Patterns of choice and visions of future: What role does socioeconomic status; gender and culture play in students' choices about mathematics education in Northern Ontario secondary schools.

Charles Daviau

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Focus of Study:

What factors affect a grade nine student's 'choice'[1] in taking applied or academic mathematics classes within Northern Ontario schools, and in what ways do these factors influence the mathematics courses successfully completed by students?

Background:

My work as a mathematics tutor and instructor in the local First Nations communities of Sagamok Anishnawbek and Atikameksheng Anishnawbek sparked my interest in trying to understand the role of socioeconomic status, gender and culture in students' choices about mathematics education in Northern Ontario secondary schools. I questioned why students were not taking academic level mathematics; since not taking this level of mathematics severely limited their future career options and earnings (Rose and Betts 2004; Rose and Betts 2001; Levine and Zimmerman 1995; Spence 1973; Altonji 1995; Joensen and Nielsen 2006). As Mason and McFeetors (2007) put it, "mathematics is viewed as the critical filter that distinguishes students' readiness for further learning" (p.293). Mathematics, to use Bourdieu's (1998) concept, constitutes a symbolic capital, and as all capital it is socially and culturally distributed. Some years later, I taught on Manitoulin Island at a school that had a high percentage of low socioeconomic families in the area and over 50% First Nations students. Again, the academic stream was not the students' first choice, notwithstanding the fact that their post-secondary and employment

[1] It is important to note that the word 'choice' in this paper implies that the student's 'choice' is influenced by parents, guardians, teachers, councilors, and community members. It is the student who takes the final step into the classroom; however, it might be the parents telling him/her to go. It might also be the case that the student is a passive participant in the process, completely influenced by others.

opportunities would be affected by this choice. I understood the problem as complex, as Waldrop (1992) defines "complex, in the sense that a great many independent agents are interacting with each other in a great many ways" (p.11).

Further, I noticed that the students I taught gained greater understanding when I used analogies and examples that were situated within their own frame of reference. Lakoff and Núñez (2000) and Barton (2009) argue that mathematics is best understood within the embodied mind, which means that mathematics is understood through human experience, stories and metaphors. Since many of the people living on First Nations communities have different histories and experiences, it follows that by teaching them through analogies and stories that are familiar to them will help in their understanding of mathematics.

Various studies (Finnie and Frenette 2003; James et al 1989; Arcidiacono 2004) have shown that disciplines, which have higher mathematical requirements such as Health, Engineering and Computer Science, Commerce, and Mathematics/Physics have the highest earning potential. Yet little is known about the reasons that lead Northern Ontario Aboriginal, Francophone, and Anglophone students from low income socioeconomic families to not embrace the academic stream in the school. As Michel Foucault (1980) contended, societies create, through their practices, webs of power and knowledge distribution and induce cultural values that nonetheless may make some knowledge inaccessible for sectors of the population. It might also be the case that those sectors fail to recognize the

empowering opportunities that could follow, had those values become part of their horizon of life. If disciplinary training correlates with earnings, how ought researchers and policy makers to think about the unequal differential that exists between socioeconomic classes as this inequality manifests in disciplinary choices? I am interested in researching the socioeconomic status, cultural, gender, class and the rural/urban effects on mathematic selections made in high school, particularly in the transition from grade eight to grade nine for Northern Ontario youth.

Finnie and Frenette (2003) show that professional fields requiring Mathematics have a higher return on educational investment; i.e. students with degrees in fields that require mathematics make more money. Therefore, the mathematics selection in high school directly impacts the range of options that a student has later in their career choices. Within the context of social and cultural distribution of wealth and knowledge it is important to consider 'choice' not as a mere subjective act, but as a social, cultural, economic phenomenon. The factors, which could influence the 'choice' in a nonlinear way, include how a child envisions her/his future, the parents' education levels, the socioeconomic status of the family, community values, and school constraints and affordances. The objective of the thesis is the investigation of the interrelations of these factors leading to a student's 'choice' in grade nine regarding applied versus academic mathematics classes. Some students 'choose' not to take academic level courses in mathematics during high school, perhaps because of cultural, socioeconomic, or other influences; and not taking academic mathematics courses can limit their choices when they get to post-secondary institutions. Students without these qualifications cannot get into

programs at the post-secondary level that require mathematics such as the Sciences, Commerce, and many Health Fields. My focus, therefore, is as follows: Considering the concept of factor in a holistic way[2], my research question is: what factors affect a grade nine student's 'choice' in taking applied or academic mathematics classes within Northern Ontario schools, and in what ways do these factors influence the mathematics courses successfully completed by students?

