Program evaluation of
Math 030 (ethno-math)

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Executive Summary:

The development of the goals of the College of New Caledonia's Community Education Department's proposed curriculum revisions for math 030 was in direct response to a perceived need to increase the number of aboriginal students and these students' overall success rate in mathematics courses. In an effort to fulfill this need, a commitment to engage in a curriculum revision pilot designed to address issues of student anxiety and fear of mathematics and reduced levels of aboriginal student interest in mathematics classes was undertaken. The scope of the revision was to complete the curricular revision of one math course, prepare an accompanying instructional manual and disseminate what had been completed/learned with regional math instructors.

The program evaluators, after consultation with the Community Education department designed a comprehensive plan for collecting data to evaluate these goals. Interviews with the Dean of the department, the First Nations Coordinator, the curriculum researcher/writer, and the instructor were undertaken. This was followed by a focus group, questionnaire and individual interviews designed to solicit the perspectives of both aboriginal and non aboriginal students. These investigative tools were chosen to ensure a richness and depth to the data collected, thereby enhancing the validity and reliability of our findings.

Our findings show that there is a strong commitment to good teaching and understanding of the importance of meeting the needs of aboriginal students within the Prince George and satellite campuses in the Community Education department. This commitment was evidenced by the significant efforts made by the curriculum researcher and the instructor prior to and during the pilot project. Our research suggests that this project has been successful in meeting many of its goals: Our suggestions for future actions are designed to build on this initial success. Our action items are divided into four categories: implementation issues, curricular content, technical or pedagogical instructional issues, and specific measures for aboriginal students. Each recommendation offers tools that could be used by the department as they continue to focus on their goal of enhancing aboriginal student success.

We would like to thank the Community Education department for this opportunity to work with them in an important field of educational research. We would also like to particularly thank the curriculum researcher/writer, the First Nations Coordinator, the pilot program instructor and the students of math 030 for their interest and cooperation. Without them, this report would have not been possible.

Actions to consider:

As program evaluators, our role was to work with stakeholders in coming to understand the goals and priorities of CNC's initiative in introducing socio-cultural examples into the mathematics curriculum as a means of making mathematics more accessible to aboriginal students re-entering the institution. As this report has suggested on several occasions, this includes asking the question "How can we continue to improve this course so it better meets the learning needs of our students?" To this end, we have designed possible "actions to consider" rather than the traditional "recommendations", acknowledging that it is the institution and its stakeholders that are best placed to consider what is achievable or desirable given their resources, mandate and priorities. We have also tried to reflect what we believe the stakeholders themselves see as important implementation issues: evaluation literature suggests this is the key to successful change.

There is a strong commitment to good teaching and an emphasis on the importance of meeting the needs of aboriginal students within the Prince George and satellite campuses in the Community Education department.

The decision to apply for funding that could improve access for aboriginal students in the department represents a commitment to institutional responsiveness to the aboriginal community, and is one example of many ways in which CNC is responding to community priorities. CNC offers a variety of supports to its aboriginal student population, and consults on a regular basis with its community stakeholders. A number of jurisdictions in North America are proposing changes to their academic programming in response to a growing concern about the gap between the performance of aboriginal and non aboriginal students in schools. Many of these have been targeted at the K-12 education system and aboriginal directed organizations; there has been less attention given to the significant role community based colleges could play, particularly in meeting the needs of a largely urban aboriginal community. While there are an increasing number of aboriginal students choosing to attend post secondary institutions, their participation rates remain relatively low (Malcolm & Rochecouste, 2002). They are also more likely to enroll in bridging programs, and this is the very niche that CNC is hoping to fill. By identifying important barriers such as success and comfort with mathematics and addressing these concerns in their adult re-entry programs, CNC seeks to offer an environment that will attract even more aboriginal students and fulfill the needs identified by its community. Investigating and reporting on the effectiveness of this program re-design will offer valuable insights to the adult learning community and other indigenous and non indigenous institutions across Canada.

There are however, significant tensions between the intentions of the Department, its faculty and support staff, and the views of students. While research and practice suggests that the socio cultural approach to teaching mathematics offers promise as a means of improving access and performance of aboriginal students in mathematics, there is no consensus among students, particularly non aboriginal students, that such steps are

necessary. In our view, this tension arises out of normative values and beliefs that place the ideal of "neutral universality" in opposition to practices of recognition or redress. We also recognize that such tensions are apparent in the broader community, and that CNC simply represents a microcosm of a public debate about how equity is best achieved: this is not unique to students of mathematics.

We do believe however, on the basis of the substantial literature in the field and the results of our conversations with aboriginal students that there is value in the work that has begun here at CNC. We see this as an opportunity to re-design curriculum and implement pedagogically driven instructional strategies that better meet the needs of a significant client population and an opportunity for CNC to take a leadership role within the region in continuing this important curricular and program innovation.

At the same time, we also believe that this program's initiatives need to consider the social context and the nature of its clientele; this means assuring that there continues to be a broad focus on improving student learning and mathematical achievement overall. We believe that the curriculum writer's decision to include a broader understanding of socio cultural applications is an appropriate one; our proposed actions suggest some ways in which this might be framed. However, we also suggest that there should be a more explicit discussion with students about the contributions of different cultural groups to the history and practice of mathematics: mathematics does exist in a cultural context, and also influences the way in which the world is viewed. Recognizing the multiplicity of views about math challenges traditional ways of thinking about and teaching mathematics, but we believe making such an effort will enrich the mathematical achievements of all students, including its aboriginal minority.

Actions to consider: implementation

1. That the Department of Community Education (DCE) continue its process of curricular modification and revision to support its goal of better serving its aboriginal clientele in math 030, including its initial plan of developing an instructional manual and engaging other instructors from its field operations.

2. That the DCE consider extending its revision process to include math 010 and math 020.

3. That the DCE consider ways in which it can build program wide commitment among faculty and staff at both the main and satellite campuses to the goals of improving aboriginal interest and achievement in mathematics.

4. That the DCE and its staff collaboratively develop short and longer term benchmarks that can be used to measure program success.

5. That the DCE continue to seek opportunities for collaboration with the aboriginal community, educational societies and the school districts in the

Prince George area and take advantage of how evolving expertise, innovative practices and initiatives in mathematics instruction can be shared.

6. That the DCE consider ways that it can draw on the experiences and leadership offered by its pilot program staff in developing an institution wide focus on meeting the needs of aboriginal students in mathematics.

Curriculum content

7. That the broader northern and/or aboriginal focus for socio cultural content be continued in subsequent revisions. Commonalities and links among cultures should be emphasized.

8. That there be specific content added to the curriculum modules that develops student's understandings of the cultural contributions of various ethnicities to modern day mathematics.

9. That projects continue to be developed that can supplement quizzes or review tests as a strategy for reducing aboriginal fear of mathematics. The projects must be clearly linked to required mathematics content and awarded marks so that the value of the activities are emphasized.

10. That projects, wherever possible, offer the opportunity for a multiplicity of ethnic perspectives to be expressed (modeled after the ethnic cookbook project).

11. That future curriculum revisions consider the possibility of offering increased student choice between projects or quizzes as a means of demonstrating student understanding and a strategy in reducing fear of mathematics.

Instructional techniques

12. That instructors continue to develop strategies that emphasize the links between everyday applications of mathematics, the purposes of math projects and core mathematical topics.

13. That instructors consider a more explicit means of discussing multiple learning styles and approaches to problem solving, including open discussions about how students process responses, i.e., use of metacognitive strategies.

14. That group work, peer/partner strategies be more frequently used during classroom instructional time to accommodate aboriginal learning styles and preferences.

15. That instructor's consider scheduling "checking in" discussions at strategic points in the school semester to encourage open communication, develop

stronger peer relationships, enhance levels of trust and reducing anxiety about math topics.

Specific measures for aboriginal students

16. That DCE consider setting targets for increasing aboriginal student enrolment in mathematics courses.

17. That the FN Center/ DCE consider implementing an aboriginal peer tutoring service in mathematics.

18. That aboriginal students be provided the opportunity to attend a workshop/ seminar on anxiety reduction strategies, including test taking skills.

19. That DCE consider how it might slow the pace of its mathematics courses, or offer additional lab type classes on a weekly basis in order to accommodate aboriginal learners concerns.

20. That DCE consider implementing a regular means of monitoring anxiety levels among aboriginal math students and track this change over time.

THE PROGRAM: MATHEMATICS 030

Mathematics 030 (math 030) is a course offered to adult students at the College of New Caledonia (CNC). Its targeted clientele includes students who have not completed a mathematics course at the Grade 10 level. Mathematics 030 is designed to offer an equivalent designation for adult students who may not have completed secondary school and are upgrading in order to receive their Grade 12 equivalency, or alternately for students who need to take a mathematics course in order to qualify for admission into a university program, trades or technology career.

The course is offered on a semester basis, and frequently is offered in multiple blocks, based on enrolment. Math 030 is one of three basic or fundamentals of math courses offered by CNC. First is math 020, which provides equivalent credit to that of a Grade 9 mathematics course; this is followed by math 030, the subject of this evaluation; and finally math 045 provides the equivalent credit of a mathematics 11 course. While aboriginal students are not formally identified at an institutional level due to privacy concerns, many students self identify as having aboriginal ancestry, including some of those enrolled in math 030. The Dean of the Community Education Department and the Coordinator of the Aboriginal Student Center both agree that there are a significant number of Aboriginal students who attend this and other basic pre- college level mathematics courses. While not able to provide us with firm numbers on how many aboriginal students were enrolled on a semester to semester basis[1] anecdotally the

[1] CNC does not track students on the basis of ethnicity at this time. We were given to understand that this policy may be under review.

mathematics instructors reported to us that approximately 15-20% of overall student enrolment would likely be considered having aboriginal ancestry.

THE CONTEXT FOR THE CURRICULUM REVISION OF MATH 030: A STRONG CONCERN FOR ABORIGINAL STUDENT SUCCESS

The Community Education department at CNC is mandated to consult with the community and identify areas of adult learning need in the Prince George and northern regions of the province. One of the important stakeholder groups that offer advice to their department includes a number of local and regional aboriginal bands and educational societies. As a part of these ongoing consultations, an area of identified concern has been the capacity of Aboriginal communities to have skilled workers in science, technology and trades available to service their regions and people. A significant barrier to achieving this goal is aboriginal student success in school: since the late 1980's the government of BC has been tracking aboriginal student success in the K-12 school system, and has documented an unacceptably high level of student drop outs among aboriginal students. Recent initiatives have been taken within many northern school districts to address this concern and aboriginal student completion rates are improving. However, community colleges serve an important role in providing an opportunity for adult students who may not have completed school to upgrade and then enter career preparation, university program or trades training. Re-entry programs that include basic skills in reading, writing and mathematics are offered by both the main Prince George campus and its satellite locations; this is an important educational resource to local aboriginal communities.

In an effort to address the needs of aboriginal learners, institutions have also focused on ways of improving aboriginal student success. One such initiative is the pilot program and curricular revisions to mathematics 030. The Community Education department sought funding from the Ministry of Advanced Education to help support the revision of its mathematics curriculum; dubbed "ethno-mathematics" the department drew on well documented research, mostly from the United States, that suggests that when there is an inclusion of indigenous socio-cultural references within the mathematics curriculum, aboriginal students experience: an increased sense of cultural pride; an enhanced understanding of the contributions that aboriginal peoples have made to the fields of math and science; they are better able to apply their mathematical knowledge to contextually relevant examples of how mathematics works in real life; that this approach enhances their interest and motivation in mathematical learning; that student performance in mathematics will improve; and that there will be reduced levels of math anxiety and increase comfort and interest in mathematics learning. (Robinson and Nichol, 1998; Meaney, 2002; Bishop, 2002)

THE GOALS OF THIS CURRICULUM PROJECT:

- Increase the number of aboriginal students enrolled in mathematics courses so there could be a greater number of aboriginal students entering trades, science and technology careers.
- Reduce fear and anxiety of mathematics among students who were considering new careers options. This fear was seen as a significant barrier to students' willingness to consider trades, science or technology careers because Grades 11 or 12 math (or equivalent) are pre-requisites to entry.
- Increase the success of aboriginal students in re-entry mathematics programs so they would be able to enter other career preparation programs.
- Disseminate techniques and materials to regional math instructors through workshops
- Compile results in a final report

STAKEHOLDERS

In consultation with the CNC Community Education Department, we identified several key stakeholders who were included in this program evaluation: the management staff in the Community Education Department; the Aboriginal Coordinator; program service providers including the individual who revised the math 030 curriculum and the instructor of pilot project for math 030; and currently enrolled students, both aboriginal and non aboriginal. Given the mixed ethnicity of the students in this class, it was felt important that we also engage non-aboriginal students in discussions about program change that had been introduced and invite these students to respond to its effectiveness.

GOALS OF THE PROGRAM EVALUATION

As a part of the program proposal to the Ministry of Advanced Education, there was a commitment to a mid-point and final program evaluation process. Quoting from a document provided by CNC to the curriculum evaluators: *"The evaluation will assess the relevance of the materials and techniques, the improvement in skills and whether the course has been successful in increasing interest and reducing fear"* (personal communication, 2004). A mid-point evaluation was submitted to CNC in April, 2004.

The math 030 course changes included some specific revisions of content and method to an already existing course entitled mathematics 030. We were asked to investigate the pilot project's effectiveness in addressing two key issues. Firstly, does this re-designed curriculum and altered instructional approach reduce math anxiety and fear among its registrants, and secondly, does the aboriginal and northern cultural focus make mathematics more accessible to students, aboriginal students in particular? An unarticulated but assumed question is "How can we continue to improve this course so it

better meets the learning needs of our students?" As researchers, we understand this to be an underlying value and belief of adult educational institutions, including College of New Caledonia. The program evaluation model most appropriate for this focus is an "improvement focused model" (Posavac & Carey, 2003, p. 29).

In this model, program evaluators consider the goals and objectives of program designers and organizational leaders in relation to clients, clients' perceived needs, the actual service provided, and the match between the outcomes achieved versus the outcomes projected (p. 29). This approach identifies potential discrepancies, and in doing so provides the opportunity to recommend actions and policies which can rectify these gaps. Such an approach requires the evaluators themselves to make personal observations in a variety of settings and with all affected stakeholders. In the case of this program evaluation, this includes a mix of both qualitative and quantitative measures involving both CNC faculty and students.

The first role of the program evaluator is to become familiar with the nature of the program they have been asked to evaluate: understand its goals and purposes, become familiar with the people it serves, and reasons for the program review (Posavac & Carey, 2003). It is also important to make clear to those responsible for the program the methodology used by the researchers during the program evaluation itself, addressing issues of validity, reliability and generalizability. In other words, how can the recipient of the evaluation be assured that the tools the evaluators use are appropriate and useful to their institution, their curriculum and their goals? This evaluation summarizes our response to these questions.

PROGRAM EVALUATORS:

Catherine McGregor and Peter MacMillan were contracted by the CNC Community Education department to conduct this evaluation. Both Catherine and Peter are full time tenure track members of the University of British Columbia in the education program. Both professors participate in the undergraduate and graduate programs within the Education Program. Catherine has been recently hired to UNBC and is currently teaching the theory and practices of mathematics to pre-service elementary level teachers; she also acts as a mentor for aboriginal students through UNBC's Northern Advancement Program. She is currently working on her doctorate with a targeted completion date of December, 2005. Peter is an associate professor who completed his PhD at the University of Alberta in 1995. He teaches a B.Ed courses in numeracy for the secondary school level, as well as graduate level courses in statistics, measurement, and research methodology.

Both evaluators have an interest in aboriginal students and mathematics learning and teaching. Peter is currently working with the Prince George school district in a collaborative partnership focused on improving student performance in mathematics, including efforts to improve aboriginal student's performance as a part of the school

district's academic plan. Catherine is researching teaching practices which may offer enhanced learning opportunities for aboriginal students.

EVALUATION DESIGN:

The evaluators met with a number of key staff, including representatives from the Community Education department, the Aboriginal Student center coordinator, and instructors of the course. An inherent assumption in this review process was the question "How can we continue to improve this course so it better meets the learning needs of our students?" This question was a central theme in many of the interview questions and responses given by those interviewed.

