the maximum area possible and S repeats this. R encourages S to sketch the question and S draws a square.)

S- Oh so max area would be 40.

R- What is the formula for area?

S- length x width (still not able to make the connection that she should be multiplying 20 x 20)

R- So what is the length and what is the width?

S- 20 and 20... Oh! So $20 \times 20 = 400$... Oh! (forgets the units for area as meters squared)

The student appeared to have solved the question with considerable scaffolding help, but it was still unclear how deeply she understood. This appeared to be a trend in Kelly's mathematical learning. She seemed to have a great deal of difficulty in mathematics particularly with understanding terms and what was being asked. Kelly was also inhibited by a lack of a belief in her ability, had difficulty communicating and showed some very clear gaps in her learning which contributed to a deficiency in conceptual knowledge and to her overall success. She was not unlike a number of other students observed in the study.

Summary of Emergent Themes

Strategies and Practices Used by the Classroom Teachers

The Classroom Environment

Ms. Adams' classroom was neatly decorated and provided an aesthetically pleasing environment for students to learn. They had access to school supplies or manipulatives that they needed. Students were seated in groups of three, although throughout much of the observations, little group work took place. Mr. Brown's classroom was also decorated with motivating posters and students were seated in pairs. The open concept classroom environment with one other class was often noisy and distracting to students in Mr. Brown's classroom. The desks in one of Ms. Chase's

classrooms were arranged in single rows, with a few posters scattered about the room. In her other classroom, the desks were arranged in groups of four and the students selected where they sat. This room was brightly decorated in comparison to the other which appeared much darker and uninteresting. In summary, the classroom environments differed slightly in appearance, but regardless of their arrangements, the students worked independently for the majority of the time.

Teaching Methodologies

Ms. Adams' lessons consisted of a mathematics related reflection to which students had about five minutes to respond, with music played in the background. She often proceeded to take up the homework, give the students a short black board note as their lesson, provide a few examples and the students would work on some practice questions. If a question was posed, the first hand up was called upon to answer and much of the ownership of the answer came from the teacher. The work provided was primarily independent but students were observed once to work on a group survey project.

Mr. Brown welcomed his students and began some of his lessons with math related anecdotes. The students were given a short note, a few examples and then practice questions to complete. Manipulatives were used until they became a behavioral issue for the students, forcing Mr. Brown to revert back to traditional lessons. During the time of the research, culminating tasks were observed as summative assessments.

Ms. Chase's lessons were similar in format to Ms. Adams and Mr. Brown's but her lessons and examples were often as long as 40 to 60 minutes in duration. Student response time to questions were also limited until the first student raised his or her hand. Students were assigned practice questions but the homework was rarely observed to be

taken up in class or checked for completion. The questions themselves were mainly procedural and a lack of problem solving was observed. Although the work assigned was mainly independent work, the students could work with one or two other students if they wished. Group work from the TIPS binder was used on one occasion but manipulatives were abused and students did not work well in this type of setting. In terms of assessment, open book quizzes and tests were used. In summary, the teachers tended to give lessons that included examples and followed them with some independent practice questions which were to be completed for homework if they were not completed in class. The difference between some of the lessons was that Ms. Adams began with a reflection, Mr. Brown with a story or anecdote and Ms. Chase's lessons were longer in duration, on average.

Response to Students At-Risk

Ms. Adams chose to place her students at-risk in a foundations program where the students independently worked on curriculum at the grade five and six levels outside of the classroom environment. She appeared to be very firm when dealing with Brian but also showed compassion as she tried to motivate him and express her belief in his ability to succeed. Mr. Brown was not observed to differentiate his lessons or assignments for Amber, Diane and Jessica. Ms. Chase was always very positive and made herself available for extra help during lunch. She conveyed this positive attitude and provided help to all students equally but did not seem to build personal rapport with her students. There was not much of a difference to the way Ms. Chase responded to her students and she said that all of her students could be considered at-risk. She expressed that she was aware of the difficulties they faced, and her method of accommodating her students was

the same for each individual. Her detailed board notes, lengthy traditional mathematics lessons and stepwise procedures are some examples of the collective, rather than individual, accommodations.

The Impact of the Classroom Environment

Mr. Brown's class was very difficult to teach as the majority of his students did not participate during his lessons, nor did they seem interested in completing assigned work. Although Mr. Brown wanted to implement hands on learning and manipulatives, he was unable to do so due to the extreme behavior issues with which he was faced. In Ms. Adams and Ms. Chase's classrooms, the classroom environment itself did not appear to severely impact the teaching and learning.

Observable Behaviors of Students At-Risk

Attendance

The attendance patterns for the three students at-risk in Mr. Brown's classroom in a three-month period are disturbing. After viewing student attendance records it was established that Amber and Diane missed about one out of every three days and Jessica missed one out of every four. Suspensions were included in the absences for Amber and Diane who also were faced with multiple school transfers throughout their elementary school years. Attendance data was not available for the other students participating in the research project but based on informal observation did not seem to be a particular issue.

Classroom Behaviour

Brian did not appear to have any behavioural issues which would be disruptive to the classroom environment and cause any means of discipline while I was in the classroom. Jessica's behavior proved to be a distraction to herself, Mr. Brown and her

classmates although during the first few weeks of the research, she was well behaved. In Mr. Brown's presence, she would speak out with often loud and inappropriate outbursts, pass notes as well as refuse to complete assigned work. Jessica was rude to a supply teacher on one occasion, pounding her fists on the desk and being very disrespectful toward him verbally and by drawing pictures of him. She was sent to the office multiple times by Mr. Brown and received conflicting treatment when compared to his discipline. Jessica was allowed to sit in the secretary's chair and assist her with attendance at times. Eventually, her poor behavior led to being placed in a transitions classroom where she worked with primary students which helped keep Jessica coming to school. She was no longer attending Mr. Brown's math or physical education classes by choice. Near the end of the research, Diane began giving me answers which were unrelated to the mathematics questions being asked and she explained it was because she felt like it. Amber on the other hand, was never observed to be disruptive. In Ms. Chase's classroom, Susan was well behaved, although she was beginning to abuse her washroom break privileges, asking to go more than once during class which was directly after the lunch period. There were no disruptive behaviors observed by Kelly, other than the fact that she passed notes from time to time. In summary, not all of the students were disruptive, but most were distracted or inattentive for at least some of the classes observed.