Perhaps the degree of parental support or the student's culture affects the placement by either influencing students' perception of their own abilities, or it might be the case that the pedagogy is not culturally sensitive. For example, a student from a working class family might be encouraged to take the easiest path in high school in order to get a job at the local factory. The cultural aspect of mathematics placement might be influenced by the link between culture and cognition. According to Luis Radford (2008), a Semiotic System of Cultural Significations (SSCS), means that there are culturally relevant symbols and methods for learning and understanding mathematics, and there is a need to take an anthropological viewpoint to see how some cultures see mathematics differently. An example of this comes from the knowledge I gained from working in First Nations communities as an instructor for the General Education Diploma (GED), and teaching mathematics for Cambrian College's (ACE) program. I noticed that many of the aboriginal students had difficulties with the Greek symbolic logic and I made an effort to use symbols and stories that they could relate to, and this made a difference

[2] By holistic way, I mean that I will take into consideration the complex ways that factors affect students' choices. Holistic also implies a complex and non-linear relationship.

in their comprehension of mathematical concepts. I began to introduce traditional symbols in my lessons, while still focusing on a narrative that related to their milieu. According to Radford (2008), SSCS influences four main areas of mathematical knowledge, first it influences the "ways of conceiving knowledge…[and the ways in which] one seeks knowledge primarily as an end in itself, while the other pursues it as a means to an end"(p.459), this implies that there are different ways of looking at knowledge itself. On one hand, a culture influenced by capitalism might see knowledge as a means to an end, a way of making money or increasing production. On the other hand, a communal culture might see knowledge as an end in itself, a way of giving back to the community around them. The second is influenced by how a culture perceives what is important; a person is affected by "what is relevant and how to deal with relevance" (p.459). The third way a culture sees itself in relation to mathematical knowledge is through "the cultural kinds of relationships between subject and knowledge (e.g. attitudes towards mathematics)", this implies that certain cultures might have different attitudes towards education. The fourth way SSCS influences main area of mathematical knowledge is through the "forms of knowledge representation that may vary from one culture to another…West's emphasis on the relevance of writing, mathematics is often reduced to the written dimension" (p.459). Radford proposes the need for an "anthropology of mathematical thinking" (p.459). This implies that there is a need for further research in the ways in which cultures respond to the traditional Western views of mathematical thinking and placement.

One way of understanding the relationship between 'choices' that students make about mathematics courses in high school is to use ethnographic research methods to gain a greater understanding of the relationships and power dynamics within the classroom. Holt (2004) used ethnographic methods when she was examining differently abled children in order to see how the relationships within the classroom can affect a student's identity. Holt's research was within one school, were she conducted twenty semi-structured interviews with children. For my thesis, I am planning to investigate some of the reasons for particular mathematics choices within high school. If I find that First Nation's students disproportionately choose applied mathematics, I might be able to conduct similar ethnographic research in order to investigate the reasons for these choices. Perhaps the classroom management practices used by teachers in the classroom in dealing with certain students affect many of the student's attitudes towards mathematics. The observation made when the teacher is not looking might shed some light on the students' real feelings about mathematics. The observations made by Holt illuminated how "children constructed child-cultures" (p.230). Child-constructed cultures means that students can create and transform expectations from teachers and influence attitudes towards subjects. For example, if a student is struggling with a mathematical concept, that student could influence others into dismissing the importance of the subject entirely. These types of observations might shed some light on the dynamics within the classroom during mathematics lessons. I believe that Holt's paper is useful for my thesis because of her classroom research method. I am planning to study children in different mathematics classes and I will be more

aware of the children's own "child-spaces within the classrooms in which to perform their own cultures" (p.232). This implies that students are not passive recipients, but active participants, overtly and covertly, creating power relations within the classroom that could affect their attitudes towards mathematics.