The evaluation was conducted over a period of approximately two months. Initial interviews were held in mid-March, 2004; a focus group with students was held in the third week of March, 2004. Student surveys were completed and collected during the final week of April and early May. Individual student interviews followed and were completed by mid-May.

All of those who were interviewed were given explicit information about the purposes of the evaluation; institutional processes were followed to assure rules for permission of student participation were followed. No individual interviews occurred without written permission; a sample permission form is included in Appendix A. All interviews were tape recorded, and then transcribed. Transcribed notes were coded for common themes and then categorized by evaluators. All tapes were destroyed after transcription in keeping with confidentiality agreements.

METHODOLOGY:

In this report, we have used a number of techniques common to contemporary program evaluation models including:

1. **Semi structured interviews**: specific questions were posed but open ended questions which encouraged participants to discuss the program from their own experiences, and beliefs were also used. Comments were taped and later transcribed. This approach was used with faculty interviews and follow up student interviews. There was a $25.00 stipend provided to encourage student participation in individual interviews. We received a total of eight student responses for follow up interviews, representing slightly more than 45% response rate. Interviews were collected in two waves: one researcher completing the first wave, the second researcher doing the second. The interviews were analyzed in two stages. The first setoff interviews were coded and themes were extracted by one evaluator. The second interviewer then conducted the remaining interviews without reference to the work of the first interviewer. These remaining interviews were coded and themes extracted. Only then were comparisons made with the

results of the first set of interviews. Similarities and discrepancies were noted. This process of member checking resulted in an integrated analysis with higher internal validity than would have been obtained with the joint analysis on the entire set of interviews (McMillan & Shumacher, 2001).

2. **Focus group**: open ended questions were posed to students enrolled in this pilot program class in order to explore student beliefs and understandings in a social context. The process was interactive, and permitted stakeholders to engage with one another in exploring implications. Questions are included in Appendix A.

3. **Questionnaires**: A follow up questionnaire was administered to all students enrolled in the class. Fourteen student surveys were returned out of a total seventeen possible. A complete survey is included in Appendix A.

4. **Content analysis**: the curriculum is currently delivered through a series of student workbooks. A content analysis comparing the former and current workbook was under taken. As only one of the three workbooks was altered with new content, only this first book was examined.

5. **Analysis of student achievement results**: CNC agreed to provide us with recent grades for students enrolled in mathematics 030; this was compared to the grades of students who are in the pilot class.

6. **Review contemporary research**: particularly in the field of program evaluation and ethno mathematics in order to provide an informed context for reviewer analysis and recommendations.

The variety of methods of data collection enhances both the reliability and validity of this program evaluation. Through the process of triangulation (Denzin & Lincoln, 1994; McMillan & Shumacher, 2001) the researcher uses multiple means of collecting data, increasing the likelihood of consistent results. This data collection process also permits the researcher to ask questions or investigate themes that emerge from field data as it is collected, and to confirm understandings with participants. One-on-one semi structured interviewing techniques in particular provide the best means by which to engage those most closely involved in the program implementation, providing valuable insights from key stakeholders and a more complete understanding of the process of program implementation. By using both open ended questions and subsequent probing for additional information as it arises in a dialogue about this pilot project math course, we have been able to narrow the focus to specifically identify emerging issues of difference or commonality, a process that helps frame potential recommendations. Rather than focusing solely on researcher impartiality, these processes engage both the researcher and the participant in knowledge building, through a dialogic engagement that enhances understanding and leads to a deeper understanding of the issue. This is consistent with the goal of program improvement.

Some readers might question the theoretical basis of our decision to interview individual students based on their response to our demographic questionnaire, and identification on the basis of ethnicity. Our reasons are two fold. First, because our focus group was conducted with all classroom participants, we were concerned that aboriginal students may have chosen to remain silent about some of their views and beliefs. There has been significant research to suggest that individuals of different ethnic or racial groups are often silenced when the mainstream, cultural constructs of a white, Eurocentric discourse are voiced (Denzin & Lincoln, 1994; hooks [sic], 1984; Lather, 1991). A commonly expressed, normalized belief about what "equality" means, that is, that all people regardless of race should be treated in "exactly the same way" often accompanies discussions which focus on accommodating difference on the basis of race or ethnicity; yet the privilege afforded to mainstream white society is rarely revealed. We were interested in creating an opportunity for aboriginal students to safely voice their own perspectives which may be different than their white counterparts. Second, some existing research suggests that aboriginal students have different learning styles and preferences in mathematics, and our intention was to explore these ideas more fully during individual interviews; this will enhance our knowledge of how to better serve Aboriginal students in mathematics education. This is consistent with our goal of identifying ways in which this program can realize its goal of enhancing student success.

LIMITATIONS OF MEASUREMENT TOOLS

One of the limitations that must be acknowledged in this report is the limited time span over which this trial curriculum has been piloted, and the ability to identify specific indicators of success within a three month time frame. While we understand the importance of meeting government requirements to engage in formal evaluation to assess success in achieving goals and outcomes, it can be difficult to measure small, incremental change in a limited time frame. As well, the goals of the program changes are broadly framed, and suggest a longer term focus: as the program improvement literature suggests, such systemic changes do not happen overnight. For example, increasing the number of aboriginal students enrolled in adult re-entry mathematics programs will be the result of a number of modifications to existing institutional practices, one of which includes the re-design of curricula. The goals of this program pilot, while laudable and supported strongly by research in the field, need to be considered within the historic context of aboriginal student success in schooling, and the continued presence of cultural, social, political and economic barriers for aboriginal students within British Columbia's (BC) educational system. It also needs to be situated in an institutional context, where curricular change is only one part of the ongoing efforts to address aboriginal student academic success. It is our hope that this evaluation is considered only the first in a series of efforts to investigate program effectiveness over time.

Torres, 1994 (cited in Posavac & Carey, 2003, p. 49) reports that program evaluations can be resisted when those who are engaged in service delivery feel they are being judged on the basis of criteria which they cannot affect. For example, teachers often resist the publication of student exam results because they believe it will be used to

judge teacher performance rather than a measure of student effort or ability. "Those whose success depends on the performance of others as in the case of teachers… face a more uncertain situation than do people who are more directly in control of the results of their efforts" (Posavac & Carey, p. 50). Therefore, it is important for evaluators to assure service providers that appropriate criteria are being used to measure program performance, that they are given a voice in commenting on the evaluation design and given the opportunity to identify limitations and contexts that should be considered in designing recommendations and drawing conclusions. During our interviews with the curriculum designer and the class instructor, we gave several opportunities to engage in such a dialogue. We invited both to consider questions that might be appropriate to ask students. As well, in designing our questions to put to students, we were conscious of the need to focus on course content, pedagogical or instructional strategies. Specifically, we informed students during the focus group that this evaluation was not meant to be an evaluation of the instructor. (A copy of the focus group introductory script and the focus group questions will be included in the final report's appendix). This was an important way to ensure that individual teachers did not equate the program evaluation with personal evaluation: we view teachers as partners in our investigation. Their role is central in assisting us in the process of reviewing the effectiveness of the program re-design.

Comparability of the mathematics 030 Classes

Neither CNC nor the researchers have any control over the students who choose to enroll in mathematics 030. From the researcher standpoint we are working with a non-experimental, specifically, an ex post facto design (Cook & Campbell, 1979; McMillan & Schumacher, 2001). The design in this study does consist of two intact groups, the current math 030 class – the treatment group, and the previous year's class – the control group. With the ex post facto design, the researchers' first task is to document the treatment, and the degree of treatment that has occurred. The second task is to gather data that allows the researcher to judge the comparability of the two groups. Again as this is ex post facto, these sources of data may be limited. If there is a possibility of mathematical correction, for example, an ANCOVA design, this will be explored. For whatever differences found, examination of alternate hypotheses, such as the data permit, will aid in interpretation of the results.

A BRIEF REVIEW OF THE LITERATURE: WHY ETHNO-MATHEMATICS?

Scholarship over the last decade in mathematics education has acknowledged the need to take a socio-cultural perspective to the study of mathematics and mathematics education (FitzSimons, 2002). This is a significantly different perspective than offered by the traditional view of mathematics as an applied science with an assumed set application of formulas and algorithms. In this view mathematics was consider an impartial and standard practice that is unaffected by student backgrounds, social, cultural or political contexts. A socio-cultural perspective offers a different lens through which to view student success, curricular content, historical contributions and educational practices.

Ethno-mathematics is a theoretical and practice based approach that can be applied using a socio-cultural framework.

D'Ambrosio (1994) is credited with identifying ethno-mathematics as a conceptual framework through which to consider mathematical learning. According to Rowlands and Carson (2002) D'Ambrosio describes ethno-mathematics as "the study of different forms of mathematics that arise from different modes of thought" p. 80). This includes recognizing the Euro-centric nature of much western mathematical thinking and educational approaches to mathematics. Ethno-mathematics provides a framework to consider how this dominant discourse has influenced our ability to see and represent the significant contributions other cultures, including indigenous cultures, have and continue to make in the field of mathematics. It also concerns itself with: the culture of the mathematics classroom; how teachers' views and beliefs frame the approaches they take to the teaching of mathematics and their inclusion or exclusion of particular mathematical ideas; the different ways that students may bring to the construction of mathematical knowledge, their prior knowledge, and their social and cultural context.

Chavey (2004) summarizes these approaches into six categories: an educational view, an anthropological view, a modeling view, a historical view, a science studies perspective (using a feminist / post colonial critical analysis), and a mathematical view. For the purposes of this pilot project evaluation, we will focus on the educational view, seeking to understand specifically how a socio-cultural perspective can enhance opportunities for aboriginal learners in particular. This includes considering research literature in the specific learning styles of aboriginal students and traditional methods of education within aboriginal communities. Framing this literature will assist our evaluation of the changes made to the mathematics 030 curriculum.

Traditional aboriginal education

Literature in the field suggests that most aboriginal communities use what are described as informal learning systems: that is, aboriginal children learn from family and community members through modeling and imitation. This learning was largely oral and story telling was a central practice in the conveying of important understandings. Often elders or other community mentors were chief conveyors of traditional or cultural knowledge; it was also understood to be a lifelong endeavour (Robinson and Nichol, 1998 p. 3-4).

Aboriginal learners

This brief synopsis of the research should not be interpreted as suggesting all aboriginal learners learn in the same way or benefit from only some pedagogical practices. However, there is literature to suggest that particular modes of learning may be preferred. According to Craven (1996 as cited by Robinson and Nichol, 1998 p. 5) aboriginal learners prefer a holistic approach to learning. This suggests that the integration of mathematics may be the most appropriate teaching pedagogy, as well as an emphasis on discursive practices such as discussion and the previewing of themes prior to specific engagement in learning tasks.

Aboriginal learners often prefer to observe and imitate rather than verbalize their knowledge or understanding. The auditory/oral nature of the traditional aboriginal education is an important element to consider. This supports the use of diagrams, models, symbols or visual images in the learning of mathematics (Robinson and Nicol, 1998, p. 5).

Other characteristics of the aboriginal learner include: a preference for kinesthetic learning (Williams, 1983 as cited by Robinson and Nicol, p. 6) and cooperative learning strategies (Edwards, 1998, as cited by Robinson and Nicol p. 6). The cultural practices of mentoring and informal learning in day to day activities also suggests that aboriginal learners are "contextual learners" (p. 6). From a pedagogical perspective, this supports a view that learning in the classroom may have more meaning when it is placed in a relevant personal context.

Finally, Robinson and Nicol (1998) suggest that students are more successful when they have developed a personal connection to the teacher. They are "more cooperative, interested in learning, willing to take risks and attempt new tasks" (p. 7). This also suggests ways in which teachers themselves may modify their own pedagogical practices to accommodate a need to increase trust and comfort in a classroom learning environment.

POSSIBLE LIMITATIONS OF THE ACADEMIC LITERATURE

After conducting a literature review, we note that there was no formal literature from British Columbia or Western Canada: much of the literature comes from the United States or other international jurisdictions such as Australia. Nor was there evidence that previous investigations had focused on some of the particular circumstances at CNC including: an adult classroom learning environment vs. K-12 schooling; its application within a predominantly white/European classroom context rather than an aboriginal only or majority aboriginal sample population; and that it was situated in an urban rather than rural setting. These are important contextual differences and as a result, this research may confirm or refute claims previously made. It does however offers an opportunity to fill an existing research gap and offers a unique opportunity to enhance educator's knowledge of how ethno-mathematical practices may work best in an urban, adult education setting, and provide useful insights into program design and delivery.

We are also aware that generalizing claims about a group of people with a shared cultural background acts can overly reinforce commonalities rather than suggest a multiplicity of potential strategies to enhance student learning. We want to avoid this pitfall by making clear that there is much that can be learned about how all students learn and think about mathematics and that both aboriginal and non aboriginal students share many similar preferences for learning styles as well as beliefs about mathematics which are reflected in this report.

ANALYSIS:

Once all data collection was complete, the program evaluators met to discuss common themes and emerging patterns present in the student and instructor responses. Each set of interviews were transcribed, re-read and coded into descriptive groupings; from these smaller coded units larger categories were created and then considered in light of the program review objectives. Student interviews and the focus group session were similarly transcribed and coded. Student survey results were tallied and then specifically analyzed for how aboriginal and non aboriginal students responded, looking for potential areas of tension or difference. The video tape of the focus group was also reviewed; the transcribed texts lacked the body language and tone of the participants that the investigators also noted in their field notes and added depth to our analysis.

It was agreed that the best way to represent the collected data was to use the program evaluation review objectives as a framework. Given the complexity and richness of the data provided by stakeholders, a narrative style reporting form was considered superior to a tabulated or grid style summary which would be unable to capture the nuances and contexts represented in this evaluation.

FINDINGS

THEME ONE: SUITABILITY OF COURSE MATERIAL AND TECHNIQUES.

DEGREE OF CONTENT CHANGE

Math 030 Ethno-math Course Content Analysis

CNC staff provided the evaluators with the current (grey copy) ethno-math textbook, the previous textbook used in Fall 2003 (green), and a summary of changes made by CNC. The new text book was compared with the previous version. First a search for changes related to Aboriginal content or culture was made without reference to the provided summary. Second, matches were made with the classification provided by the CNC course developers/instructors. Then the results were compared with the CNC-provided summary. The final analysis of the Aboriginal/First Nations content is described in Table 1. All question and page numbers relate to the new text book. The table does not document the entire course content or even the all the new additions and relocations of items and topics. We have listed only those changes that relate to the Aboriginal/First Nations content. The left column provides some context surrounding the Aboriginal content that has been introduced.

Table 1. Newly Introduced Aboriginal Content

Old Content	New Content
C1-C4 graphing p. 12-16	**C1 p. 13-15 1 graph, 1 table 9 questions on Aboriginal populations** C2-C5 then p. 16-21 Canada & BC census data p. 24-25
Exercise 1C Q 1-20	Exercise 1C Q 21-29 **Q 29 a, b p. 23: US sled dog prices**
1 project graphing p. 20	**Circle graph: [Navaho] Aboriginal or other ethnicity recipe p. 26**
Unit 3 p. 35-36 paragraph on the "English king"	Unit 3 p.42-43 "**Olemec Indians**" then "history of measurement added"
p. 64-66 Unit 3 self test Q 1 to 7	new Q 6, 9 sensible units a to i added. Several could be considered **aboriginal**, northern, rural or simply local, e.g. sockeye salmon
Unit 5 Geometry Constructions Self Test Q 1-8 p. 116-117	Unit 5 **Navaho & other designs** p. 118 information – no question or activity
Exercise 6.2 Q 1-22 p. 127-131	Q 21 p. 130 **First Nations drum**
Exercise 6.3 Q 1-3 metric conversion	Q 1 p. 132 **ice fishing**
Exercise 6.4 Q1-17 p. 135-137	Q 17 p. 137 **firewood**
Exercise 6.5 Q 1-12 p. 140	Q 10 p. 140 **hunting cabin**
Exercise 6.6 Q 1-9 p. 142-143	Q 9 p. 143 **Red Hawk Trading Company**
Exercise 6.10 q 1-10 p. 150-151	Q 10 p 151 **cans of salmon**
No previous project	p. 153 **Moose caller project**

Evaluators viewed the changes as to be of one of three classes. Some changes made direct reference to First Nations or Aboriginal groups as part of the mathematics data. The inclusion of Aboriginal census data (p. 13-15) and the related questions would be one example of this type of change. The "moose caller" project (p. 153) goes a step further in that students must participate as if one were a member of the Aboriginal group rather than just learn about aboriginals, e.g., the census data. The second class of changes included content that the course developer assumed to be aboriginal in nature but did not specifically draw attention to this as part of the questions. The dog sled purchase (question 29, p. 23) was one such example. The third class of change was organizational in nature. These changes reflected attempts at improvement in course delivery or teaching effectiveness that were not visibly connected to the attempt to improve the fit of course content to aboriginal students.