Assessment Results

The results for Brian's assessments were unavailable, as his homeroom teacher did not feel comfortable giving this information to me. However, Brian was given work at the grade five and six level (instead of grade seven) as it was felt there were gaps in his learning. This workbook was then graded as sections were completed and given back to

Brian. The three students at-risk in Mr. Brown's classroom rarely handed in assignments and were barely passing mathematics. It was difficult for Mr. Brown to evaluate the girls based on the small amount of work they handed in. Susan, a student in Ms. Chase's classroom, had an average of 40% after three months of school due to many assessments left blank or not submitted. There were a few assessment assignments in which she completed and received marks of 100%. She did, however, demonstrate conceptual knowledge verbally when I was working with her at times, yet no assessments given were verbal. By the middle of the third month of research, Kelly had a weighted average of 67%. Her test marks were quite low with two failures but her assessment tasks were generally much higher.

Personal and Mathematics-Related Learning Characteristics

Difficulty Reading

Brian's difficulty in reading was apparent when he was trying to problem solve and read instructions required to complete his workbook questions. This made it difficult for Brian to work independently. When working one on one with him, explanations of the questions seemed to be helpful for Brian to complete the assigned work. There were no observable reading difficulties among the other at-risk students.

Difficulty Problem Solving

Brian was observed to choose inefficient methods when problem solving, particularly with lengthy problems and did not lead to the solution. He chose not to use his calculator on a number of occasions and it seemed as though doing these calculations was stressful as shown by his physical reactions. The questions themselves often needed to be reworded as it was difficult for Brian to complete them independently in their given

form. Susan often needed prompting to get focused on problem solving tasks. Kelly had difficulty understanding what was being asked but with discussion and prompting, she too was able to complete her work. For different reasons, Brian, Kelly and Susan had difficulty problem solving but what was common to all three was that assistance was needed in one form or another.

Difficulty Focusing

Brian often needed reminders to stay on task with respect to note taking and completion of homework questions. He needed to work on being organized as he frequently was in trouble for forgetting his books, bringing work home and for not having the necessary school supplies. Diane outwardly admitted that she did not pay attention in class and that was why she was unsuccessful with test taking. Susan often seemed to be highly distracted and would ask questions or tell stories about topics which were unrelated to mathematics. Without prompts to begin her work, she was often slow to get started. Jessica and Kelly could be found passing and reading notes on a number of occasions, thus concentrating on this activity rather than devoting their attention to the classroom.

Confidence

On more than one occasion, Brian quietly would ask himself if his answers were right and if he was smart. He was never observed to participate during the lessons, although he would quietly whisper the answers to himself, which were sometimes right. Jessica, Diane and Kelly said that math made them feel stupid and frustrated. One reason they had for not doing their homework was that they were afraid they would not know how to approach the questions or would get answers wrong. Even when Diane was

correct on one occasion, she still thought her answer was incorrect. Amber expressed that she was too shy and embarrassed to ask for help. The girls also felt that if they wrote a test, they would automatically fail. They explained that for the past few school years they had not been successful in mathematics and that their grade eight year would not be any different. It should also be mentioned that Kelly was a part of a self esteem group during the lunch hour with other girls at the school. Whether her involvement with the group was making a difference in her life can not be answered as this could not be investigated as part of the study. In summary, confidence seemed to be a significant issue for all the case study students.

Lack of Motivation to be Successful

Brian did not always put in the necessary work and effort to be successful in grade seven mathematics. Past failures for Amber, Diane and Jessica led the girls to go as far as saying that they hated the subject. The girls could not see very many reasons to get excited about succeeding in mathematics. When a difficult problem arose, they often would put their pencils down, outwardly say they did not want to finish their work, or ask to leave the room to go to the washroom. Susan did not see how mathematics was relevant in her life, nor did she have any aspirations of attending school or working after graduating from high school. Although Kelly was not always focused, she seemed to be putting forth an effort and did not make any negative statements as the other students at-risk in this study did.

Need for Guidance and Encouragement in the Classroom

Brian did not have the strategies or desire to become organized on his own. He needed constant reminders to stay on task, complete work and bring supplies to school.

Also, when I was sitting with him to clarify word problems, he was able to complete many of them. Brian either needed or relied on someone else, including someone with a sound mathematical background in order to be successful. The three girls in grade eight would abruptly stop doing their work and not ask for assistance unless there was someone there to guide them and encourage them to continue with the task at hand. Susan was often very slow to begin her assigned work but with prompts she would begin to work. We would often discuss the problem before she got started and Susan would finish the question independently. There were times when all that she needed was to be reminded to use her formula sheet or to hear some supportive words. Kelly did not always ask for help when she needed it, so the one on one support was necessary to intercept the difficulties she was having with mathematics. Ms. Chase was consistently asserted that having me in the room was very helpful for Kelly and Susan. Hence, possibly related to the confidence issue, all of the students appeared to benefit from the individual support they received from me during the research.

Verbal Skills

Although Kelly rarely took initiative for help with her homework, while working one on one with her, it was difficult for her to convey exactly what she did not understand. Ms. Chase recognized that this was an issue for many of her students and she suggested writing down all of their thoughts first and then trying to organize them. This trend of not using verbal communication to ask for assistance when needed was consistent among all of the students at-risk. While working with them, it became obvious that they could not complete certain questions independently, but this would not have been known to the teacher or myself had someone not been sitting beside them.

Mathematical Skills

Common themes among Brian, Kelly, Susan were that they did not use the resources available to them, primarily, their calculators. Kelly and Susan often rushed through their assigned work and were not observed to double check their answers. They also did not use their formula sheets to guide them or make use of checking their solutions in the back of the text books. The issue of not knowing how to record subsequent steps when expanding and simplifying equations applied to Susan, (Ms. Chase) Amber and Jessica (Mr. Brown).

Conceptual Knowledge

Kelly was successful in completing procedural questions but could not apply the concepts from the procedures to related problem solving type questions. Difficulty in recalling definitions made it challenging for Kelly to complete questions which required conceptual knowledge as she could not fully understand what was being asked of her. Contrary to this, Susan demonstrated a deep understanding of the derivation of the formula for triangle area and also was able to apply concepts to solve problems. Brian showed that he was able to apply the concept of unit rates and ratios to various problems, suggesting that he had obtained some form of conceptual knowledge. As for the three Aboriginal students, there were not enough opportunities to observe whether or not they had a deep understanding of the concepts in their grade eight math class. In summary, conceptual knowledge varied as it was evident with some of the students but in other cases did not seem apparent or remained inconclusive.