Another example of the social issues surrounding mathematics within First Nations communities is the tension within the community against Western culture. Many of the students who I tutored often felt excluded from other community members when they succeeded in school. This is also evidenced by the derogatory comments made by students in the community. One of the terms used by Sagamok Anishnawbek children is the word 'apple'; students who succeeded academically, were called 'apples' by other students because they may look red on the outside, but they are white on the inside. This type of language and exclusion of students within aboriginal communities sheds some light on the tension and peer pressure that the youth from the communities face from what Helin (2000) describes as 'lateral violence'.

Methodology:

In order to get a representative sample of the students within Northern Ontario who are making the decision about what mathematics courses they are taking in high school, I am therefore proposing to use a representative sample of grade nine students across Northeastern Ontario schools. Ideally, I would like to send out questionnaires and then survey students from a variety of school boards,

including the Rainbow District School Board, the Sudbury Catholic District School Board, Algoma District School Board, Huron-Superior Catholic District School Board, the Near North District School Board, Conseil scolaire de district catholique du Nouvel-Ontario, Conseil scolaire de district du Nord-Est de l'Ontario, District School Board Ontario North East, Northeastern Catholic District School Board. The questionnaires would enable me to gain an understanding of a variety of schools across Northeastern Ontario. I would also like to sample a variety of schools from various First Nations, including but not limited to Sagamok Anishnawbek, M'Chigeeng First Nation, Wikwemikong Unceeded Indian Reserve, Dokis First Nation, Nipissing First Nation, and Aundeck Omni Kaning. The questionnaires would be rather simple to complete with minimal cost. However, the interviews would require substantial resources depending on how many students are chosen from each board, and First Nation schools. I would like to conduct enough interviews with students from a variety of cultural and socioeconomic background to provide a representation of the student population. Given that I am currently working on Managing Information for Student Achievement (MISA) a project with Laurentian University, the Ontario government and many of the school boards mentioned above, I do not believe that getting the school boards to agree to such a study would be difficult. The difficulty does not arise from getting the school boards and communities to agree to such a study, but rather the difficulty comes from getting the appropriate funding to pay researchers to speed up the task of interviewing a number of students from the various towns and cities from Northeastern Ontario.

A representative sample might be achievable by sending out questionnaires and sampling students from the Rainbow District School Board, the Conseil scolaire de district catholique du Nouvel-Ontario, M'Chigeeng First Nation, Wikwemikong Unceded Indian Reserve, and Sagamok Anishnawbek. The geographical area would cover the areas of at least 14,537 km^2 including Manitoulin Island, Massey, and the District of Sudbury. These school boards and communities would encompass 50 elementary schools and 15 high schools within the sample area. The differing socioeconomic statuses and cultures found within this area are indicative of many rural and urban areas within Northern Ontario.

I plan to develop descriptive statistics of the population of students within the study. It is important to get a sense of the student population in Northern Ontario, what percentage has First Nation Ancestry, what is the average EQAO score for the student population, and what is the socioeconomic status for the various regions within Northern Ontario. Shapka and Keating (2003) also examined descriptive statistics on the students' "parental education, perceived parental expectations, perceived teacher effectiveness, school, and pre-high school math achievement" (p.937). This information will enable me get a good sense of some of the challenges faced by the student population being studied. The measure of central tendency such as the mean, of certain population groups, could provide some insight into some of the differences between the rural and urban population groups, differences in males and females, differences in Northern Ontario Aboriginal, Francophone, and Anglophone students from low income socioeconomic families. Any categorical data could be analyzed through the median, in order to get a picture

of the responses from the various groups. The dispersion of the data measured through standard deviation would also be useful in gaining insight into the differences between population groups. It is important to note that association does not imply causation, descriptive statistics could provide insight and understanding into the various groups within the sample, however, it is important to note that it does not imply causation.

In order to find 'choice' patterns, I will use statistical analysis. I propose to use quantitative data from the school boards, regional economic data, and the EQAO (Education Quality and Accountability Office) generalized provincial test. Because of the nested structure of the data (student, school, community), I propose to use a hierarchical method model (Raudenbush and Bryk, 2002) in order to examine how characteristics such as: socioeconomic status, class, culture, language of instruction, gender, and the rural/urban differences affect a student's 'choice' in high school mathematics classes. I hypothesize that one factor that can influence a student's 'choice' is their family household level of income. Mighton (2007) argues that 'intellectual poverty' is one of the deepest sources of poverty, and that every mathematical concept is accessible to everyone. The accessibility of mathematical concepts implies that anyone can learn math, and the given the correct instruction any concept can be learned. In analyzing the EQAO scores, socio-economic data related to specific schools, I am hoping to be able to show a correlation between mathematics 'choice', income, and other factors, such as socioeconomic status, cultural, gender, class and the rural/urban effects.