The first class of changes, direct mention of aboriginal content inescapably draws to attention to all students to aboriginal people and aboriginal issues. The evaluators have noticed that some of the overtly aboriginal content is American in origin, e.g. Navaho patterns. During the interview and discussion with students, some reaction to this content was noted. However, once students are not being asked about the inclusion

of these items for evaluation purposes, there may not be any reaction from non-aboriginal students as to the reasonableness of the inclusion of such items. A goal that all students see aboriginal content as a routine part of mathematics will have been achieved. Should such a reaction continue to occur there might be reason for class or individual student-instructor discussion about why the inclusion for information related to any particular group within Canadian society should not be a welcome addition to increase mathematics relevancy in the course.

The second class of changes consisted of content that the course developers felt had an aboriginal connection but may or may not be perceived as such by either aboriginal or non-aboriginal students. Content may be more broadly described as northern rural. Some examples in this category were the hunting cabin, the purchase of firewood, and ice fishing. The strength of this type of content is that all students may perceive the examples as relating to them. The non-aboriginals cannot view the material as catering to a group other than themselves and the aboriginal students may be able to identify with the content as something out of their own experiences. A current weakness of this class of content is that lack of evidence that the aboriginal students do identify with this content.

The third class of course changes were either simply organizational in nature. However, the evaluators wish to draw attention to the increase in practical or real-life problems that probably benefit all students including the aboriginal ones. While there is some research to suggest more practical or hands on approaches may benefit aboriginal students, it would be hard to argue that these approaches are not beneficial to all students.

The degree of the intervention was examined by comparing the amount of aboriginal content with the total content that could have been altered. Simple counts of discrete examples and questions were taken. No attempt was made to weight items as to their relative importance. For example the moose caller project was coded as one item as was the phrase “Olemec Indians”. Instances of each are recorded. While the following table is not exhaustive, it provided the evaluators with a rough comparison that could be made. The comparison of the aboriginal/northern/rural content and the total content that the evaluators judged to capable to alteration is summarized in Appendix B, Table B1. Any small inaccuracies or disagreements with the evaluators’ counts should not affect the overall interpretation. Based on the totals at the bottom of this table, the aboriginal content was assessed at less than 10%. This degree of this ethno-math invention must be viewed as mild. The overall appearance of the text book, the percentage of instances of possible aboriginal content, and the classification of most of the instances of aboriginal (not overt) all support the evaluators’ view of this ethno-math intervention. This view agrees with the course developer and course instructor expressed views. This minimal degree of intervention should be taken into account when the effectiveness of this program change is evaluated.

Suggestions Arising from Content Analysis

This first class of items should be unapologetically used and expanded upon. While some of this content is highly desirable but unavoidably non-Canadian, (after all the Mayans with their counting system were not Canadian residents), other examples that deal with Canadian content, even British Columbian content could reasonably be included. The long houses, the totem pole construction and the box making of the West Coast cultures would provide a wealth of problems and projects for many of the units that comprise Book 1. Not to neglect the traditional inhabitants of the Interior, the Shuswap round pit-houses with their cone shaped roofs could be a source of non-trivial geometric mathematics problems. The addition of traditional local technology might reasonably be expected to result in a greater degree of identification for both aboriginal and non-aboriginal CNC students alike.

The content of the second class, i.e., not overtly aboriginal, needs to be examined by an outside group of CNC aboriginal students and/or staff. If the aboriginal students do not see this as relating to them, then the value would be lost. One particular instance, the cans of salmon question, Q 10 p. 151, was not independently identified by the evaluators as being of aboriginal content. However such an item could easily be re-worked to take place within a Port Simpson cannery and then would be un-mistakenly identifiable as an aboriginal content item to these students. This class of items has particular value in that these items and examples can have appeal to all northern rural modern cultural groups rather than simply the aboriginal students that choose to value traditional aboriginal culture. Again, the quantity of this category of could be greatly increased to match the backgrounds of the majority of CNC students in the Math 030 course.

The evaluators recognize that this analysis does not include any adaptations made to any general teaching strategies as adaptations for the aboriginal students. In this sense, we have underestimated the overall adaptation of this course. Continued searches for strategies that are more effective and increasing learning while decreasing anxiety levels about mathematics are to be encouraged.

INSTRUCTOR VIEWS:

As the literature review in this report indicates, the majority of literature in the field supports the view that increasing the amount of aboriginal content is one of the key routes to improving enrolment and retention rates of aboriginal students in post secondary institutions. As Malatest (2002) notes: “It has been argued that if students do not see their culture reflected in the curriculum or in the larger culture of the post secondary institution, they are less likely to want to enroll” (p. 57). This was also the conclusion reached by the curriculum reviser (hereafter referred to as CR) after engaging in several months of research and attendance at a number of different workshops and seminars about aboriginal student success in mathematics.

However, as the CR made clear in her interview, this College level mathematics program differs from most of the current research in the field in that it is a course offered

to both aboriginal and non aboriginal students in an urban environment. Understanding this context suggested she would need to broaden her focus to ensure that any revisions considered the need for good mathematical instruction and examples that supported all learners. She supported this decision based on her review of the literature. More specifically she stated: "*What's good for First Nations students is good for everybody. If I do some things to try and accommodate their learning styles, we probably make that more accessible and less of a terror for the majority of students."* As a result, the CR made a decision to include a number of socio-cultural examples that represented a broader "northern" perspective, rather than one that was exclusively aboriginal. In this way she could also avoid the inclusion of potentially contrived examples; based on comments from elders and experienced aboriginal educators she met with during the revision process, this is an important consideration. Lack of authenticity can be easily detected by both aboriginal and non aboriginal students.

These changes were also driven by more than the needs of aboriginal students, but also the broader context of good pedagogical instruction in mathematics. As the CR pointed out "*I've wanted to do [this] for a long time….I gave a lot of thought of how to bring some continuity into the book. I don't think students saw the relationship [between math topics]… So I am hoping they will… that this is an application of what they learned before. We [teachers] think they are totally connected, but students don't see the connections."* It is through the introduction of projects in particular that this conception of applying mathematical knowledge to practical examples was seen as a priority enhancing all student learning.

An important observation that the CR offered was how through research, workshop attendance and the curriculum revision process her own knowledge and understanding changed: she became much more aware of the links between the recognition of aboriginal culture, its contributions to the world of mathematics and how this enhanced aboriginal interest and success in mathematics.

The course instructor (CI hereafter) also has a strong pedagogical commitment to ongoing course improvement, including the introduction of meaningful examples that will enhance course relevance to students. She saw the goal of introducing these changes in the curricular material, particularly its focus on aboriginal culture as consistent with this goal. As she stated, "*If we…[add] first nations content then that makes it more interesting for the first nations students, and for all of us!"*

The introduction of ethnic examples also had the benefit of increasing her repertoire of "unique strategies" she could use to enhance overall student learning. As a long time teacher of mathematics she was aware that students often needed a variety of ways of thinking about mathematical ideas, and the inclusion of more examples that were meaningful to students could serve to enhance her teaching approaches and student learning.

The CI also believed that it was important that the success of these socio-cultural examples be judged by the person who used them in the classroom and could see how

students responded: did it enhance or inhibit learning? It was her belief that if these socio-cultural problems/projects enhanced student understanding by providing useful models of how to solve problems, that students expressed interest and enjoyment, or that it reduced student anxiety then the curriculum revisions were a success. In other words, the changes in curriculum content had to have an overall effect of improving the course's effectiveness and student learning. In the opinion of the CI, there has been considerable success using these instructional measures.

STUDENT VIEWS:

Our questions to the students in the focus group, in the questionnaire and individual interviews were designed to probe for the degree to which problems or ideas that incorporated aboriginal people or culture successfully engaged the students in mathematical ideas and drew their interest. However, this was very difficult to determine as the students were more interested in responding to the College's decision to add these examples into the course: There were strong feelings among the students enrolled in this course about the appropriateness of including material that offered an socio-cultural focus. This topic generated significant interest and animation during the focus group session, significantly more than any other question discussed.

There were two views presented, one quite strongly: the inclusion of content designed to draw on aboriginal traditional knowledge or uses of mathematics was not appropriate. One student expressed it succinctly as follows: "*Math is math. I don't think that math is important for culture…They want to put race and stuff in history or sociology, that's [OK] to do those things but not math… you don't need anything but numbers."* One student expressed the concern that including specifically targeted examples using aboriginal people might spark racism among students who would resent its inclusion. Another expressed the concern that what was of interest to aboriginal students would not be of interest to others. A comment that doing well in math is more about personal motivation and commitment than anything else was similarly expressed: *"These people got to figure it out for themselves—that's just a fact".*

This sentiment was reinforced in the student survey. When students were asked to respond to items that would be a "useful way to learn math", examples which had an aboriginal origin had a high majority of students disagreeing. For example, references to using an aboriginal fish wheel, planning a trap line, or designing a pattern for weaving a basket all showed well over 60% disagreement. (See Appendix C)

Interestingly, one example that would be considered to have aboriginal content "creating a recipe for a native feast" was supported: this is likely because it replicates a very similar project that was actually done during their pilot math class. What this may illustrate is support /or respect for their teacher who had asked the students to work on an ethnic recipe/ graphing project. Because the questionnaire example drew on the same context as an activity they had completed and enjoyed with their teacher in class, there was likely a higher level of support with its inclusion.

There was a limited amount of support for the inclusion of socio-cultural examples by some non-aboriginal students. Generally, this was framed in a "do no harm" framework: in other words, we have to do math problems anyway, as long as we are doing the math, how can it hurt to include problems that include aboriginal people. One student commented: "*Yeah, but why shouldn't they be included? Its still a math question so it doesn't really matter.*"

In the case of aboriginal students, there was a higher overall belief that the inclusion of aboriginal examples could assist learning and increase interest. The student surveys, when analyzed on the basis of identified aboriginal ancestry showed a higher degree of preference for examples that included a native focus (See Appendix C). However, this was not unanimous belief. This was reinforced during the personal interviews conducted: One interviewed aboriginal student was not in favour of introducing aboriginal culture into mathematics: she shared the view expressed by others during the focus group that "math is math" and it doesn't require any cultural content. However, she did support its inclusion in initial courses that were offered to aboriginal students, particularly those who had recently moved to the Prince George area and who might be less familiar with the urban environment. "*Maybe for lower levels like 015, 010…when you are at the lower levels that is when you first come off the reserve…and when you are right into the school system you are doing it like everyone else.*"

Follow up individual interviews permitted a chance to probe student beliefs more fully. We asked the students to respond to three possible ways of improving math instruction; each example asked the student to consider whether a certain approach should be used when different groups (on the basis of gender or ethnicity) when experience demonstrated a learning style preference and improved performance in mathematics. In each case when this example was used, students had a significantly higher level of agreement with the claim that these strategies should be included. What this demonstrates is that these students, when asked to acknowledge different learning styles and preferences understood the value of a more inclusive instructional approach. This may offer a means of designing future references to continued program changes: if it is characterized as a means of accommodating a multiplicity of learning styles, non aboriginal students will likely express more support for the initiative.

PROGRAM TECHNIQUES

The most apparent change in program techniques was the introduction of course projects. Projects were designed to replace quizzes at the end of several topics within the first course book. As the comments from the course designer noted, this was seen as a way not only of accommodating more aboriginal focus, but a way of enhancing student interest.

One other conscious change in teaching technique included the effort to more clearly link ideas between topics and themes. This was done to enhance overall student retention of material and deepen student understanding of the relationships within the field of mathematics. It was also a way in which more practical, real life examples could be used to illustrate mathematical ideas.

INSTRUCTOR VIEWS:

As noted in this report both the CR and CI were strong proponents of changes to the program that could enhance student learning, although both expressed the general concern that the inclusion of socio-cultural examples enhance should all student learning, not just those of aboriginal students. Both believed that the projects served a broader pedagogical purpose— they represented a teaching approach that enhanced the learning environment and the ability of students to make connections between the every day applications of mathematics and conceptual ideas, symbols or formulas.

Both also expressed concern that this content might create a backlash among non aboriginal students: one student (who later dropped out of the course) made a comment that suggested the changes were motivated by "some sort of left wing bureaucratic agenda". The CI's response was that its purpose was to make the course more interesting. While this was not perhaps a complete description of goals of the curricular changes, it avoided what might have become an opportunity to make racially motivated statements. This sensitivity to the non aboriginal community's views of changes which accommodate native students was also represented in the CR's comments about the title of the course and the cover design. She expressed the view that the cover design should not be obviously aboriginal as this might "turn off" other students who would then no longer want to take the course. This tension is difficult to resolve and offers a challenge to the Community Education department and its instructors.

While one of the central reasons for including the projects was to introduce aboriginal content, another was to create better links between conceptual ideas introduced throughout a chapter or topic. Both the CR and CI expressed a strong pedagogical belief in the usefulness of introducing more ways in which students could practice and link related mathematical ideas through these projects.

STUDENT VIEWS:

Students were given several opportunities throughout the evaluation process to reflect on what helped them to learn, that is, in what ways the class or instruction could be modified to accommodate their own learning styles. This approach gave an open ended opportunity to identify those practices or changes that had been made, and see if students reported on these changes unprompted. Individual interview questions and the questionnaire also gave a more explicit opportunity to comment on both the project and improving links between mathematical ideas.

Students responded in a mixed manner to the projects. During the focus group, student expressed a preference for tests over projects. Several suggested that tests were a better measure of what the students knew or understood: The test permits a display of individual knowledge in a way that a project can't. As one student stated, if you do a project at home and hand it in, it could have been completed by someone else. The student questionnaire also suggests a high level of support for tests and a reduced level of support for projects.

There was some support for the use of projects. As one student suggested, "*I think some people do better on a project than they do on a test so then it's also a change in your everyday – it's a different way of looking at your math and I think that the content of it is good… It was kind of a break from the regular and yet it was still math."* Another student suggested it was a way of showing personal commitment: "*I think its fair ball because it goes to show who does their homework and who doesn't, and its such a simple project, you get given a week, there's no excuse and it doesn't take long at all."* Projects were also considered something that would reduce fear and anxiety by reducing the amount of tests taken.

One important point to note is that several of the aboriginal students interviewed expressed both a high level of interest in the projects themselves and the possibility that other projects, such as beading, offered a way of integrating math and aboriginal culture effectively. Another important factor for aboriginal students was that projects had the effect of reducing fear, particularly fear that arises from taking exams. This is an important point to note because the student survey indicated a higher overall level of general math anxiety and fear of testing among aboriginal students. I will return to this theme in a subsequent section, but this difference offers an important way of thinking about the effectiveness of projects as a teaching and learning technique.

THEME TWO: IMPROVEMENT IN SKILLS:
Analysis of Student Letter Grade Achievement for the new (Ethno-math 030) and the Earlier Version of Math 030

Student letter grades for the Winter 2004 new version of math 030 (ethno-math) as well as student letter grades for the previous Fall 2003 math 030 were submitted by CNC to the program evaluators. The letter grades were converted a 12 point scale reflecting the number of CNC letter grades, see Table 2.