CHAPTER 5 - DISCUSSION

Teacher Case Studies

Throughout many conversations with the teachers involved in this study, all three teachers claimed to be very interested in student success and said they made decisions with their students' best interests as a priority. For example, Ms. Adams had said on more than one occasion that she truly believed that moving Brian to a Foundations program would be the best solution for him. She felt that it would fill in the necessary learning gaps and give him a chance to be successful in mathematics. Ms. Chase had said that she was well aware of many of the behavior issues and family situations that some of the students were involved with. She had said that this was the reason she had ignored a lot of outbursts which would normally not be tolerated by most teachers. She had a good understanding that many of her students had personal issues and that mathematics was not a priority, and tried to remain positive and encouraging. Mr. Brown had some sense of the importance of real world problems, hands on tasks, and other reform based approaches.

The following is a discussion of the dominant themes which arose from the teacher case studies. The discussion also provides further examination of some of the factors which affect these students at-risk in mathematics as well as examining the needs of the student and the teacher.

Strategies and Practices Used by the Classroom Teachers

The Classroom Environment

The students in this study were provided with the materials which they needed if they did not have the necessary supplies themselves. In Mr. Brown's classroom, the students could use one of many individual baskets which contained a ruler, writing instruments, erasers as well as a calculator. Ms. Chase always brought in a class set of calculators and let students borrow pencils if they did not have one. Ms. Adams also lent out supplies to her students when necessary. Greenwalk, Hedges, & Laine (1996) report that student success may be correlated to the resources that a school can provide. Thus, when students have the necessary school supplies, they will be more likely to achieve success in mathematics than if they did not. These provisions attest to the genuine desires of these teachers to provide for their students.

Social interactions among the students were rarely observed during the mathematics lessons and practice time in the classrooms. Elementary schools may often offer students a more social and relevant environment as Csikszentmihalyi (1990) proposed, and students may not find this in an academic achievement based intermediate setting (Daniels & Arapostathis, 2005). Thus, students may find the environment more structured as the grades progress. In addition, a classroom which does not foster communication and group activities does not allow for those students to meet their social need for interaction and acceptance among peers (Hannula, 2006). Students therefore need to be interacting with one another and constructing knowledge socially and this important aspect was not generally observed in the four classroom environments studied (Ward, 2001).

The Ministry of Education in Ontario, National Council of Teachers of Mathematics (NCTM 2000), and other sources have stated that student centered learning is most beneficial to learning (Ontario Ministry of Education, 2007). In Ontario for example, the Ministry has attempted to support reform-based teaching by providing supports such as 'TIPS' (Teaching, Implementation & Planning Supports), is a resource containing many ready-to-go lessons in a reform-based style. However, as described in the literature, students can not generally make the shift immediately from a teacher directed environment to such a reform-based style without considerable attention given to developing social norms, problem solving skills, communication skills, and understandings of appropriate manipulative use. These understandings need to be developed by teachers over time with students. Ms. Chase attempted to have her students work in groups and follow a TIPS lesson but this lesson style was very different from other lessons I observed. Students were supposed to be developing the concept of maximum area given a fixed perimeter, using geoboards. The majority of the class was observed to be off task, whether talking to other students or playing with the manipulatives in a way that would not foster learning. Van de Walle & Folk (2005) recommend that group activities with two to four students per group in a mixed-ability setting provide a proper social setting highly conducive to learning. Students who had no previous opportunity to develop appropriate problem solving skills for use in a group setting might have found the abrupt switch to a reform-based lesson difficult and frustrating. After attempting this 'TIPS' lesson, Ms. Chase decided it was ineffective and she was not observed to attempt another lesson of this structure. Although students can obtain a sense of independence from working in a group setting and perhaps even

associate mathematics as a positive experience (Phillips, 2005), the transition to this mode of working may not be straightforward.

It cannot be assumed that students will develop skills for working in problem solving groups on their own. The anecdotes reported above underscore typical situations in which teachers shift abruptly from a highly teacher directed teaching style to a reform based lesson such as a TIPS lesson, when none of the required skills such as social math norms for group work or problem solving strategies have been developed. As a result, such lessons are at-risk of being a failure and the teacher “gives up” trying them again.

Effective support to help teachers begin to develop in students the necessary interactive and investigative skills, scaffolding them over time, may be needed. Professional development might help to support the smooth and consistent transition to such student-based environments. The development of investigative and problem solving skills takes time, must be done gradually, and cannot be done overnight especially for students at-risk (Kajander & Zuke, 2008; Kajander, Zuke, & Walton, 2008).

Mathematical discussions of any kind were not observed within these classrooms, although at times Mr. Brown appeared to attempt to initiate discussions. Van de Walle & Folk (2005) state that teachers need to be consistent if they are going to apply student directed learning. This implies that the students were perhaps not responsive to brief attempts at discussion because it was something the teachers were not being consistent with.

In addition, when Mr. Brown attempted to use manipulatives, many of the students responded poorly. The students had not developed an understanding of, or a respect for, the use of these learning tools. Mr. Brown experienced highly inappropriate

behavior with the manipulatives. The result was that manipulatives were no longer used, a problem that could have perhaps been prevented. Manipulatives help students to bring a hands-on experience and help to solidify concepts which may otherwise seem very abstract (Expert Panel on Student Success in Ontario, 2004). With all of the behavioral issues, however, they were no longer perceived as useful instruments by Mr. Brown in his classroom. Mr. Brown's decision to remove the manipulatives was not made because he had decided they were not useful, but rather because he could not manage their use in his classroom. This could have potentially had a negative effect on the overall quality of learning and instruction taking place, and students expressed frustration that manipulatives were no longer available.

Ms. Chase was observed to have remained very positive with her students, constantly encouraging them, despite the fact that many were unmotivated and would likely not do well in mathematics that semester. There were many times where a new unit or assignment was beginning and she reminded the students that this was their opportunity to succeed and have a fresh start. A recent Ministry of Education document states that it is important that the teacher remains very positive and energetic when instructing the students (Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6, 2005) and Ms. Chase's attitude seemed to be very appropriate and perhaps what many of these students needed to hear. A student's beliefs about mathematics may be reinforced by an influential person in their life (Phillips, 2005). Teachers have the potential to affect their students' beliefs and attitudes, and Ms. Chase tried to do this.