I would use a hierarchical model to analyze what relevant factors affect a student's 'choice' in high school mathematics class. The model would be similar to the Ordinary Least Squares (OLS) approach used by economists to see if there is a correlation between the dependent variable, a student's 'choice' in high school mathematics class (Mp), and the independent variables namely, Income (I), Population (P), Education Quality Assessment Office test (EQAO) 3, EQAO 6, First Nation (F), Sex (S), School French (SF), School English (SE), School Aboriginal (SA), Immigrant (I), Parental level of education (PL), Southern Ontario (OS), and Northern Ontario (ON). The hierarchical model will be useful because many of these variables are nested within each other. For example, a student coming from a low-income family, with a low level of education in a Northern rural community might have more barriers to taking academic level mathematics courses; this could have compounding effects that a traditional linear model could not analyze.

In order to understand the root causes of student's choices I propose to use qualitative survey questions and interviews in order to analyze the reasons for the students' selection. In order to further the study, surveys will be completed by students, parents and teachers regarding the mathematics courses taken, and followed up with a set of interviews based on the survey results. I am proposing to use surveys and interviews in order to gain a greater understanding of how the factors contribute to a student's 'choice'. Perhaps the degree of parental support or the cultural background of the student affects the 'choice' by either influencing the student's perception of their own abilities, or that the pedagogy is not culturally sensitive. For example, a student from a working class family might be encouraged

by their parents and friends to take the easiest path in high school in order to get a job at the local factory.

Mason and McFeetors (2007) survey questions included "We would like to learn about the reasons why you chose your math course(s). Often, students describe may different factors. List the top three factors that affected your choice of a math course for Senior 2" (p. 296). The follow up interview included questions such as:

- Describe, briefly, your experience in previous math classes. How did those experiences affect your choice of math courses for this year? Your approach to math class this year?
- How did you make a decision about your math course (process)?
- What strengths as a student do you think will matter most to your success in math this semester (p.296).?

These questions would need to be developed from my own online survey, however, I can use some of the ideas from Mason and McFeetors (2007) study to help guide my research. Currently, I am not interested in how students plan to succeed within high school mathematics course, nevertheless, this issue could become important in follow up studies. My concern is about why students 'choose' the mathematics courses they do; therefore, my surveys will question the students, parents, and teachers about their role and reasons why students end up taking the courses they do.

Length of the Study:

Thus far I have been working with various First Nation groups within Northern Ontario. When I began my research in Sagamok Anishnawbek I wanted to examine how First Nations students learn mathematics, I started by writing researcher notes weekly based on what I observed in class. The scope of my teaching included teaching two basic mathematics courses for Cambrian College, as part of their Academic and Career Entrance program (ACE). Some of the teaching methods that I wanted to evaluate were the effects of frequent testing, the use of cultural symbols within the classroom, and the use of stories and analogies to help the students understand mathematical concepts.

In January 2010, I began teaching in a small portable in Sagamok Anishnawbek that had laptop computers, blackboards, and a whiteboard. The only real limitation within the portable was the lack of Internet. Although there was Internet within the community, it was too slow to be effective. Most of the students at the beginning of the year discussed their anxiety towards mathematics, and how they didn't really enjoy math.

I taught Mondays and Fridays, which presented a challenge during holidays or festivals. The loss of one day would often mean one week without math, and consequently the students would have some difficulty re-engaging the material. Attendance was an issue throughout the courses, and it posed considerable

problems to deal with. The students missed class for a variety of reasons including: family commitments, funerals, personal days, and appointments, in fact, the average attendance for the students was 60%. The students had difficulties re-entering and re-engaging the material; therefore, I set up an individualized math program for each student. Students were able to work through practice tests and material at their own pace, however, any questions or mini-lessons were done for the whole class. I found that many students paid attention to the mini-lessons in order to further their understanding. Many of the students were very quiet during the class, and it was difficult to see if they understood the material. Shirvani (2009), Wolf (2007) discussed the benefits of regular assessment to help inform the teacher and students about their learning. Subsequently, I initiated a system of my lessons, pre-tests, and tests, with the ability to redo a test when the student's personal goals where not met.