Table 2. Letter Grade to Grade Point Conversion

Letter Grade	Points
A+	12
A	11
A-	10
B+	9
B	8
B-	7
C+	6
C	5
C-	4
D+	3
D	2
D-	1
F	0

A two tailed t-test between the two sets of class scores was performed. The results ($t = -1.98$, $df = 36$, $p > .05$) did not indicate any statistically significant difference between the two groups. This lack of difference occurred in spite of reported instructor perception of the students in the new Math 030 (Winter 2004, ethno-math) group as possessing a lower degree of skills on entry than the previous class (Fall 2003). While the course instructor provided the evaluators with the limited previous grades of the students, the data were too incomplete to test for differences in student abilities upon entry to Math 030. This was unfortunate as had we been able to document and statistically adjust for the class ability differences, an effect favouring the new Math 030 might have been detectable. At present, we have no conclusive evidence of achievement level differences. The instructor perception of overall class ability was supported by the responses of two students who were questioned on this topic when the main interview they volunteered that they had take the course in the previous, Fall 2003, session as well. Neither student knew the reason for the line of questioning. Each was simply asked about the nature of the two different classes. The students were completely consistent in their descriptions of class size, quality and frequency of student-student and student-teacher interactions. Given these interpretations, the lack of a drop in letter grades for this lower ability/skills class may be viewed as a possible sign of success for the ethno-math curriculum intervention.

THEME THREE: INCREASING STUDENT INTEREST

INSTRUCTOR RESPONSES:

As we noted in our preliminary report, an important perspective on student success that needs to be included are the views of the instructor. The one person most familiar with the behaviours, needs and responses to the changes represented in this pilot ethno-math class is its instructor, so measuring her satisfaction with the course design, its instructional elements and content is central to determining success. In this case, there were several elements of the course revision that have been considered highly successful by its instructor. First, she has endorsed the amended program content. As an experienced teacher of math 030, this instructor is intimately familiar with its complexity and the amount of material that has to be completed within a single semester. An important criteria by which to judge success then, is the degree to which the content adds to conceptual understanding, enhances meaning without adding new content demands that would simply put additional time pressures on both students and instructors.

In particular, the program instructor repeatedly identified student interest as an important indicator of success, and one that she found to have been particularly important for this program revision. *"Oh, enjoying math! Enthusiasm about math! Yeah, if they get relaxed about math, and not freaking out about their tests and having fun in math… The other day [a student] said "Oh, I just love math. It's hard for me but I just love it. Its just like a puzzle, its so challenging, it seemed hard before, but now that you know that is not that difficult, its OK…"* This teacher's tone implies the great pride she takes in assisting her students in learning. It also illustrates how an interest in math can trigger a

higher degree of motivation, permitting a student to take on more complex problems without fear.

Mathematics educators have studied for some time the role of motivation in learning mathematics: a key method for developing a strong interest in mathematics is by introducing practical, realistic examples of how mathematics is used in everyday life. The National Council of the Teachers of Mathematics (NCTM) have developed a series of content and process standards for the basic school mathematics curriculum: an area of heavy emphasis is the process of problem solving and the inclusion of real life application of mathematics in classrooms. These goals have been an important part of the math 030 program revisions, and are represented in the introduction of projects and problems that use aboriginal cultural experiences and examples which would fit the social context of local aboriginal and non aboriginal students. It also enhances mathematical interest, which in turn increases the possibility that students will persevere with difficult or complex problems. Therefore student interest, as identified by teachers is a highly relevant category of program success.

STUDENT RESPONSES:

Given the mixed response of students to the projects during the focus group, our interview questions probed with individual students about the effectiveness of a particular project, the moose caller area/volume problem. Several questions on the questionnaire were also designed to probe for the degree to which interest increased as a result of the different projects included in math 030. Again, we looked at the results in by sorting aboriginal and non aboriginal student responses.

The one project that generated interest across both aboriginal and non-aboriginal students was the ethnic recipe graphing activity. As noted earlier, it was one of the few examples from the student survey that received nearly unanimous support. This support might be explained in one of two ways: that it was a reflection of the respect they had for their teacher who had assigned the project, or that it exemplified a more inclusive example that drew on the ethnicity of all students, or some combination of these factors. Regardless of reasons, the support for and interest in this project offers a useful way of thinking about how other projects could be designed in future course revisions.

There was some sentiment expressed that math could be boring, and that introducing examples in class that increased student interest would be a good idea. For example, one student stated: "*like some of the questions are boring, like the bore of an engine or something. Like some people just got that because they're mechanically inclined and that's good because they go, oh I know exactly what that is and the question is interesting. I think that if you relate to something that we're going to do – interesting... [Another student interrupts] Yeah, kind of life situation.*"

This idea that interest can be increased with the inclusion of real life examples was also represented in the high level of support for these questions on the student questionnaire: students expressed a high level of agreement with statements that

suggested the use of "real life" mathematics and topics I am "interested in" (see Appendix C.)

A commonly expressed view was that personal goals and in particular, capacity to access other training programs was the highest motivator for these students. There were several references to a "chart" that had been placed on the classroom wall that detailed what math prerequisites were necessary for a variety of careers or trades. As a course designed to meet the needs of adults re-entering education in order to access higher levels of education and training, this shouldn't be a surprise. Personal success and completion of the course was frequently described as the most powerful motivator: in some respondents there was almost an impatience, a desire to "get on with it" and therefore anything they saw as a barrier to completing the course in the shortest possible time frame was problematic. No one objected specifically to measures that might make the course more interesting, but it simply didn't register with them as a priority need.

However, there were some noticeable differences among Aboriginal students. Aboriginal students shared with other students a high degree of interest in completing the course in order to continue with their personal employment, training or career plans. But during personal interviews there was an individual expression of interest in the moose caller project and other projects that focused on aboriginal knowledge: one student described what she believed might be other areas of aboriginal culture that could be included in the course. She also summarized a concern she believed was important to address in accommodating aboriginal learners coming into the college environment: "*I liked it because it was a part of native culture [and] that was quite interesting…its good to see native projects in school, cause that sort of gives… its good for the other people who have anxiety about going back to school to see that there is some native things happening, to make it more interesting*."

The final gauge of student interest was measured on the student questionnaire by asking students to respond to a series of statements about their continued interest in taking higher level mathematics courses. As Appendix C indicates, there were some differences between aboriginal and non aboriginal respondents: interest in math content as expressed by "enjoyment" of math 030 was higher among aboriginal than non aboriginal learners.

THEME FOUR: REDUCING FEAR

Fear or anxiety around mathematics is a well documented phenomenon in mathematical literature: student fear is considered one of the factors that cause students to avoid taking mathematics classes at senior levels in high school and in post secondary education. Several researchers who have investigated the prevalence of student fear of mathematics point to it as a learned behavior: it often begins as early as pre-school aged children who have been exposed to parental fears or self-declared "poor ability" with math.

Regardless of how it is acquired, fear of mathematics is a significant barrier to college student success. For example, a study conducted by Becker (1999) at Southern Illinois University suggests, "Of all academic subjects, math is the biggest barrier to

student advancement. It is the subject with the lowest student success rates and highest "drop" rates—[it is] the subject most feared and most postponed by students" (L.A. Times, Monday, March 15, 1999, [Home Edition], p. 1 (Section A). It is described as a "bottleneck" in its effect of limiting student access to other programs that require higher levels of mathematic skill as prerequisites.

For aboriginal students, the barriers to accessing a post secondary degree or certificate are even higher. As Malatest and Associates (2002) report in their review of aboriginal post secondary enrollment to The Council of Ministers of Education in Canada (CMEC), participation rates of aboriginal students, particularly in math and sciences, are significantly lower than the rate for other Canadians.[2]

To what extent is student fear of mathematics a factor in this under representation of aboriginal students in mathematics? While there has recently been a rise in attention of the social, economic and educational barriers to aboriginal student enrolment at the post secondary level, little of this work has focused particularly on mathematics. Studies on student's fear of mathematics have not distinguished among aboriginal and non aboriginal students. However, one can certainly extrapolate from the high school drop out rate and the reduced numbers of aboriginal students in mathematics courses at the post secondary level that this could be an important factor to address. The results of how aboriginal students responded to this question may assist in beginning such a discussion in the mathematics literature.

INSTRUCTOR VIEWS:

Both the CI and CR held the belief that increased student success through the content and instructional changes would enable an attitudinal change that would mean a decrease in student concern or fear of mathematics. The FN Coordinator described what she believed to be the strength of these proposed changes as an opportunity to "*draw more on their [aboriginal student] knowledge of math so that they get rid of math fears, and the feelings they can't do it, their frustration… [And] perhaps modify the methodology to see if that is a way of better communicating the information to students*". All faculty and support staff interviewed believe that a reduced level of student anxiety or fear would be an important measure of the program changes success. Another indicator of success that the FN Coordinator suggested was the willingness of aboriginal students to want to continue taking mathematics courses, attend classes more regularly, or express an interest in considering science or technology careers. Drawing on these ideas, the evaluators included statements on the student questionnaire that would measure these attitudinal changes among aboriginal and non aboriginal students.

Another significant observation made by the CI was the relationship between student success and instructional practices. While the introduction of aboriginal

[2] According to Malatest's data, aboriginal student's rate of participation in post secondary math and physical sciences is about .4% of overall student enrolment compared to the non aboriginal rate of .9% in trades or non university certificates. At the University degree/certificate program level, 2.5% enrolment for aboriginal students is compared to 4.3% of non aboriginal students. (Table 2-1 p. 59)

examples in the course content was important, perhaps a more critical feature was teaching methodology; practices that take a variety of approaches, and engage students in a supportive learning environment would increase students comfort and therefore permit a change in attitudes towards math. This was seen as central to student success in mathematics: building trust through confidence building talk and inclusive, success oriented strategies during instruction were key elements of reducing student fear.

Finally, the FN Coordinator offered her observations about the degree to which fear of mathematics might be a more significant barrier to enrolment in mathematics courses for aboriginal students. Drawing on her knowledge of the Prince George area and her work with the Prince George school district, she reported that aboriginal students were more likely to have taken alternative math classes or have dropped mathematics all together during their high school years. She reported that this was a significant factor in their reluctance to take mathematics classes at the College level: they had learned through their school experiences that they were unable to "do real math". This belief about themselves acts as a significant factor in their reluctance to enroll in math courses. Anecdotally, she reports that students are much more able to catch up their skill levels in written composition than in mathematics. As a result, more aboriginal students enter career training fields that rely on fewer mathematics prerequisites. This anecdotal evidence is supported by the statistics reported by Malatest (2002) quoted earlier in this report.

STUDENT VIEWS:

The topic of math fear and anxiety was explored in the focus group, interviews and in the student survey, represented in a Likert scale assessment of fear pre and post math 030. Understanding the source of math fear/anxiety is an important step to understanding if introducing particular approaches to teaching math is a factor in reducing this fear. Students expressed a number of views about why there are math fears including: math's complexity and level of difficulty; lack of success in high school mathematics; a history of substituting math courses with lower levels of difficulty rather than the mainstream math represented in grades 10, 11 and 12; social factors particularly related to rebellion in adolescence; not putting adequate effort into their previous attempts; fear of failure; fear of being made to look bad in front of others; and lack of personal motivation: that is, I don't need math to succeed in life. Fear at the college level was also linked with a fear of the unknown, particularly for students who had been out of school for sometime. There was a generally expressed view in both the focus group and interviews that one could "get over math fear" and once that this hurdle had been overcome, the math fear would disappear.

The links between understanding how math is essential to life future careers was seen as a tool in overcoming fear-- as one student stated: "*I think if people understood the importance of math more they'd want to do it. 'Cause math is in everything you do – engineering, anything – cooking even, like everything we do in our lives revolves around math. Or at least some mathematical principle. Even when you're on computers – you know, it's a bunch of numbers organized together – it's all math".*

Another way of overcoming fear was simply expressed as understanding the reality of life without further training or skill development: minimum wage jobs sent many of these students back into classrooms to upgrade so they could enter further career or trades training.

Another theme was increasing student comfort: by increasing the level of student trust, anxiety could be reduced. This was perceived to arise from having a good relationship between student and teacher. As one student suggested, "*If you don't know anything about your teacher or you don't – can't relate to them then I just don't want to learn from them. You're not comfortable there".* Similarly another student suggests: "*once you're in it, your teachers get you through*." Clearly, teacher support and encouragement were seen as a means of reducing fear and therefore enhancing learning.

Another strategy that was suggested by students was the practice of peer tutoring, or peer assistance during class time. This was seen as a non-threatening practice: students suggested it often felt easier to ask another student questions than to ask the teacher. Students did not want to be perceived as having lesser math knowledge: fear arose from feeling they would be labeled by their instructor if they were to ask too many questions.

The response of aboriginal students showed some significant differences from non aboriginal students that should be explicated. There were many common sentiments expressed about the nature of math fear and anxiety including fear of failure, complexity and difficulty, and fear of the unknown. This latter point is particularly of concern to those aboriginal students who have recently moved to the Prince George area and were not familiar with the routines and processes of institutions like the College. The idea of having someone that could offer support in a peer type relationship was suggested as a good way of bridging between the traditional aboriginal community and the educational environment of a large campus. The Aboriginal Student center was seen as an important resource.

Differences arose in the degree to which the pace and speed through which mathematical concepts were introduced and then left in order to cover the many topics included in the course. This was a factor that increased anxiety about math: being able to devote between 2-3 hours a day in homework for math alone was a factor in students falling behind and becoming more afraid of failure. At the same time, it increased the level of anxiety about higher levels of math: if they were falling behind at this lower level of math, would it become worse over time and as the difficulty of the math increased in higher level courses?

Overall, according to the student survey, there is a generally higher level of overall anxiety about math among aboriginal than non aboriginal students (see Appendix C). As well, there was not as a significant a change from the beginning to the end of the course: while anxiety levels dropped for some aboriginal students, it increased for others.

Another area of higher anxiety was in the area of math tests. More aboriginal than non aboriginal students feared tests; as a result, they were more likely to favour projects as a way of showing understanding or knowledge. (See earlier section of this report).

Individual tutoring was identified as a successful strategy for reducing fear. However, access to tutoring for all students was problematic: several students expressed a need for extra help but could not access it because of course load or financial constraints. The reduction of class sizes was also identified as a possible solution to assisting with more one on one support between teacher and student.

One aboriginal student made clear that anxiety is not a one time thing to be overcome simply by familiarity with the institution, developing trust between faculty and student, or the nature of the mathematics learning environment: anxiety can return in each new term or topic as uncertainty is re-introduced. While student success could decrease levels of anxiety, this was not necessarily a permanent change.

From these results, it is clear that anxiety, while being reduced through a number of instructional practices including teacher encouragement, tutoring, peer pairing, and the use of projects it remains an area requiring ongoing attention.

There was at least one unintended outcome of this evaluation that is worth reporting on in this section of the report. One student noted that the actual face to face discussion that was encouraged through the focus group format lead to an improved overall classroom climate, in particular, a willingness to talk with fellow classmates, and a greater confidence in asking questions of one another. This student reported that this had greatly enhanced the learning environment and expressed a desire that similar opportunities for student to student dialogue about the course, topics and issues be incorporated into future classes.

OTHER FINDINGS:

Aboriginal student Attendance:

In the student questionnaire, students were asked to comment on whether or not their increased success/interest in math 030 had caused their attendance in class to improve. As Appendix C notes, this was true for aboriginal students and offers evidence of the success of the course in meeting the needs of aboriginal learners.

Aboriginal student identification:

This report will not address the pros and cons of asking students to identify themselves as to their racial/ethnic background; that is beyond our mandate. However, the authors note that the Aboriginal Coordinator made reference to the lack of capacity to track student success, as well as a means of formally contacting aboriginal students about Center activities because of this decision. We note that it would considerably ease the ability to track student success, identify potential peers, leaders or mentors that could

provide support to aboriginal students taking mathematics courses. We therefore leave this matter for the Community Education department to consider.

Improvements in the student workbook:

While the work of this evaluation was to report on how math 030's curriculum revisions had affected aboriginal student performance, we wanted to ensure we attended to several of the general suggestions made by both aboriginal and non aboriginal students. Many saw a need to enhance the accuracy of the student workbook: students noted it contained many errors. Additionally, they advised that there was a need for the inclusion of more detailed examples of problem solving techniques for practice purposes. Another suggestion was the creation of a CD rom that had additional examples that could be borrowed or purchased for student practice.