Administrative support may also be needed for teachers to succeed with difficult classes. For example, Mr. Brown appeared to become increasingly frustrated due to behavioral issues in his classroom and school, as well as with how he perceived the administration to be handling specific cases at times. This frustration may have suggested a very passionate concern regarding his students and their well being. The students possibly also saw his discontent at times and perhaps may have misinterpreted it as being their fault. Student behavior, a pronounced issue at that particular school, was observed to have inhibited the way Mr. Brown would have liked to teach and likely affected his attitude toward teaching. In other words, he wasn't able to do the things he wanted to in his classroom because of his students' behavior. What Mr. Brown felt were unsatisfactory methods of discipline from the administration seemed to be indirectly affecting the students also, and Mr. Brown's deteriorating attitude seemed to be exacerbated by this perceived lack of support. In summary, all three teachers appeared to care very much about their students.

Teaching Methodologies

Since Ontario's new mathematics curriculum strives to follow the constructivist approach (The Ontario Curriculum, Grades 1-8 Mathematics, 2005), students should be able to develop critical thinking skills in an environment which fosters the development of knowledge primarily coming from the students (Ward, 2001). Teachers certainly need to be given time to participate in better professional development which is meaningful and can be applicable to their teaching methodology and the way they approach certain situations (Askey, 1999). The emotional toll of dealing with at-risk students is not addressed in the literature and should also be considered in professional development. It

appears likely that supporting reform-based learning in Mr. Brown's and Ms. Chase's classes in particular would have required extensive training and support.

In a three-part reform-based lesson, the teacher introduces the problem and provides necessary background, students work together using materials and construct and debate their own solutions, and then a discussion aimed at sharing different solutions and developing a general consensus takes place with the entire class (Van de Walle & Folk, 2005). The third phase of the lesson is the part which requires the most teacher skill to facilitate in that it requires sophisticated teacher knowledge of both the mathematics as well as questioning techniques to draw out, compare and stimulate student discussion and consensus without "telling" the students if the methods are right or wrong. This type of environment was rarely observed during the course of the research project. The following is a comparison of what was observed as a typical lesson for each of the three teachers.

Ms. Adams, the teacher with over 30 years experience, utilized student reflection as recommended in the Math Makes Sense textbook (Brown et al, 2006) at the beginning of most classes. The reflection portion of the math period gave the opportunity for students to provide alternate solutions to problems as many of the reflections problems instructed the students to do so. As well, it was a time for students to quietly think about a proposed topic in a very private and safe manner. These ideas were not shared with the larger group however. As well, the remaining portion of her lessons was rarely student based as she would give the students a note to copy from the board followed by time to complete assigned questions.

One goal with respect to the constructivist approach is to have students generate the methods and answers in order to best retain new knowledge (Ward, 2001). Students

were limited in the amount of social learning that could take place by one of Ms. Adams's rules in particular, namely that during the homework period, students were restricted to asking a friend one question and Ms. Adams's one question. This may have created some confusion with the students in having to figure out which question they should save to ask their friend. The students were seated in horizontal groups of four which were parallel to the chalkboard but nonetheless this arrangement could have promoted more social learning than if the desks were separated in rows. Had these students been able to talk freely about mathematics with one another, they may have learned from each other and benefited from the assigned questions in a deeper way than they did on their own.

Ms. Chase's students were often given very lengthy lessons which involved teacher directed learning and copying examples from the chalkboard. At times, the instruction and note copying portion of the lesson took as long as 30 minutes or more before students were asked to attempt homework questions or assignments on their own. Blackboard notes were carefully constructed with relevant examples and diagrams, and step-wise procedures were often included to give students a way to complete sample problems from start to finish. Phillips (2005) reports that assisting students by giving them procedural steps can be helpful to improve short term memory, but overly long teacher-directed and procedurally oriented lesson do not conform to the notions of math reform (NCTM, 2000; Van de Walle & Folk, 2005) as described in the framework. Perhaps for students who have difficulty with short term memory, providing the steps would have been advantageous, as long as they already have had the opportunity to explore the ideas conceptually which was not the case here. In fact a significant body of

research indicates that providing procedures initially significantly decreases the potential for subsequent conceptual investigation (for example, Huhn et al., 2006; Van de Walle & Folk, 2005). Alternatively, students might have been able to develop conceptual as well as procedural knowledge had they been engaged in meaningful self-directed activities (Wheland et al., 2003).

Although socializing in the grade nine classes was not restricted, mathematical discussion was not specifically supported or encouraged. Students were seated in rows and most conversations I overheard were unrelated to mathematics. Many students were unmotivated to complete their homework and it was rarely observed to be shared or corrected the next day. There was no real incentive to complete practice problems and many of the students did not appear to be intrinsically motivated, or motivated at all by the material. Those students who often did not pay attention, particularly those who sat in the back of the classroom, were also observed to distract other students around them. A negative environment as described which favours a lack of participation places those students who are at-risk in an even more disadvantaged situation (Sullivan et al., 2006). The type of peer influence whereby one student may negatively influence the behaviour of another is termed as “self-handicapping” and may occur for a number of reasons (Dorman & Ferguson, 2004). It was apparent in Ms. Chase’s class (as well as Mr. Brown’s) that students had behavioral issues or could not stay focused during the lesson because they were unmotivated or disengaged altogether. As discussed, students would socialize during the lessons, pass notes or distract other students by playing with school supplies. One boy in particular was observed to try to pay attention but was easily distracted by many boys around him who would frequently talk to him. It appeared that

he would join in with them to conform and so that they would think his behaviour was noble as well. When Ms. Chase became aware of this, she immediately rearranged the seating plan. Afterwards, there was less distraction at the back of the classroom and the boy who was previously not focusing was observed to be much more attentive during the lessons.

Student wait time was observed to be yet another issue which was controlled by the teacher and may be an issue for students at-risk in mathematics as described in the framework. For Ms. Adams and Ms. Chase, the waiting period for a student response to a posed question was only as long as it took for the first student to raise their hand. Thus, students who needed more time to think about their answer may have felt pressured, rushed or incompetent if speed was not one of their strengths. This may also have affected an already poor attitude and level of confidence for students who were already at-risk or susceptible to an at-risk situation in mathematics. Accommodations of this kind need to be considered for students at-risk in mathematics. Just as extra time for response may need to be given, students may also need extra time for examinations and extensions on assignments (Expert Panel on Student Success in Ontario, 2004). This was certainly observed as many students in the case studies were receiving marks of zero on assigned work as well as leaving many test questions blank which may possibly have been due to time constraints.