The students were also taking Computers, Science, and an English class through Cambrian. The students seem to respond well to the workload, and it increased their confidence within the classroom. The ability to redo a test gave them confidence and allowed them to take some risks. The students began to build confidence in their math abilities and started helping each other out more in class. I encouraged the students to work together and to come to the board to work on their problems. Although there was some resistance to coming to the board, it seemed to help them to verbalize the math problems.

I noticed that some of the students would get anxious when new topics where introduced, and some students would even have outbursts in class when they encountered problems that they could not understand. I tried to introduce new topics by relating them to previous ideas, or symbols from within the community. In one particular tutoring session, I used traditional Anishnawbek symbols to solve an algebra problem. The use of familiar symbols seemed to lessen their anxiety and once the Greek symbols were introduced I could easily interchange a variety of symbols because they understood that it represented an unknown. I also used a variety of stories and examples that related to their community. I discussed wheelchair ramps, and Sagamok Road to introduce the concept of slope. I used the ideas of a feast, walking to familiar places, and sharing food to help them understand concepts such as mixed numbers, word problems, and fractions. I encouraged them to journal their thoughts on mathematics and create a list of new mathematical ideas. This helped them to write what they were learning in order to build up their confidence.

The problems on the black board were done with attention to detail with a step-by-step process, which was meticulously explained, and the reasons for each step were given. The students seemed to like the attention to detail, and at the end of the course when I would accidently skip a step they would question how I got from one step to another. The math discussions would engage all the students and participation increased as the course progressed.

In the end, the students responded well to the frequent tests, and pre-tests. It seemed to build up their confidence and they were able to take ownership over their learning. The use of cultural symbols seemed to lesson the stress of new topics by giving them some familiarity. The use of stories and analogies from their own experiences help scaffold their learning and helped them to understand new mathematical concepts and ideas. I believe that the true success came when the students actively participated within the classroom, and in the end, each student discussed how they were more confident in math. The students all felt that they were able to tackle any math problem through hard work and perseverance. The ability to take risks, combined with hard work, and confidence will surely allow these students to succeed in any future math course.

Actions and Strategies:

In order to teach mathematics effectively, I believe that assessment is important. By using the Western and Northern Canadian Collaboration in Education (2006) publication *Rethinking Classroom Assessment with Purpose in Mind*, I focused on:

- Emphasizing progress and achievement rather than failure
- Providing feedback to move learning forward
- Reinforcing the idea that students have control over, and responsibility for, their own learning
- Building confidence in students so they can and need to take risks

- Being relevant, and appealing to students' imaginations
- Providing the scaffolding that students need to genuinely succeed p. 7.

The focus on assessment for learning provided the framework that enabled me to help the students and encourage them through testing.

Conclusions (including next steps):

This research will provide an in-depth study of students' choice in applied and academic mathematics classes in Northern Ontario, and some of the reasons for their choices. The study could provide further research regarding the complex links between culture, poverty and knowledge in rural communities: given the large aboriginal population, the rural communities with low socioeconomic status, the low percentage of people within the communities with university degrees, and the lack of employment that require post secondary education.

In essence, this study could profoundly affect educational policies dealing with First Nations, Francophone, and gender issues. For example, if it is found that students from rural areas are not taking academic mathematics classes because they do not see particular jobs within their realm of possibilities, then perhaps educators, the province, and universities might need to change the way that they relate to and promote different education and employment options. I will continue my research over the next few years collecting data, preparing my survey, and interviewing focus groups.

Key Learnings:

I have learned a lot about teaching while reflecting on the students' discussions, assessments, and achievements. I believe that using cultural symbols, stories and narratives helps lessen the anxiety of new mathematical concepts and thereby allows students to better understand new ideas. Students also seem to respond favorably to frequent testing, and assessment. I believe that math teachers could use frequent assessments as a way to build a student's confidence in mathematics and provide excellent feedback to what the students actually know; in so doing this informs instruction.

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