IMPLEMENTATION ISSUES

INSTRUCTOR VIEWS

As was reported in our first phase report, a number of implementation issues were reported by the curriculum reviser as well as the instructor. While these do not fall within the four themes described in the program evaluation section, it does fit within the mandate of the "improvement focused model" referred to at the beginning of this report. This assured a focus on the question "How can we continue to improve this course so it better meets the learning needs of our students?"

ENGAGING IN ONGOING PROGRAM IMPROVEMENT

As noted earlier, there is a strong commitment to good teaching and an emphasis on the importance of meeting the needs of aboriginal students within the Prince George and satellite campuses in the Community Education department.

This commitment is also evidenced by the strong commitment among CNC staff to improve their effectiveness as instructors of aboriginal students. All interviewed staff expressed professional goals which emphasized continued improvement in teaching skills, improving familiarity with aboriginal culture and practices, as well as focusing in on instructional strategies and approaches to instruction that accommodate Aboriginal preferred modes of learning. Each articulated a strong desire to look beyond the context of the classroom to more effectively support the variety of social needs of the aboriginal student. There was a commonly expressed belief that academic progress in mathematics is their central priority, but all instructors and support personnel also expressed a desire and willingness to provide a safe, open and supportive learning environment.

IMPROVING THE CURRICULUM REVISION PROCESS

There are a multiplicity of views about the purposes of the revisions to math 030.

One of the most important features of effective program implementation is the need to build a common understanding of the program's goals, objectives and purposes. In meeting with the different institutional stakeholders, it became clear that each individual had different understandings of what the program pilot was meant to achieve. This is due, in part, to the nature of the program objectives which are broadly framed and therefore offer a multiplicity of potential interpretations. For example, one instructor voiced the perspective that the goal was to "*make it [math 030] more relevant to…them [Aboriginal students]…and it make it more interesting for the Aboriginal students… because it's the dominant culture in Prince George"*. In contrast, the First Nations Coordinator expressed a view that the goal was to "*increase the number of aboriginal students who get their credit for 030…and to possible go on into a career in science or technology."* The program designer on the other hand, emphasized the need to enhance student comfort in mathematics by strengthening relationships among faculty and Aboriginal students, and by placing an emphasis on ways of modifying instructional approaches and activities to take into account social, economic and cultural contexts. Each of these individuals saw significant value in the goal of piloting a more responsive curriculum, but each took from this specific interpretations which flavored the choices they made about how to implement the curriculum changes. Although there are a number of different opinions on how to best achieve improved success for aboriginal learners in mathematics, there are clearly commonalities as well. What is very clear is there is a strong personal and professional commitment to enhancing the success of their aboriginal students.

One factor in this lack of consistent understanding about the program goals could not have been anticipated: the original implementation planning proposal saw the chief program designer also acting as the pilot project instructor, ensuring an effective transition from design into practice. Unfortunately, student enrollment necessitated some changes in staff assignments, leading to the situation where the individual who designed the pilot project changes and had been given the time to research and plan the program changes was assigned to a different mathematics course, and different instructor asked to implement the program in her classroom. Not surprisingly then, there was a gap in the knowledge of the program's research foundation, and in particular, knowledge of the approaches common to the ethno-mathematical framework.

Despite a need for specific goals and well understood benchmarks of achievement, it is also necessary, particularly in educational programming, to be sufficiently open as to permit faculty members to practice professional autonomy: teaching beliefs and values strongly influence the choices that a teacher makes in making instructional decisions (Burden and Byrd, 2003). This desire to respect professional autonomy was expressed in particular by the program designer: her comments illustrate several important elements of program commitment.

> *"I can't say to someone else when they teach the program that I want you to be sure you make the First Nations students feel that they are worthwhile people… I found it very hard to write down the teacher practices. I started to compile what I am calling an instructor resource manual with some first day ice breaker type*

things that would try to draw in all the different cultures of students. But it is very hard for me to say to… [another instructor] this is how you need to teach the course. Because I don't think you can do that."

These comments illustrate two components of autonomy: personal comfort with culturally sensitive practices and the need to acknowledge the variety of approaches that are necessary to accommodate many different learners within the classroom setting.

These views suggest at least two professional development needs of faculty who are currently involved in the program pilot project, and potentially other instructors, should this revised course continue to be taught or expanded to other mathematics foundation courses. These needs include: enhancing knowledge of student learning styles, particularly those of Aboriginal learners; the sharing of the research base foundational to the program design; and the need to engage all faculty in a discussion about how to more inclusively accommodate Aboriginal culture issues in their classrooms. The responsibility for meeting the goals of the program and committing to the organizational values represented in the program revisions should be considered collectively by all of the program staff.

There is a need to set some specific targets and measures of success for evaluating this pilot program in the short and longer term.

When we were contracted for this review, we were given a broad framework from which to consider this evaluation. While offering considerable flexibility in designing methodology, it has also presented some specific challenges for determining measures of program success. Therefore, as evaluators, part of our work during interviews was to probe for what faculty and staff understood to be markers of student success in mathematics 030. This probing for how different institutional staff members understood appropriate markers of success has revealed some important values and potential measures of success. This informed our subsequent discussions with aboriginal students who volunteered to participate in follow up interviews. Some of these measures include: student enjoyment, student motivation, active engagement in learning, attendance in class, attitudinal change, a C or better in final grade, an increased willingness to enroll in another math course, a reduction in fear from the beginning of the course until its end, expressing an interest in entering a science or technology career because of being able to meet the math pre-requisite, and a willingness to recommend this course to friend or family member. These measures were used to gather data in the student survey and when reviewing the final grades of the students in this class at the end of the semester.

PILOT IMPLEMENTATION ISSUES: CONCERNS ABOUT RESOURCES, COMMITMENT AND LEADERSHIP.

Our review offered a very useful window into the effectiveness of the pilot program. This section of our report relied on coming to understand the implementation concerns of the instructors who were charged with its design and trial instructional period.

The budget for this pilot program included release time for its writer. The institution released the program author from teaching duties for one class during the fall 2003 semester, just prior to the pilot trial period. The goal was to complete the entire revisions to math 030 before the next semester (January 2004): this required the re-writing of three student workbooks that are used as texts and instructional guides. A second task was to complete an instructor's manual that would accompany the student text. This would include references to the research foundations of ethno-mathematics, examples of creating a culturally inclusive classroom and learning community, as well as instructional strategies that accommodated known characteristics of aboriginal learners. In preparation for this task, the curriculum writer was first required to engage in several preliminary tasks including: research into the field of ethno mathematics; scholarly reading and study; and attendance at a number of workshops or conferences on the role of cultural integration in mathematics. This was followed by a period of intense writing, complicated by the institution's decision to change word processing programs so that the entire workbook had to be re-entered into a new database. Another complicating factor was that the math 030 student workbooks were also used as a manual for students taking a self directed mathematics course. This required the curriculum writer to spend significant effort in ensuring that the needs of these independent learners were accommodated by providing as much written explanation as possible.

What became clear to the evaluators was the time needed to engage in this curriculum revision was under estimated. While the products of the implementation plan were entirely appropriate, the amount of work needed and its complexity made the timeline impossible to achieve. The author simply ran out of time; only one of the three workbooks was completed, and an instructor's manual is now being considered as a professional development project to be completed in the summer semester. Should the institution determine on the basis of this review that efforts should continue in revising mathematics foundation courses to include a cultural/aboriginal component, the need for additional funding will be necessary to complete the implementation plan.

A second implementation issue was identified earlier: the unfortunate situation where the curriculum writer was not able to use her own considerable knowledge developed during the research and writing phase and apply it to the instructional phase. As evaluators, we give significant credit to the curriculum writer and instructor in their efforts to stay in regular contact throughout the implementation period so that there could be a very useful and productive trial of the revised curriculum. While not ideal, they have worked hard to ensure that there would be an adequate trial of the new material.

A third area of implementation concern arose in the decision to choose to apply the pilot program dollars to the revision of mathematics 030. We were informed that the original application to the Ministry of Advanced education was for mathematics 045, which is equivalent to the Grade 11 curriculum. However, the curriculum writer was able to persuade the Community Education department that they should request an amendment to that plan, arguing that there was insufficient opportunity in the grade 11 curriculum to include a significant portion of aboriginal content or practical, real life problems. In interviewing both the curriculum writer and the instructor, it became clear

that both felt a revision to the first mathematics foundation course, mathematics 020 might be an even more appropriate place to introduce a component of cultural knowledge. This is because mathematics 020 covers the grade nine curriculum, and its content lends itself in particular to the introduction of more real life examples. It would also permit a greater capacity for linking related topics and permit more explicit instruction in the connections between related mathematical skills. For example, proportion, ratio, percentages, fractions, and decimals are all related topics in the math 020 course: all topics that lend themselves to an opportunity for increasing the use of cultural examples, and in particular, the use of word problems. This would permit a greater emphasis on application of mathematical ideas, and increase student ease and comfort with foundational mathematical concepts. As the curriculum writer noted:

> *"That's where the majority of our first nations students come in…Obviously they have to get through grade 8, grade 9, grade 10 math before you can do grade 11 math, and we lose them along the way… Typically they come in at a very low level, usually an 020 fundamental: and many of them never make it. Maybe because they don't have the background, maybe they don't have the support of mentors, or maybe the course isn't interesting to them… but we do know that that's where we lose them. So I would really like to see something done."*

The implication here is that the way to draw aboriginal students into developing a stronger interest in mathematics and to lessen fear/ failure is to include a more significant ethnic/cultural focus in their initial attempt at re-entering the mathematics stream.

The final implementation issue that will be noted in this preliminary report is an important one: the need for leadership in an ongoing program revision and a strong commitment to creating a more inclusive and ethnically sensitive math curriculum within the institution. Based on her reading, research and discussions with aboriginal elders and other mathematics educators, the curriculum writer who revised math 030 is convinced that CNC is heading in a positive and important direction.

> "*What it needs is someone who can direct it, pull it together than convince people that this is something useful…. I don't want to see it stop here because I don't feel comfortable that we have really done much. In three months time, maybe I've done a lot, but… I think there are certainly opportunities. And I believe if our regional campuses were told [about our work] and even had a one day talk session, to talk about what they do that works with their students, I think we could get some ideas."*

CONCLUSION:

As this report has indicated, there are significant opportunities for institutions that are interested in developing effective models that can offer a means of increasing aboriginal student success in mathematics. CNC has placed itself in a leadership position, and continuing this work offers the opportunity to develop successful models that can be applied in other BC institutions.

We would like to thank the Community Education department for this opportunity to work with them in an important field of educational research. We would also like to particularly thank the curriculum researcher/writer, the First Nations Coordinator, the pilot program instructor and the students of math 030 for their interest and cooperation. Without them, this report would have not been possible.

APPENDIX A

PLEASE INDICATE THE FOLLOWING:

AGE: □ under 20 Education status: □ some high school
□ 20-29 □ high school graduate
□ 30-39 □ some post secondary
□ 40-49 □ post secondary certificate, degree
□ 50 +
Aboriginal: □ Non-Aboriginal □

Part I: What you believe about math learning.

Please circle A to agree or circle D to disagree with the statements below based on **what you believe about how students learn math.**

Things I Believe About Math Learning.	AGREE / DISAGREE
The best way to understand what students know in math is to have them take a written test.	A D
The best was to understand what students know in math is to ask them questions about the math they are doing.	A D
The best way to understand what students know about math is to ask them to tell you how they got the answer to the question.	A D
I learn well when I get to try several different kinds of learning activities.	A D
I learn well when I get a chance to discuss my thinking with others.	A D
I learn well when I can try one of several different ways to solve a math problem.	A D
I learn well when someone explains a way of solving a math problem.	A D
I learn well when I can read the problems from the text and take as much time as I need to solve them.	A D
I learn best when there is a gradual increase in new math ideas, with lots of time to practice.	A D
I learn best when I feel confident with a new math concept before I start a new one.	A D
I learn best when I am given a range of problems: some that are easier to do, but some that challenge me as well.	A D
I learn best when I get a chance to listen, to write, to read and speak about my math ideas.	A D

I learn best when my teacher directly teaches a new idea and uses a model to help explain how to solve this problem.	A	D
I learn best when my teacher talks about the connections between real life math and the math we are learning in class.	A	D
I learn best when my teacher uses examples in math that are about things I like and am interested in.	A	D
I learn best when my teacher teaches me the steps of how to solve a problem.	A	D
I learn best when I am able to make a picture of the math ideas in my mind.	A	D
When I see math as a challenge or a puzzle, I am more interested in trying to solve it.	A	D
I learn best when I am able to draw pictures that illustrate the parts of the problem I am trying to figure out.	A	D
Math is easier for me when the teacher goes slowly so I don't get overwhelmed.	A	D
Math is easier for me when I am taught the formulas to remember.	A	D
I learn more from doing math projects than from tests or quizzes.	A	D
I learn better when someone from my own cultural group helps me.	A	D
I like it when my teacher shows the links and similarities between different math ideas. Seeing connections helps me to learn better.	A	D
I think a math peer tutoring service would be helpful for me.	A	D
If there were lots of example sheets of different math problems I could get when I was studying on my own it would help me learn math more easily.	A	D
When I trust my math teacher I am more likely to ask questions about how to do a problem.	A	D
It is more important to understand math than to like it.	A	D
I do better in math class when my instructor tries to understand my culture and beliefs.	A	D
I would do better in school if my teacher understood more about my personal life and the problems I have.	A	D

Part II. Barriers to learning math

Please read the following and circle T for True and F for False to indicate which if any of these examples were true when you first started to **take math courses here at CNC**:

Barriers to Learning Math	TRUE / FALSE
I found some of the mathematics language difficult to understand.	T F
I found it hard to keep up with the reading I needed to do.	T F
I found it hard to remember what I read: I wasn't able to keep the information in my head.	T F
I had trouble reading the problems.	T F
I had trouble making sense out of the lectures presented in class, especially in the beginning of the course.	T F
I had trouble understanding assignments.	T F
I had trouble summarizing the key ideas of what I was reading and required to do in my math workbook.	T F
I had trouble expressing my ideas in writing.	T F
There were new terms and ways of talking about math that were not familiar to me.	T F
I had trouble relating what I knew about math to what was being taught in the classroom.	T F
I was worried about taking risks such as answering a question in class or volunteering to solve a problem.	T F
I was afraid of making mistakes and looking stupid in front of my teacher.	T F
I was afraid of making mistakes and looking stupid in front of my classmates.	T F
I hated the idea of math tests because I was afraid I would fail.	T F
I was afraid to ask questions because I thought I would appear stupid or unable to learn.	T F
I didn't know how to ask for help or who to ask when I was confused or didn't know what to do.	T F
Most of the College publications used unfamiliar language that made everything difficult to understand.	T F
There are lots of skills I needed to have that I wasn't familiar with, such as using the library and how to do research, how to register, figure out which courses to take, or how to make appointments with the right department.	T F

I didn't feel welcome here at CNC: I felt different than everyone else.	T F
My cultural knowledge was not considered important.	T F
My family situation made my success in school difficult.	T F
Money is always a problem: coming to College is expensive.	T F
My teacher often misunderstood my questions or answers; I couldn't talk in a way that I could be easily understood.	T F
I experienced intolerance from others because of my race.	T F
My family responsibilities made it very hard for me to make a commitment to go to school.	T F
I saw many examples where white people were not aware of aboriginal people or cultural practices.	T F

PART III: What do you think is good math teaching?

Research suggests that students learn well when they are given examples of how math can be used in everyday life. Please circle A to agree or circle D to disagree with the following as useful examples for learning math:

A Useful Way Of Learning Math	AGREE / DISAGREE
How to shop for food bargains.	A D
How much fabric to buy to make curtains.	A D
How to figure out the cost of gas or diesel fuel.	A D
Counting fish returning to spawn using an Indian fish wheel.	A D
How to figure out the amount of wood needed for a new floor.	A D
Figuring out the best cell phone plan on the cost per minute.	A D
Total volume of trees in a clear cut.	A D
Planning the route of a trap line in a wilderness area based on wildlife counts.	A D
Creating a recipe to feed 100 people at a native feast.	A D
Studying how buildings are made and designed.	A D
Calculating the cost of a mortgage based on varying interest rates.	A D
Creating a pattern for weaving a basket.	A D
Calculating capacity of a basket based on diameter and depth.	A D

Part IV: *Your experiences in Math 030.*
Please circle A to agree or circle D to disagree with the following statements.