Response to Students At-Risk

Most of the environments did not involve any modifications for students at-risk, and the one modification noted did not follow the literature recommendations. The students in these case studies were also observed on a number of occasions to shy away

from rising to a challenge and refusing to attempt somewhat difficult problems without being motivated and coaxed into doing so. They were also generally extremely loath to ask the teacher a question. This meant that the students were not able to truly see what they were capable of mathematically simply because they were too afraid to try or too embarrassed to ask for help. The teachers in the study appeared to have difficulty creating a classroom environment where students felt that it was safe to make mistakes and ask questions.

A common misconception by teachers is that at-risk students should not be challenged, but need more time with basic and fundamental skills (Woodward & Brown, 2006). Brian, for example, was removed from the classroom to work on lower level fundamental mathematics which may have in fact been slowing down his learning and further jeopardizing his success in mathematics (Expert Panel on Literacy and Numeracy Instruction for Students with Special Education Needs in Kindergarten to Grade 6, 2005). As explained by Woodward & Brown (2006) and others, leaving Brian on his own to attempt to complete 60 plus pages of a workbook, might have caused him to practice incorrect methods. The other students involved in the case studies were not subjected to these modified programs, however, they were also not receiving work which was different from other students in the classroom who may not have been at-risk in mathematics. According to Ontario's Ministry of Education, such students should be offered an even more stimulating mathematics program (Expert Panel on Student Success in Ontario, 2004). The literature indicates that students at-risk should sometimes be given differentiated work which would be appropriately challenging for them, rather than only extra lower-level practice.

Summary

Teachers observed in the study described many frustrations in their daily work. They described some of the main issues as problems with the administration, lack of extra support, time constraints and in particular issues with the students in their classes. First and foremost, if students are not attending school, there is a major issue which probably provides the greatest contribution to their at-risk status. Teachers are restricted in terms of their ability to convey mathematical concepts as well as be supportive in their students' personal lives if students are not attending school. This restriction also applied to some of the techniques that two of the teachers tried to use to give their students a hands on experience with mathematics. For example, manipulatives should certainly be a part of concrete learning and math reform, yet in a classroom with so many behavior problems, implementing their use became quite an issue. Other behavior issues among students also had an impact on their learning. Many of the students at-risk had so many issues going on outside of school that it appeared as difficult for many of them to actually focus on mathematics, to really concentrate and analyze information which was required to solve problems. However, many of the students observed were also not engaged by the mathematics itself. While the new curriculum is designed to support improved mathematics learning, most of the classroom teaching observed was highly traditional, procedural, and teacher directed. Meaning making, engaging relevant contexts and problem solving were generally not supported in any observable way. Most lessons remained highly procedural. Students were generally expected to work on decontextualized tasks without social interaction or other motivating aspects. Few connections to their worlds and interests were made, with the exception of attempts by

Mr. Brown. Best practices for students at-risk as described earlier in this report were seldom observed during this research.

Student Case Studies

Observable Behaviors of Students At-Risk

Attendance

Attendance was a significant issue for most students in the case studies. As well, lateness, leaving class and off task behavior added to time missed. This factor alone would have been enough to place over half of the case study at-risk. The way in which a student views school can significantly impact his or her attendance (Railsback, 2004). Many of the students observed claimed that they were bored in the mathematics classroom and that they could not see the value within it. Attendance was such a major issue for the students in this research project because they were missing days where marks were accumulated for assigned work or tests. As well the students were missing concepts through lessons which they most likely would need to succeed when it was time for evaluation. Their personal issues, a lack of desire to attend mathematics class was obvious. This is somewhat understandable when the material itself is examined since student engagement was not supported in general, and the length of the formal lessons in the grade nine class in particular was overly long for these students. Conflict in the home environment, a lack of parental discipline, and poor socialization skills at school could all be factors which lead to their poor attendance (Corville-Smith et al., 1998).

Just as daily attendance seemed to be contributing to poor performance in school and mathematics in particular, the number of times some of these students have

transferred schools was also quite significant. Many adjustments and social issues were also likely to be factors among the girls as a result of having to move so frequently (Corville et al., 1998). It is highly unlikely that each school attended had been following the same schedule with respect to the mathematics curriculum they were covering. The new teachers needed to make sure that they determined what previously covered and make sure that the students were brought up to speed with the rest of their new classmates. Students' gaps in mathematical knowledge and difficulty adjusting to new environments may have contributed to placing them at-risk in mathematics (Beekhoven & Dekkers, 2005; Corville et al., 1998).

Behaviour Issues

Behavior issues in the classroom were quite pronounced among several students. The literature is very supportive of the reality of these examples and states that the needs of the students should be examined to perhaps explain the cause of certain behavior or misbehaviour (Hannula, 2006). Intermediate students in particular need their most basic needs met as a priority but also have the need for identity, independence and social acceptance (Sullivan et al., 2006). As well, although educators may make an honest and well-meant attempt to fulfill these needs, that opposition to learning and behavioral issues may still exist. Teachers may have varying levels of understanding of the application of best practices for students at-risk. With these case studies in particular, there were varying degrees of behavior issues from one day to the next. It is important to uncover the potential source of the issues so that perhaps the student may be assisted in fulfilling some type of need. Behavior issues were a significant factor which affected performance of the many of these students in mathematics and may have been one of the many causes

which led to these students as being classified at-risk. Both external factors such as home-life, and internal factors such as a dry and uninviting subject matter presentation including some overly long formal lessons may have contributed to students' lack of engagement to varying degrees.

To balance the previous discussion about students, one must also view behavior issues through the lens of a teacher. Kajander (2002) found that although attendance was a major issue, performance tasks which could be related to concrete life situations were much more effective than tests (Kajander, 2002). This form of assessment appeared to be less threatening to the students and helped to alleviate some of the behavior issues that were faced (Kajander, 2002).

Assessment Results

For those students in the study for whom grades were available, it was noted that most assessments were tests, and the study students did not do well on them. However, when performance tasks were used instead of formal tests, Kelly and Susan in particular, were observed to have achieved much greater levels of success. It might be argued that continuing to use performance tasks as the primary means of evaluation might have contributed to greater success and a more positive attitude towards mathematics itself (Kajander, 2002).

Self-Confidence and Belief in Ability

Another observation which emerged over time was students' lack of self confidence and belief in their ability to succeed in the mathematics classroom. Negative experiences with mathematics may contribute to lowered confidence in the subject area

which ultimately can affect a students' performance (Butterworth, 1999; McFeetors & Mason, 2005).

Mathematical success - or lack thereof - may have affected the case study students' overall self-confidence, as well as their confidence and willingness to try in mathematics itself. This implies that teachers and parents should be consistently using positive reinforcement and providing students opportunities where they can feel successful in mathematics. Negative experiences and past failures are not forgotten by many students and can have a lasting impact on their success in mathematics. To counter this, teachers should help the student build confidence on mathematics by focusing on recent success in the subject area (Augustyniak et al., 2005).

Issues Pertaining to the Curriculum – Relevance and Motivation

The need for independence is an important for intermediate students (Sullivan et al., 2006). When the students are subjected to rote learning without understanding, the need for independence cannot be met (Hannula, 2006). Such unfulfilled needs might partly explain why many of the students in Ms. Chase's classroom were constantly making excuses and looking for ways to leave the room as soon as they could escape after the formal lesson was complete. Kelly also appeared unmotivated as she consistently was passing notes and not paying attention in class. Susan expressed that she did not see the relevance within the curriculum and could not understand why she had to be learning the mathematical concepts she was being presented with. As well, Jessica's abrupt statement, "I'm bored" after completing only 10 minutes of mathematics work perhaps describes it best. In summary, I did not observe the study students experiencing a curriculum which was interesting to them. The observed lack of motivation and outward

expressions through their behavior suggests that some type of need was not being fulfilled (Hannula, 2006; McFeetors & Mason, 2005). These needs could have been a combination of needing a relevant curriculum and possibly a better quality of life in general (NCTM, 2000; The Ontario Curriculum, Grades 1-8 Mathematics; Butterworth, 1999). The traditional structure of the lessons followed by many of the teachers appeared to be only adding to their disengagement. Thus, the curriculum itself as well as its mode of delivery, and the contexts teachers use in problems, need to be explored (Hannula 2006, Agbo, 2002). The students were questioning the relevance of many tasks, and appeared to be disengaged partly as a result of a lack of interest in these tasks.

Cultural Issues and Impact

The framework for this study suggests that a person's knowledge and means of socialization are influenced by the culture in which they live (Brimi, 2005; McLaren, 2003). It is argued that schools often negatively repress minority cultures by imposing a dominant Western European culture (McLaren, 2003). Agbo (2005) reported that Aboriginal students have inherently different values and knowledge based upon tradition that is quite disconnected from Ontario's curriculum. The classroom issues among the three self-reported Aboriginal students in this study may have had something to do with the fact that their cultural needs were not being met.

Specific cultural factors may be a major factor contributing to the mathematical difficulties which students who are not a part of the Western European culture face. The three different teachers who participated in this research could be classified as teaching in a manner of a low context culture typical of Anglo European Americans and Canadians.

This means that often they primarily relied upon direct, verbal communication (Lynch & Hanson, 1997).

Aboriginal or African American students who are from the non-dominant culture may be less advantaged when taught by teachers from the dominant culture. McLaren (2003) says that students from the non-dominant culture may struggle in the school setting, however, this study indicates that students from the dominant culture are also at-risk in mathematics. There may be multiple explanations for this. One such explanation may be attributed to the informal and formal processes of learning mathematics. Children informally learn and construct knowledge prior to entering school, as the environment in which many grow up is quantitative in nature (Ginsburg, 1997). It is important to note that such a quantitative environment may not solely depend upon a particular culture or race (Ginsburg, 1997). Prior to entering the formal school setting, much of the desire for children to learn is through their own curiosity and motivation. Many of the students involved in the research project reported enjoying mathematics at a very young age, which reinforces the suggestion that the structure of the subsequent curriculum is displeasing for many. Specifically, the formal mathematical learning often opposes the freedom and enjoyment of informal mathematical learning and prior means of constructing knowledge (Ginsburg, 1997).

Reform-based practices are supposed to provide opportunities for all students, as the equity principle states (Kajander 2003; NCTM, 2000). Reform-based practices may conflict with some cultures, and should carefully be applied to culturally-diverse students. Students from high context cultures could benefit from mathematics reform-based practices as they promote communication and interaction among students.

Considerations should be made in terms of the forms of communication which are utilized in the classroom environment. For example, Aboriginal students may not feel comfortable with making eye contact and thus, large group presentations may pose a problem for some (McLaren, 2003). A student who is less verbal and has low self esteem may also face some initial difficulties in the reform-based learning environment, because they may feel less comfortable or willing to engage in discussions. Therefore, the construction of knowledge might look different from one student to another, depending on learning styles and culture. Thus, it is imperative that a teacher knows his or her students and understands that different cultures respond differently to reform-based learning.

As recommended by the literature, connections between the school, family and community should be fostered to help students become more successful in the classroom environment (Wang, 1996, Agbo, 2005). Linking the different environments will help unify values and beliefs toward the importance of education as well as better help all stakeholders to have a better understanding and respect for one another. A plan should be implemented which would help teachers to identify students at-risk as early as possible and intervene as necessary. Such an intervention may mean direct help from the teacher academically or personally. As well, teachers need the skills required to recognize issues and refer students and their families to the services they need.

Students come from unique environments of which they are a product (McLaren, 2003). Not all Western European cultures are identical, nor are all Aboriginal, Asian or African American cultures. It is for this reason that it is important for teachers to know both their own cultures and traditions, as well as make the effort to understand those of

the students in their classroom (Agbo 2002; Lynch & Hanson, 1997). A teacher taking the time to become culturally competent within the classroom environment increases the chances for the success of all students (Agbo, 2002).

Personal and Mathematics-Related Learning Characteristics

Difficulty Reading and Problem Solving

Since Brian's difficulty with problem solving seemed to be related to his reading comprehension, it may well have often been that it was the written text (rather than the mathematical ideas) which he did not understand (Robinson, Menchetti, & Torgesen, 2002, Geary, 1994). In Brian's case specifically, many of the questions assigned appeared to have little relevance to the life of a grade seven student (Expert Panel on Student Success in Ontario, 2004).