Your Experiences In Math 030	AGREE / DISAGREE
The Math 030 curriculum is interesting because it uses lots of real life examples of how math works.	A D
I learned about how math is used by people in different ways; for example, how aboriginal people have used math as a part of their culture.	A D
I learned about how mathematics is important in every day life.	A D
The ethnic cookbook we created in class is a good example of a project that helped me understand how math is used in every day life.	A D
The ethnic cookbook project made me proud of my culture and beliefs.	A D
I was surprised when someone asked me to figure out how much birch bark it would take to make a moose caller for a math project.	A D
I liked working with my classmates on the moose caller problem.	A D
I attend math class more regularly because I am starting to enjoy math more.	A D
I think putting an ethnic focus on math is wrong: math is math; it isn't different for different people.	A D
Because I am getting so much better at math, I would like to help another student with their math.	A D
I enjoyed the group projects and math projects that were added to this course.	A D
I like the way my teacher made connections between math ideas; it helped me to understand and learn.	A D

Part V: *Math anxiety.*

One of the goals of the changes made in this semester's math 030 was to **reduce student anxiety and /or reduce worry about mathematics.** Please complete the following.

On the scales below, circle a number, 0 to 7, that describes how anxious/worried you were about taking a course in mathematics **before you began Math 030**.

0	1	2	3	4	5	6	7
No anxiety							Very anxious

On the scale below, circle a number, 0 to 7, to indicate your degree of worry about mathematics **after completing math 030.**

0	1	2	3	4	5	6	7
No anxiety							Very anxious

Part VI: *your future plans for taking courses in mathematics.*

Will you enrolling in math 045? Please circle the answer.

YES NO

If your answer was NO, please skip these questions.

Reasons for taking Math 045	AGREE / DISAGREE
I will take math 045 because I enjoyed math 030.	A D
I am less afraid of trying more difficult math skills after math 030.	A D
I will take math 045 because I need it to be accepted into another program.	A D
I enjoy math now and math 030 reinforced my confidence.	A D
Math 030 was very useful and I want to learn more.	A D
Math 030 has given me the confidence that I can do more difficult math.	A D
I realize math is an important part of day to day life that I need.	A D
Because of my success in math 030, I may consider further math courses so I could train in a science or technology career.	A D

Part VII:
Please add any additional comments you would like to share with us in the space below.

_____

_____

_____

_____

_____

_____

PLEASE RETURN YOUR SURVEY TO YOUR MATH TEACHER ONCE IT IS COMPLETE BY PLACING IT IN THE ATTACHED ENVELOPE AND SEALING IT.

Thanks for your help!

Focus group about Mathematics 030

Name _____

Phone number/or address _____

Age:

( ) below 20

( ) 20's

( ) 30's

( ) 40's

( ) 50's

( ) 60's

Education:

Years of formal education finished (circle the appropriate number)

6 7 8 9 10 11 12 post secondary certificate or degree

Race:

( ) Aboriginal ( ) White

( ) East Indian ( ) other

( ) Asian descent ( ) Hispanic, Latino, Chicano

Gender:

( ) female ( ) male

Student category:

( ) full time student ( ) part time student ( ) working outside the home while attending school

☐ **I WOULD BE WILLING TO PARTICIPATE IN A FOLLOW UP PERSONAL INTERVIEW TO BE ARRANGED AT A TIME CONVENIENT FOR ME.**
A $25.00 STIPEND WILL COMPENSATE YOU FOR YOUR TIME.

Focus group: opening statement

Hello, thank you for agreeing to be a part of our focus group discussion today. My name is Cathy McGregor, and this is Peter Macmillan: the college has hired us to evaluate the course you are all enrolled in, math 030 because it has been changed and adapted to include more references to aboriginal practices and culture than was previously the case. The College staff and faculty hope that these will make the course more meaningful for aboriginal students in particular, to help reduce student anxiety about taking mathematics, and enhance student success. Of course, we know that not only aboriginal students take math 030, so understanding how these course changes affect all students is an important for us to understand so we can continue to improve the course.

Before we begin, I'd like to briefly highlight some important discussion points. First, please speak up as we are tape recording this session as we don't want to miss any of your comments. If you could please have only one person at a time talking, otherwise we lose the quality of the recording. We want to hear from everyone, so please feel free to add or comments, or disagree with the statement of another: I only ask that you listen to the views and beliefs of others, you are not required to agree with them. We want to hear as many views as possible, so don't feel you have to agree with others. We will be writing a report for the College and the government of BC that will contain comments from today's focus group, but no one's name will be directly attached to any statements, thoughts or ideas expressed. We hope to complete this conversation with an hour.

My role is to listen and ask questions. From time to time I might direct a question to someone who hasn't offered an opinion, or I might ask you to clarify or give more information to a comment you've made. I will also be trying to move the conversation along at some points so we can get to all of the questions. I have posted all of the ideas I'd like to discuss here on the chart, so you'll know what topics we hope to cover. Peter will be taking a few notes and may also ask you to clarify comments.

One final comment: we are more interested in your opinions about the program, what the College or other agencies might consider doing; we are not interested in rating or commenting on the specific people who teach the course. The College asks you to do this formally in another way.

Let's begin by just going around the table and getting each person to tell us why you are taking math 030.

Focus group questions:
Q 1: Why are you enrolled in math 030?

Q 2: What makes many people afraid of mathematics?

Q 3: What things could be done in a classroom to reduce fear of mathematics?

Q4: What helps you to learn math? What kinds of things are you doing when you are learning math well? What are the qualities of a good environment for learning math?

Q 5: Can you describe an activity from this class that you thought was a particularly useful way of learning about a math topic?

Q 6: The person who re-wrote this course replaced many of the chapter quizzes or tests with projects that were designed to apply math learning to the project. Did this enhance your math learning?

Q7: Can you recall a specific example of a problem or project during this math class that you would consider culturally sensitive, had an aboriginal focus, or was particularly meaningful to you? How did you feel about it?

Q8: is there anything we've missed that you think would be important for us to consider in developing this report?

Follow up interviews with selected students:

1. Math fear/worry about math. This is something that many researchers have written about, that how a student feels about their ability to learn math can influence how they do in math. What are your feelings about math? Were you worried about math when you began taking this course? Did you feel less worry as the course went on? How did you get over this worry?

2. Tell me something about how you learn math best. For example, some people believe that seeing a problem with pictures is the best way for them to learn. What do you do to help you learn math?

3. Note to us: Because the students didn't have as much familiarity with examples of the projects and specific ethnic examples that were used in this class (because it was only in the first book of the course and they are well beyond it at this time) we should begin by giving an examples of one several of the projects or problems used that had a practical or an ethnic focus.

One of the goals of this course revision was to introduce some "real" examples of math to help students learn. It was also a goal to include examples that would have meaning to aboriginal students who might take the class: for example, the project where you were asked to design and figure out the area of a moose caller. Did this project help you to learn about area more easily?

4. I am going to make a series of statements and I want you to agree or disagree with each.

I want you to imagine that a series of research reports about how students learn mathematics best have recently been released.

First, this report identifies that men/male persons learn math best when they are given written examples of how to solve particular kinds of problems. For example, if the topic was volume, male students were given several examples of problem solving showing the steps from 1 to 6 in written form so they could look at it while they were solving problems. Knowing this information, should math teachers incorporate this way of teaching into their classrooms?

Secondly the report identified that women/female female student learn math best when they are given the chance to talk through their approach to problems. For example, female students who worked in small groups and talked about how to solve the particular math problem did better than women/girls who did not. Knowing this information, should math teachers incorporate this way of teaching into their classrooms?

Thirdly, the report identified that aboriginal men/women learned math best when they were asked to solve math problems that related to their own cultural experiences. For

example, when learning about graphing, examples that discussed trapping and hunting were used and made the math concepts more understandable and interesting. Knowing this information, should math teachers incorporate this way of teaching into their classrooms?

5. Questions for Aboriginal students. The CNC continuing education department believes it is important to support aboriginal students in learning mathematics. There has been some research to suggest that aboriginal students face more barriers to learning math than others. Aboriginal students are also under represented in math, science and technology, as well as trades courses. Many bands are anxious that aboriginal students take these training programs so they can fill the need for people with these skills on reserve or in service to the aboriginal community. Given these facts, changes to the content of the math course and including examples of how aboriginal people use mathematics would be part of the solution for these problems.

Do you feel that having these examples helped you to learn math more effectively? What other changes might be considered to this math course to make it more accessible for aboriginal students?

Please respond to these statements:

I feel safer in a class where there are other aboriginal students.

I would rather get math help from the First Nations Center than from my instructor

I learn best when someone else tells me.

I learn well when I can work with others or in a small group.

I learn better from a friend who helps me than I do in the class.

I get worried about asking questions in front of all the other students during math class.

I like to understand why some math concepts are important, so then I can see a reason for learning the math.

I like to read the math problems alone and only ask for help from the teacher if I need it.

I feel embarrassed to ask for help in math.

Program staff Interview questions:

FN Coordinator:

Tell me how you became involved in this ethno-mathematics course.

Probe for: role in development
Personal perspective on math education
Concern for aboriginal students (a possible story of a student)
Is there an ongoing role that this person plays in helping aboriginal students with their learning, particularly math?

Why math as a focus of concern?

What hopes do you have for this program?

What would you see as an important indicator of success in this program?

Is there anything else you'd like to tell me about before we end our interview?

Program writer:

1. Tell me how you became involved in this ethno-mathematics course.

2. What hopes do you have for this program? (probe for understanding of program goals and objectives)

3. Why is math a focus of your concern?

4. What did you learn about ethno-mathematics that excited you, challenged you, concerned you, gave you pause…

5. Were there any issues you felt could not be adequately addressed in this program design? Can you tell what they were and why you felt they have not been sufficiently addressed.

6. In what ways would you describe this course as significantly different, or substantially the same as the other basic grade 10 math course you offer here at CNC.

7. Tell me what you think about the way this course was developed: written by one person and taught by another: was this, or does this remain a concern for you?

8. Tell me about the course implementation process: what worked well, what would you want to change given a chance to offer this course again?

9. What would you see as an important indicator of success for this program?

10. What measures do you think would help us understand how effective this program is for students of aboriginal descent?

Instructor:

1. Tell me how you became involved in this ethno-mathematics course.

2. What hopes do you have for this program? (probe for understanding of program goals and objectives)

3. What did you learn about ethno-mathematics that excited you, challenged you, concerned you, gave you pause…

4. In what ways would you describe this course as significantly different, or substantially the same as the other basic grade 10 math course you offer here at CNC.

5. Can you share a story (an anecdote) that describes how you approach instruction differently in this class than others you have taught in the past?

6. How do students respond to your teaching practices? Do you see any changes

APPENDIX B:
Summary of the Relative Amount of Aboriginal Content

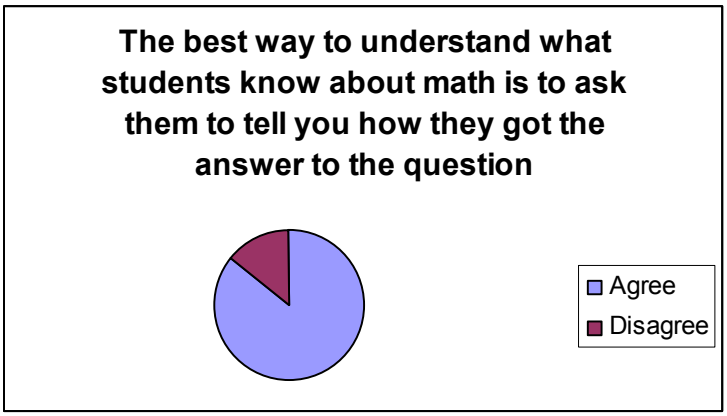
Table B1. Assessment of the Relative Amount of Newly Introduced Aboriginal Content

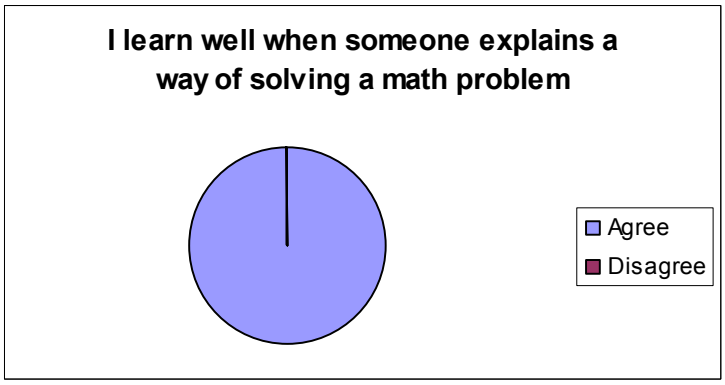
Total Possible Content	Count		Count
p. 6-7 patio stone example	1		
Section C3-C5 p. 18-21 34 questions	34	C1 p. 13-15 1 graph, 1 table 9 questions on Aboriginal populations	9
Q 10-34 p. 22-25	15	Circle graph: [Navaho] Aboriginal or other ethnicity recipe p. 26	1
p.29 examples Mrs. Zigg, Mrs. Smith p. 30-31 Q 1-24 p.	27	Q 29 a, b p. 23: US sled dog prices	1
p. 42-45 Unit3 Measurement	1	Olemec Indians	1
p. 53 Q 16-19	4		
p. 56 Q 13-18	6		
p. 60 Q 11-12	2		
p. 60-64 Precision section	1	1 brown? skinned basketball player	1
p. 66 Q 6-7 (15 sub questions)	15	Several that might be northern / rural	3
p. 67 Project: price of gas	1		
p. 70 angles Chaucer reference	1		
p. 74 Q 15-18	4		
p. 91-93 Q 1-9	9		
p. 100 Q 9-10	2		
p. 107 Q 8, 10	2		
p. 110 Q 1-3	3		
p. 113 tessellations Project A p. 114	1		
p. 118 South West Native American Art	1	Unit 5 Navaho & other designs p. 118 information – no question or activity	1
p. 123 Q 1-13	13		
p. 127-131 Q 1-32	32	Q 21 p. 130 First Nations drum	1
p. 132 Q 1-3	3	Q 1 p. 132 ice fishing	1
p. 135-137 Q 1-17	17	Q 17 p. 137 firewood	1
p. 138-139 examples of cylinders	2		
p. 140 Q 1-12	12	Q 10 p. 140 hunting cabin	1
p. 142-143 Q 1-9 cones	9	Q 9 p. 143 Red Hawk	1

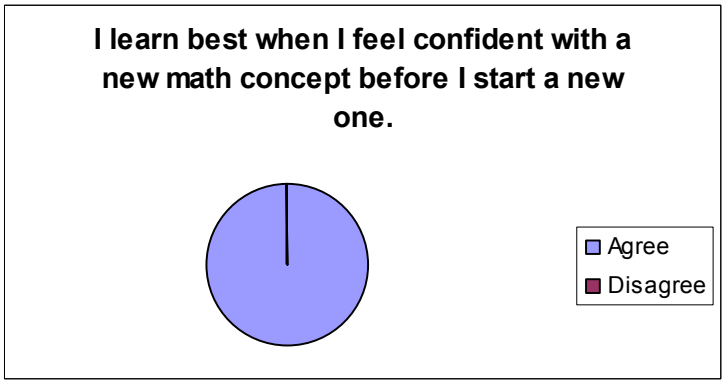
		Trading Company	
p. 144-146 pyramids Q 1-6	6		
p. 146-148 spheres Q 1-12	12		
p. 148-150 Q 1-15 volumes	15		
p. 150-151 Q 1-10	10	Q 10 p 151 cans of salmon	1
	1	p. 153 Moose caller project	1
p. 154-155 geometry self test	8		
TOTAL INSTANCES	268	TOTAL INSTANCES	24

APPENDIX C:
Summary of selected student survey results

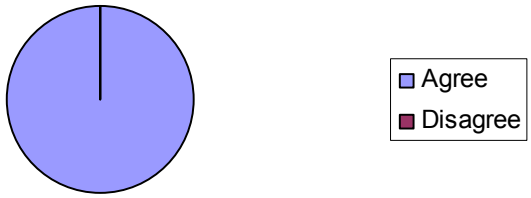
Things I believe about math learning
No significant differences between aboriginal and non aboriginal respondents



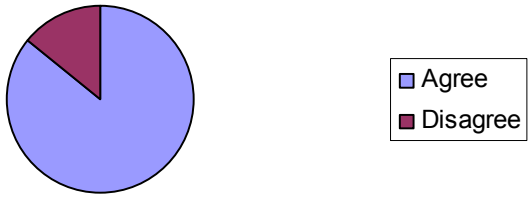




I learn best when there is a gradual increase in new math ideas, with lots of time to practice.

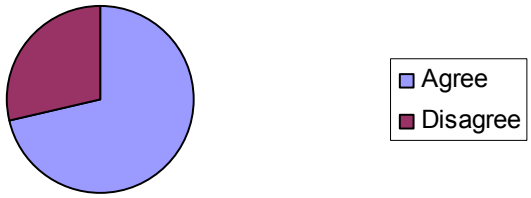


I learn best when I get a chance to listen, to write, to read and speak about my math ideas.

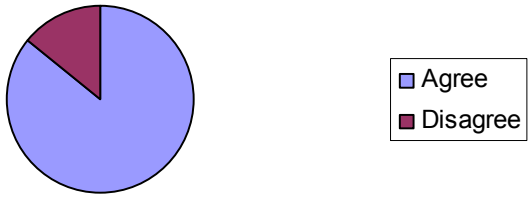


I learn best when my teacher talks about the connections between real life math and the math we are learning in class.

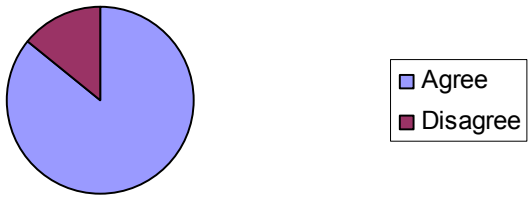
I learn best when my teacher uses examples in math that are about things I like and am interested in.



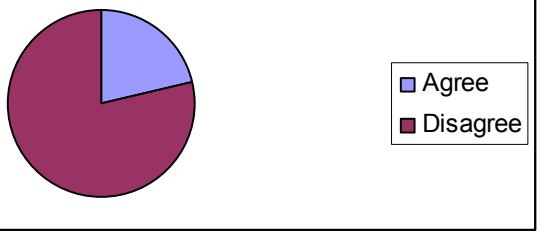
When I trust my math teacher I am more likely to ask questions about how to do a math problem



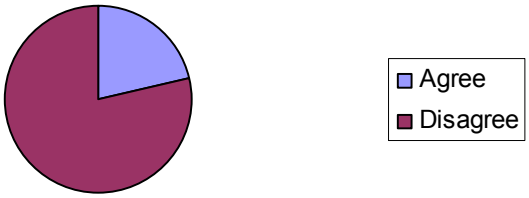
The best way to understand what students know in math is to have them take a written test



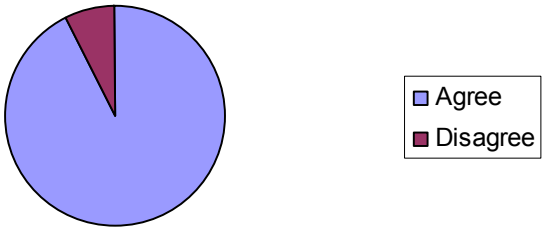
I do better in math class when my instructor tries to understand my culture and beliefs



I would do better in school if my teacher understood more about my personal life and the problems I have.



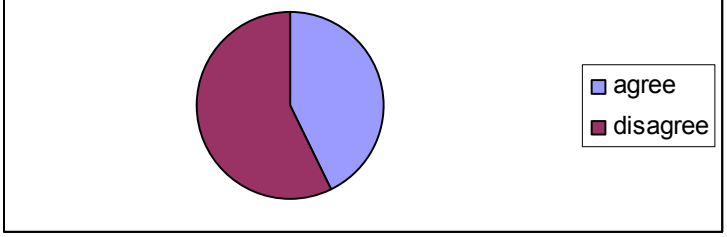
Math is easer for me when I am taught the formulas to remember



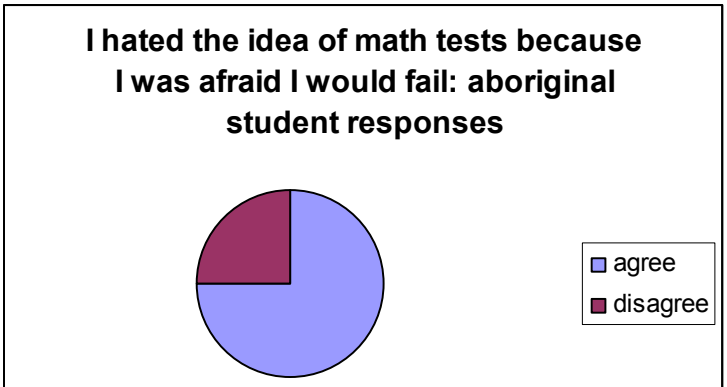
Barriers to learning math

Differences between aboriginal and non aboriginal respondents noted

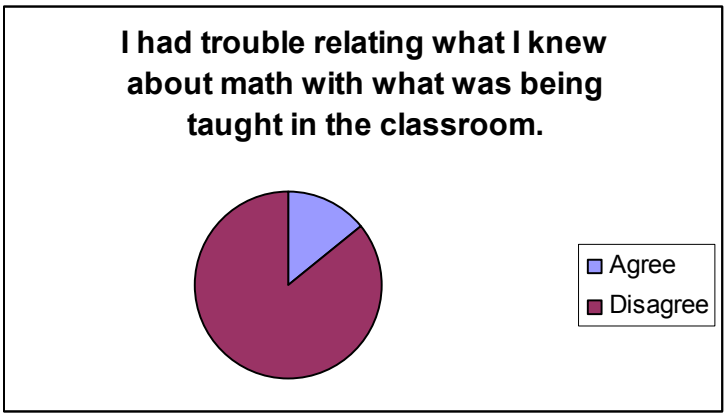
I hated the idea of math tests because I was afraid I would fail: non aboriginal student responses



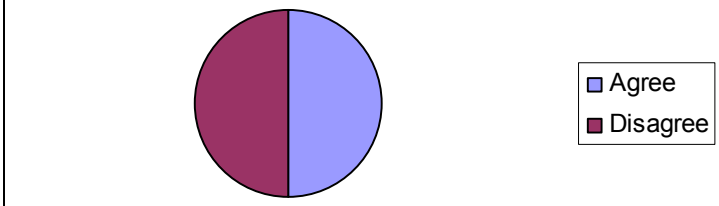
I hated the idea of math tests because I was afraid I would fail: aboriginal student responses



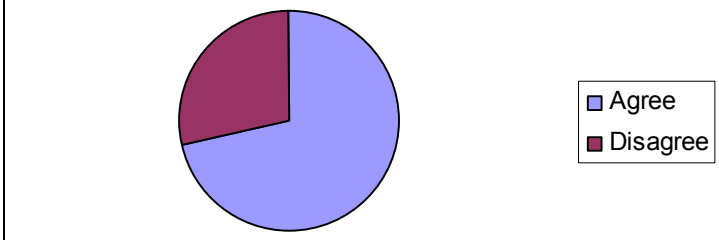
I had trouble relating what I knew about math with what was being taught in the classroom.



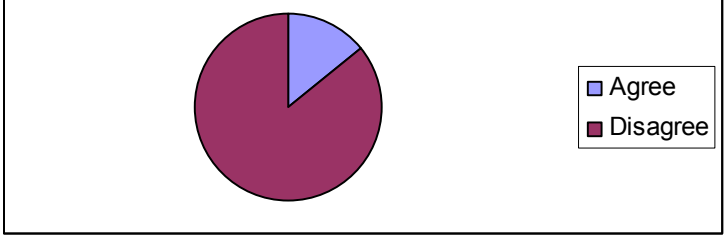
There were many new terms and ways of talking about math that were not familiar to me.



Money is always a problem for me: coming to College is expensive

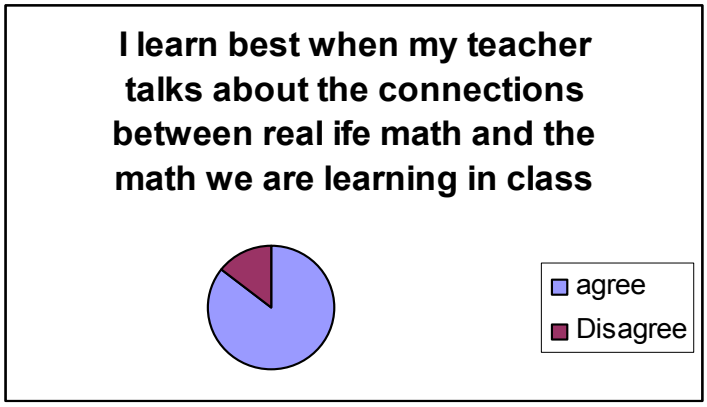


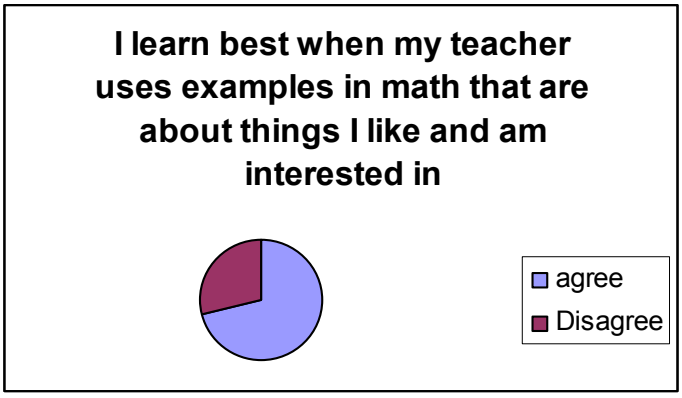
My family responsibilities make it very hard for me to make a commitment to going to school.



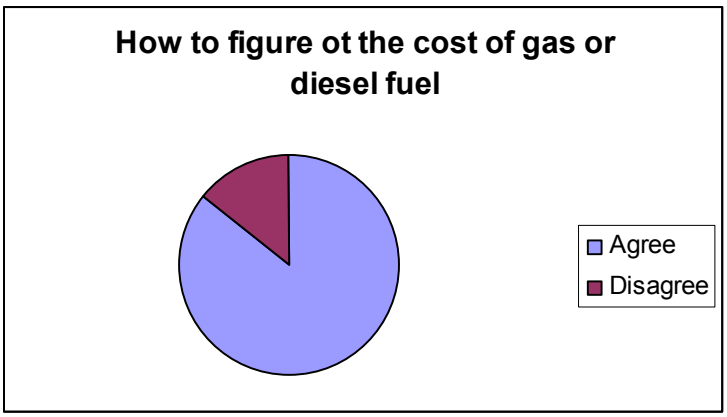
Useful ways of learning math

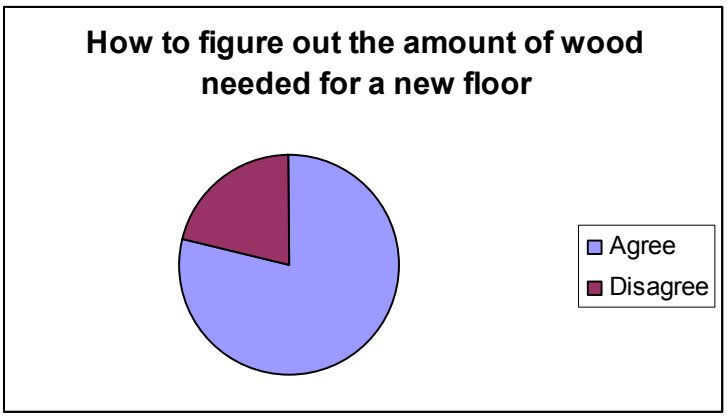
Differences between aboriginal and non aboriginal respondents noted

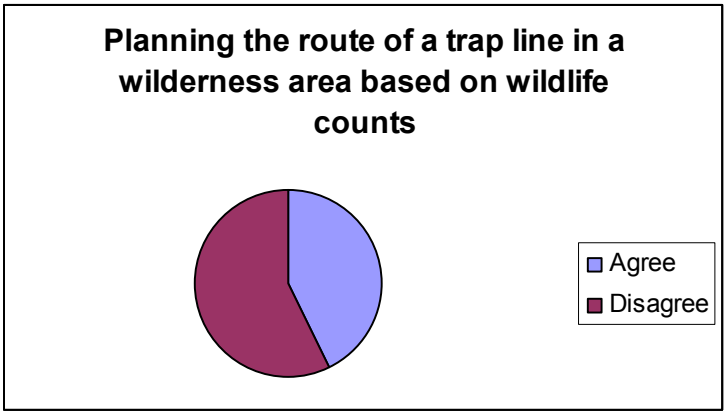


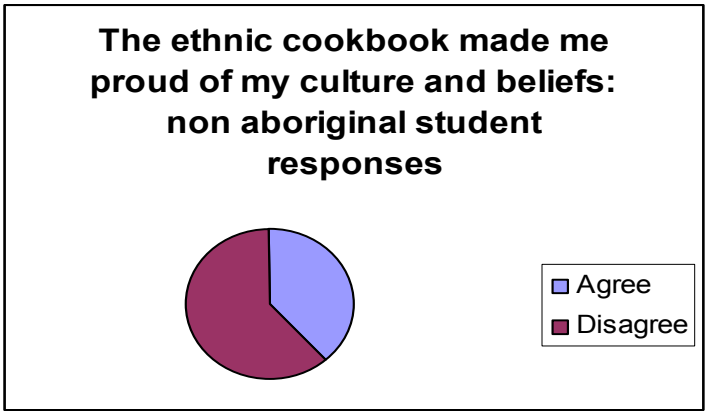


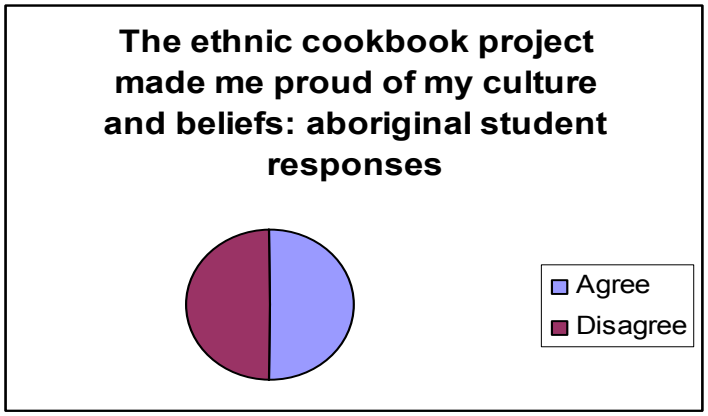

How to shop for food bargains
Agree
Disagree

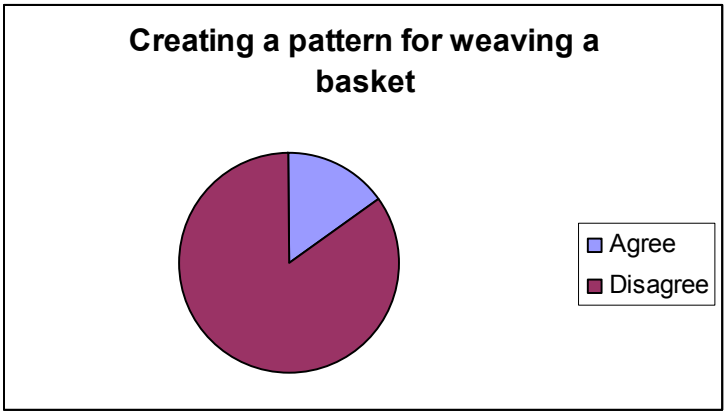

How to figure ot the cost of gas or diesel fuel
Agree
Disagree


How to figure out the amount of wood needed for a new floor
Agree
Disagree


Planning the route of a trap line in a wilderness area based on wildlife counts
Agree
Disagree