With respect to problem solving specifically, the opportunity to see and share solutions with other students may have deepened Brian's understanding but was not provided (Daniels & Arapostathis, 2005). Relying on the calculator was not comfortable for Brian; perhaps it was relatively unfamiliar, or perhaps it added to his perception of being "not smart".

Placing Brian in a life skills program may in fact not have been necessary for mathematics in particular. Possibly it may have even been detrimental in that the mathematics was not at the grade seven level. From observation, it seemed that reading and comprehension were the main issues and this is where some remediation may have been needed. Watching him work through the thick booklet of grade five and six work (with the help an educational assistant or myself but almost never the regular teacher)

made me question whether this was the best solution to Brian's mathematical education. The assumption that he needed more time with the basic skills could have been boring for Brian (Woodward & Brown, 2006). Instead, he could have benefited from rich problem solving tasks as these rote basic tasks could have been taking away from developing his learning capabilities (McFeetors & Mason, 2005). He was moving through the booklet at a much faster pace than the other two students who had been given it and also with very little assistance. The parts that he found difficult seemed related to the reading difficulty, and he could even identify that the word problems were the toughest for him. Once he understood the meaning of the words however, he appeared to have little difficulty. Therefore, to help him read and understand the math problems, Brian could have used an assistive software program for reading. Assistive technology has been shown to significantly increase reading comprehension and might therefore have helped Brian understand problems and instructions for his mathematics tasks (Higgins & Raskind, 2004). Brian could have also used the help of another student, teacher or educational assistant.

If Brian had his own educational assistant with a strong mathematical understanding, or perhaps one who could have paid a bit more attention to him and attended to his reading difficulties, he may quite possibly have been successful in the grade seven curriculum. Educational assistants currently do not receive particular mathematics training despite being placed in mathematics classrooms.

Difficulty Focusing

Brian had difficulty focusing in the mathematics classroom which could have impeded his ability to be successful. However, with assistance, he was observed to

complete the tasks he was given. It is important that the classroom teacher be aware of those students who have difficulty remaining on-task and give helpful reminders as much as possible. Another realistic solution would be to place the students in close proximity to the teacher's desk, near the front of the classroom and away from other students who could pose as a distraction (Wood et al., 2006). It should also be determined whether a student has any attention issues for which an individualized education plan

Students like Brian might need some assistance with organization as well and how to effectively use an agenda to remind them of school related responsibilities like homework. When the key concepts of lessons were re-discussed with Brian in different ways that he could understand, such as drawing diagrams or stating questions in another way, he was able to grasp and apply them to his assigned work. The organizational reminders and reading reinforcement may be what some students need to be successful in mathematics. In time, students like Brian could potentially learn how to stay focused on their own. If students could learn to identify when they are having difficulty and to ask for assistance during these circumstances, this would also be helpful.

The Need for Guidance and Support

A good rapport or trust relationship between the teacher and the case study students was not observed in any of the cases. Many of the girls at School B expressed that they sensed that their teachers were often frustrated with their lack of understanding and that this was very intimidating for them as they no longer wanted to ask questions. Students who were sent into the hallway to work on their "life skills" math booklets may have felt abandoned by their teachers. At times they had questions and the teacher was not with them, so they may have felt that they were not given much support. In fact, these

were the students who likely needed the most attention from their teacher. It was hard not to worry about what would happen to the study students when I was no longer working with them. I believe that many of the students in the case studies had come to rely on my assistance and felt that I had become their advocate. They whispered things to me that they were not sharing with the teacher, and asked me for help more often than they had asked the teacher at the start of the study. Again, it should be noted that the individual support the students seemed to be benefiting from is not always practical in a classroom setting where a teacher may have several at-risk students who each need assistance (Kajander, 2002). Therefore, there exists a significant challenge for these teachers to provide for each individual student's daily needs (Kajander, 2002).

The benefit of my rapport-building with the students was that they were able to discuss personal issues with me due to having gained their trust. Although it is not necessarily the job of the teacher to solve personal problems for the students, at least with some understanding of what is going on in their lives, teachers could direct them to the help and support that the teacher may not be able to provide. While it would not be impossible for students to open up to their teachers and be able to express that perhaps they were facing personal issues in their lives for which they needed assistance and support, but it would certainly take time and effort on the part of the teacher. After only a few visits and by my expressing a genuine concern for their well being and interests, the students seemed to be much more attentive to the things that I was saying to them than those the teacher said. If students feel respected and feel they can trust the teacher, it may open up many other avenues and ultimately assist the students in becoming successful mathematics students.

Proximity may also be important; the students would frequently whisper mathematics-related questions to me while I was sitting next to them, but would rarely be seen to get up and approach the teacher with such questions (Wood et al., 2006). It is for this reason that it is very important that teachers circulate the room and constantly ask these students in particular how things are going and if they need assistance with their work. Otherwise, it would be very unlikely that these students would approach the teacher themselves. On the other hand, I was not their teacher and would have no part in their assessment. This may have added to their level of comfort with asking questions and taking chances. Nonetheless, I was approaching the students and they felt they could use me as a resource when they were at a roadblock with a question. One of the teachers in the study in particular shared this view and stated emphatically that the two case study students would never have passed the course without the my presence. External sources of support and motivation were necessary on many occasions as internal motivation did not appear to be sufficient for independent success with the case study students deemed at-risk in mathematics. Another study teacher admitted that the individual assistance some students needed could not be fulfilled by the teacher alone and that more support was necessary. If teachers attempted greater proximity as a strategy, perhaps communication in the mathematics classroom could be better encouraged.

Conceptual Knowledge

The questions used by the classroom teachers were highly decontextualized and did not appear to promote engagement or deep conceptual thinking (see Figure 4). Butterworth (1999) equates success in mathematics with conceptual knowledge and it was observed that the students involved in the research had few opportunities to attain such knowledge.

The procedural tasks given ignored many of the elements of best practices as described in the framework such as the use of manipulatives, real world examples, or contextual and motivating problems. The procedurally oriented and decontextualized questions I observed being assigned did not appear to be supporting these students' conceptual development.

Limitations

Although the study was planned with significant teacher input from the professional learning groups from the previous year, perception checks from the teachers regarding their teaching methodologies were not conducted. This could pose as a limitation to my chosen methodology as the observations made were often solely based upon my own perceptions. I only discussed perception checks regarding student performance with their respective teachers, as retelling their personal stories to the classroom teachers would violate the ethical guidelines to which the students and their parents had consented.