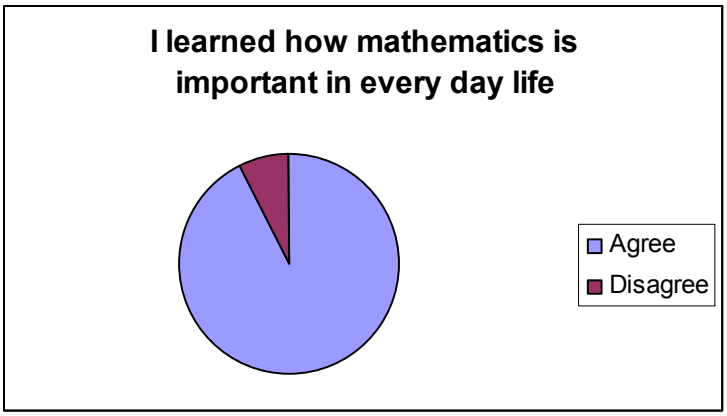

The ethnic cookbook made me proud of my culture and beliefs: non aboriginal student responses
Agree
Disagree

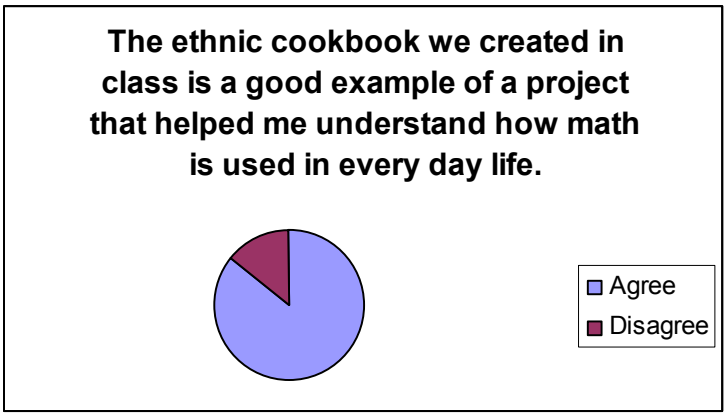

The ethnic cookbook project made me proud of my culture and beliefs: aboriginal student responses
Agree
Disagree

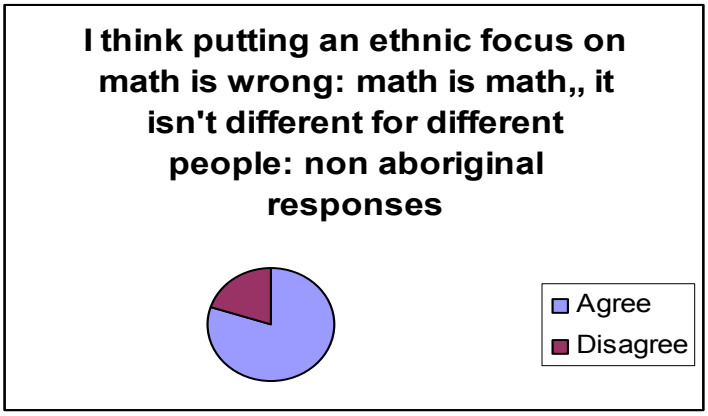


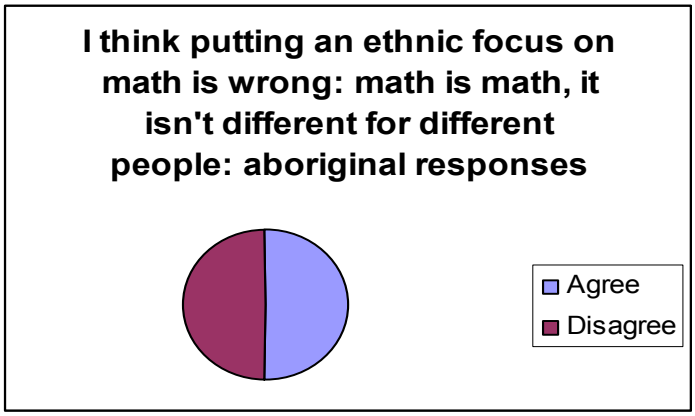
Your Experiences in Math 030

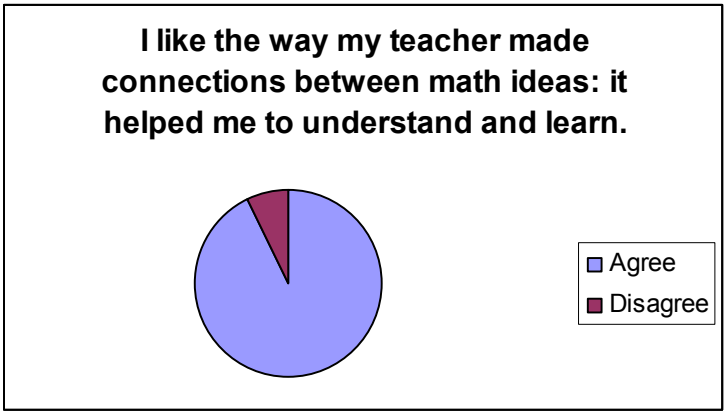
Differences between aboriginal and non aboriginal respondents noted



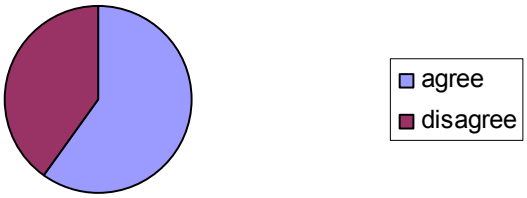



I think putting an ethnic focus on math is wrong: math is math,, it isn't different for different people: non aboriginal responses
Agree
Disagree

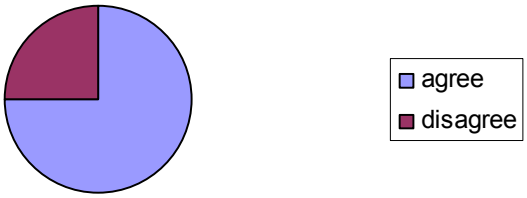

I think putting an ethnic focus on math is wrong: math is math, it isn't different for different people: aboriginal responses
Agree
Disagree


I like the way my teacher made connections between math ideas: it helped me to understand and learn.
Agree
Disagree

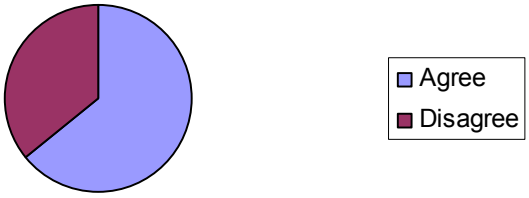
I attend math class more regularly because I am starting to enjoy math more: non aboriginal students

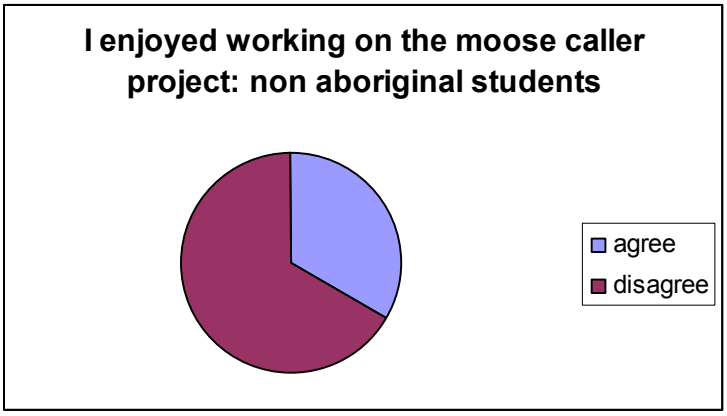


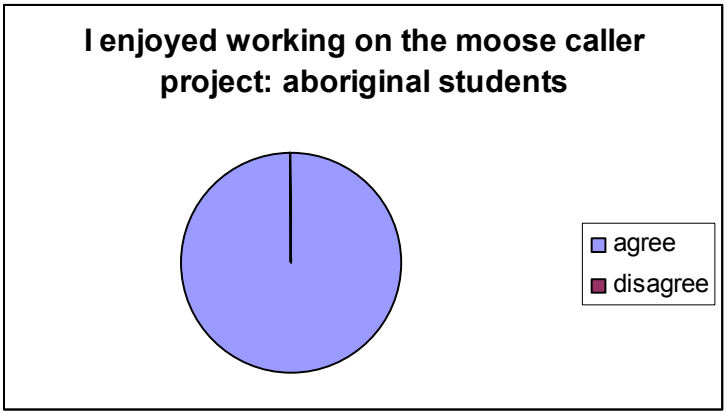
I attend math class more regularly because I am starting to enjoy math: aboriginal students

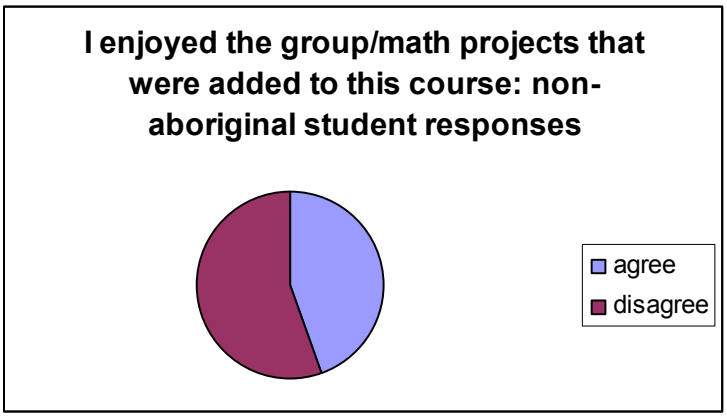


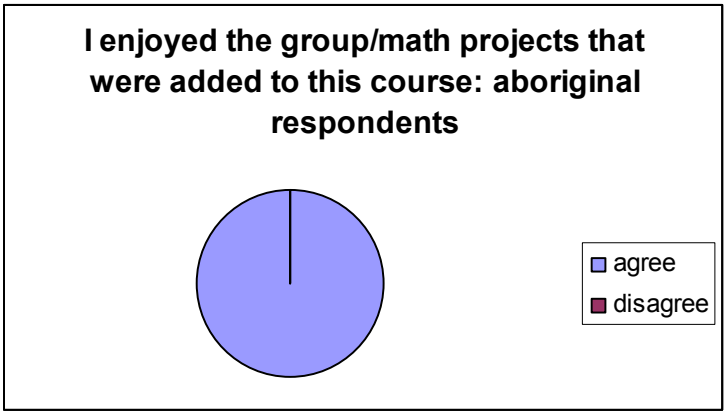
The Math 030 curriculum is interesting because it uses lots of real like examples about how math works.



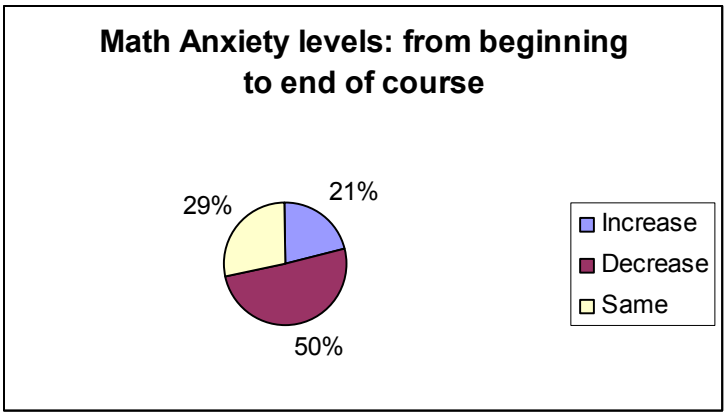

I enjoyed working on the moose caller project: non aboriginal students
agree
disagree


I enjoyed working on the moose caller project: aboriginal students
agree
disagree

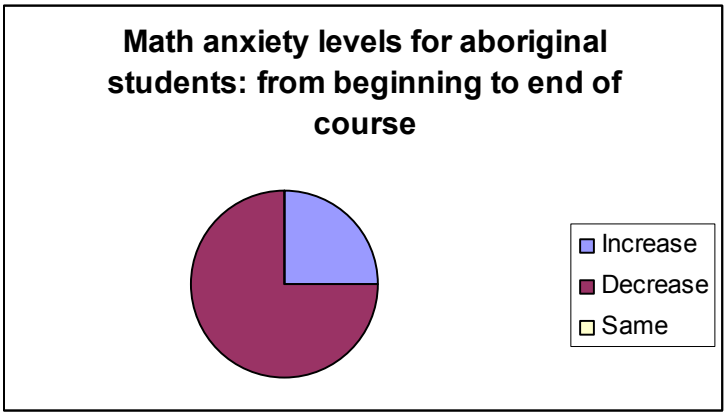

I enjoyed the group/math projects that were added to this course: non-aboriginal student responses
agree
disagree



Math Anxiety levels: all students



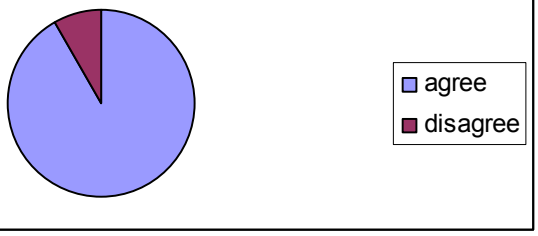
Math anxiety levels: aboriginal students



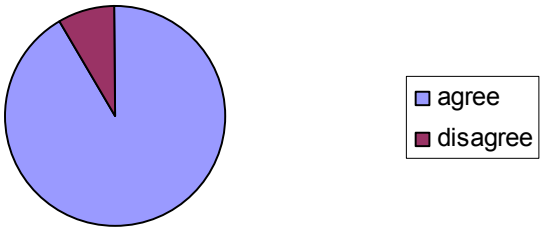
Reasons for taking next level of Math (044 OR 045)

Differences between aboriginal and non aboriginal respondents noted

I will take math 044/045 because I need it to be accepted into another program



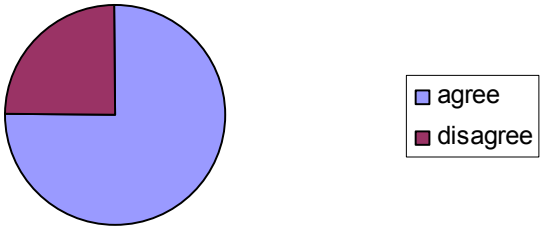
I realize math is an important part of day to day life that I need



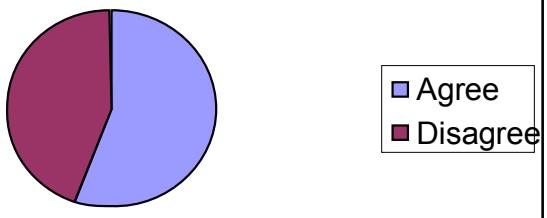
Because of my success in math 030 I may consider a future math courses so I can train in a science or technology career: non aboriginal student responses

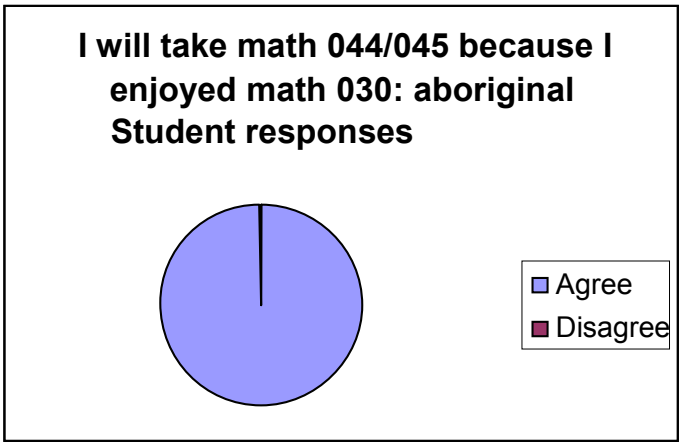
Because of my success in math 030 I may consider further math courses so I could train in a science or technology career: aboriginal student responses

Math 030 has given me the confidence that I can do more difficult math



I will take math 044/045 because I enjoyed math 030: non-aboriginal student responses




I will take math 044/045 because I enjoyed math 030: aboriginal Student responses
Agree
Disagree

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