At the time of the research, I was not a classroom teacher and perhaps the lens I was observing from was very different than that of a more experienced teacher. I am also not a member of a high-context culture and thus relied on relevant literature and the guidance of my committee member who was very knowledgeable regarding cultural capital. Thus, much of my knowledge was literature-based and came from experiences I could draw from as a student, a mathematics tutor and from my teaching placements. I definitely felt badly for the case study students and felt a strong desire to assist them during the research. I was not ever labeled at-risk, in fact, I received enrichment within

the subject area. Thus, a lack of perception checks and my 'world-view' could arguably have been limitations to this study.

Conclusion

The factors that affect students at-risk in mathematics, as explored through this research, are very specific to each student's experiences both within and outside the school setting. Factors such as attendance, behavior, motivation, belief in ability, and the subject material of the mathematics itself, were observed as issues for different students at-risk in mathematics. The multiple factors which affect students at-risk in mathematics were present in various combinations and levels of severity, thus indicating that the individuality of students is a major contributor to this issue. Individuality of a student will have been shaped by particular experiences and circumstances which may have been influenced by social identity, gender, class and ethnicity (Pearce, 2005).

According to the framework for this study, the definition of one's culture includes race but also incorporates the concept of individual values and beliefs that each person brings to the school environment. People are a product of their environment and the different experiences and situations shape who they are and what they will become as individuals. The teachers and students in this research were only a subset of the population yet were examples of many of the different circumstances as well as factors which may affect individuals and their success in teaching and learning mathematics.

Concluding thoughts related to each research question follow, organized by research question.

Question 1. What types of strategies and practices were the study teachers using in their classrooms for all students, and were there any other strategies used for the students who they believed to be at-risk in mathematics?

Emergent themes included: the physical classroom environment, teaching methodologies, the response to students at-risk and the impact of the classroom environment. Specifically, the classroom environments varied in terms of row seating and groups, with seating plans that were not observed to change throughout the observations. The teaching methodologies were mostly traditional in nature and students at-risk in the study were generally not treated any differently than the rest of the students in the classroom, with the exception of one student, who received a remedial learning package. The classroom environments involved few social learning opportunities and teachers were not observed to utilize the recommended 'wait time' for student responses. In general, the teachers were not observed to be using strategies as outlined in the literature which were recommended as best practices for all students and students at-risk.

Question 2. What were the observable behaviors of the students identified as at-risk in the study as they interacted in the classroom environment?

Emergent themes included: attendance patterns, behavior issues, and weak assessment performances. Attendance was the poorest for the three Aboriginal students, who often made it difficult to conduct research because they were not present. Attendance was an on-going issue for the girls and had been an issue throughout many of their elementary school years for various reasons. Some of the students at-risk demonstrated issues with respecting authority and refused to complete their assigned work. Assessment results were generally poor for all six students in the case studies. However, when utilized

as a form of assessment, assignments proved to be the better of the grades when compared to tests. Overall, students' observed classroom behaviors seemed to be inhibiting their success in mathematics.

Question 3. What personal and mathematics-related learning characteristics were observed in the case study students?

Students variously had difficulty with reading, problem solving, verbal communication and computational skills. Conceptual knowledge was another mathematics-related characteristic which appeared to be inhibiting the success of at least some of the students. With respect to individual learning characteristics, confidence and a lack of motivation to be successful may have been related to the observed need for the students to have some form of individual guidance and encouragement. The personal and mathematics-related learning characteristics were unique to each student, yet each student displayed mathematical weaknesses which may in turn have been linked to difficulties in their overall approach to learning.

Suggestions for Future Research

Studies in the future may want to concentrate on only one or two aspects (e.g. attendance) in greater detail to come to a better understanding of the effects of a particular factor on mathematical development. The time length of future studies should also be taken into consideration as rapport building is an important aspect in order to create a comfortable and natural setting for all involved with the project. As the study was limited to one Northern Ontario city, a comparison of students at-risk across many different regions may yield different results and potentially affirm speculations that the environment plays a key role.

This research was a rewarding and rich experience not only for me but I believe also for the teachers and students involved. Further research of this kind will allow for the expansion of knowledge regarding students at-risk, and may also touch the lives of all who are involved.

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APPENDICES

Appendix A – Information for Students and Parents

Information for Students and Parents

Research Study related to intermediate student success in mathematics

Your son, daughter or ward has been recommended by their classroom teacher to participate in a research study called *Factors Contributing to Success for Intermediate Students of Mathematics: The Needs of the Teacher and the Needs of Students* taking place in your school. The purpose of the study is to identify needs and issues for student success in mathematics.

If you agree, your child would receive one-on-one assistance and observation by an approved research assistant from Lakehead University several times a week during their regular mathematics class for the fall of 2007. All interactions would be approved and supervised by the regular classroom teacher. This study will allow us to collect information about the needs of students in mathematics, and may also be of individual benefit to selected student participants. All data will be confidential, and at no point will your child's name be used in sharing the results. Participants may choose to withdraw from the study at any time.

If you are willing to participate, please sign and return the attached Consent Form to your classroom teacher. Feel free to contact your teacher or Ann Kajander the researcher, as below with any questions or concerns. Thank you for your interest.

Dr. Ann Kajander
Lakehead University
phone: 343-8127
email: ann.kajander@lakeheadu.ca

Appendix B – Consent Form for Students, Parents and Classroom Teachers
Consent Form (student, parent, and classroom teacher)

My signature on this sheet indicates I agree to participate in the study *Factors Contributing to Success for Intermediate Students of Mathematics: The Needs of the Teacher and the Needs of Students* with Lakehead Public Schools by Dr. Ann Kajander of Lakehead University and it also indicates that I understand the following:

1. I am a volunteer and can withdraw at any time from the study.
2. There is no apparent risk of physical or psychological harm.
3. The data I provide will be confidential and data will be securely stored at Lakehead University for 7 years.
4. The study has no impact whatsoever on student grades, nor will student or teacher names be associated with study results in any way.
5. I will receive a summary of the project, upon request, following the completion of the project.

I have received explanations about the nature of the study, its purpose, and procedures.

 Signature of Student Participant

Name (print) _____ Date: _____

 Signature of Parent or Guardian

Name (print) _____ Date: _____

 Signature of Classroom Teacher

Name (print) _____ Date: _____