

Mathematics and Culture Nexus: The Interactions of Culture and Mathematics in an Aboriginal Classroom

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Approaching the teaching and learning of mathematics from a cultural standpoint serves a two-pronged purpose: It tends to build a bridge between the student's background knowledge, and the formal mathematics teaching and learning the student would encounter over several years in a typical school setting. This bridge, if appropriately built and solidified, facilitates the learning of mathematics especially in aboriginal communities, where tradition and culture play significant roles in the lives of youngsters. This paper is an effort in that general direction - the building of a bridge between culture and mathematics. It focuses on mathematics instruction in aboriginal classrooms, utilising environmental phenomena, materials and practices in traditional Cree settings as inviting 'appetisers' to introduce and vivify mathematics teaching/learning.

Set in an aboriginal (Cree) community in Northern Manitoba, Canada, the paper highlights the positive effect, and overwhelming influence, that integrating the learner's culture and environment into mathematics instruction had on a group of undergraduate pre-service, aboriginal teachers.

Interactions, Culture, Mathematics, Aboriginal, Classroom

INTRODUCTION

Enrolment in mathematics and science courses at all levels of education is an issue that has attracted the attention of educators and researchers over a long period of time. In recent years, the issue has gained more prominence because of rapid declining enrolment patterns in these subject areas; a situation that has assumed alarming proportions worldwide (Ezeife, 1999a). As reported by the National Research Council on the future of mathematics education (1989):

Mathematics is the worst curricular villain in driving students to failure in school. When mathematics acts as a filter, it not only filters students out of careers, but frequently out of school itself.

Still dwelling on the unpopularity of mathematics as a school subject, the National Research Council (1989) stated:

Public attitudes about mathematics are shaped primarily by adults' childhood school experiences. Consequently, mathematics is seen not as something that people actually use, but as a best forgotten (and often painful) requirement of school. For most members of the public, their lasting memories of school mathematics are unpleasant – since so often the last mathematics course they took convinced them to take no more.

Backhouse, Haggarty, Pirie, and Stratton (1992) paint a similar picture, observing that for some learners, “the word they can best associate with mathematics lessons is ‘panic’!” Even

such highly industrialised countries as Canada and the United States of America are not free from the declining enrolment plague. Recent studies (Ezeife 1999b; Smith 1994) indicate that the situation reported by the National Research Council in the late 1980s is getting worse worldwide, especially with regard to the enrolment and performance of minority groups in mathematics/science courses. Narrowing the analysis further, it is known that North American Aboriginals are under-represented in mathematics, science, and related disciplines. Schilk, Arewa, Thomson, and White (1995) aptly describe the situation, stating:

Native Americans have the lowest representation percentage of all minorities in scientific careers and are at risk in pursuing science in high school and in post-secondary education.

Davison (1992) specifically draws attention to the situation in mathematics, saying, “What cannot be questioned is that the mathematics achievement of (*American*) Indian students as a group is below that of white students in the United States”. The plight of Canadian Aboriginals is similar to that of Native Americans with regard to low enrolment, substandard achievement, and high dropout rates in science, mathematics, and technological fields, as observed by MacIvor (1995).

Why is the situation as it is? Can anything be done to rectify and improve the status quo with regard to the teaching and learning of mathematics in aboriginal communities? If so, what can be done? How can we set about doing it? These are the key questions this paper will address.

Why is the situation as it is?

One of the reasons advanced for the high dropout rate and poor performance in examinations by the few aboriginal students who enrol in mathematics or science is that mathematics and science taught in school is bereft of aboriginal cultural and environmental content (Cajete 1994; Smith 1994). Accusing fingers have also been pointed at the way mathematics is taught in schools, and the lack of relevance of mathematics content to the students’ real life experiences. Expatiating on the issue with respect to Native Americans, Davison (1992) stated:

American Indian students’ capacity to learn mathematics is influenced by language, culture, and learning style. However, the methods by which mathematics is typically presented do not take into consideration these factors. Textbooks ... present mathematics as an essentially abstract subject. While many textbook series now refer to the use of tactile and visual aids, few teachers present mathematics in other than an abstract manner. To learn mathematics successfully, many American Indian students need a more multisensory approach to mathematics than is usually encountered in schools.

Need to improve aboriginal students’ enrolment in mathematics

The need to increase aboriginal students’ enrolment and participation in mathematics can be seen from several viewpoints. First and foremost is the importance of mathematics and related disciplines in the development of aboriginal communities. At present, there is an urgent need for local personnel to take over the servicing of community infrastructure in most aboriginal communities in North America. However, there is an acute shortage of qualified local personnel, and so these communities have to depend largely on outside experts who are hard to get, difficult to retain, and definitely exorbitant to maintain. An aboriginal research and author, Cajete (1994) lamented on this situation, stating:

Alienation from science, as it is conventionally taught, is widespread among Indian students (*by ‘Indian’ here, the author means native American, that is, aboriginal*). This affects student performance in mathematics and science as indicated by their generally low test scores in science and related areas. This alienation from science has resulted in lack of science expertise among all

tribes, leaving them vulnerable to exploitation and dependency on non-Indian consultants for decisions related to resource development, health, and other areas requiring scientific expertise.

No doubt, qualified local personnel would serve their communities better in terms of ready availability, and dedication to positions they might hold in the communities. The availability of such qualified personnel in the communities would also instill a spirit of self-reliance and self-sufficiency in the community, and with time, might lead to the production of more qualified manpower as younger community members could gradually learn from the older ones through the apprenticeship system - the age-old method of knowledge transfer in indigenous societies.

Employment opportunities in aboriginal communities in North America can be boosted if aboriginal students enroll more in mathematics and related disciplines because these areas of study can lead to careers in computer and technology fields - specialties that aboriginal reserves are in dire need of at present. Expertise in technological fields would not only help in creating new jobs in aboriginal communities but would also go a long way toward modernizing the traditional, aboriginal occupations of fishing, hunting, trapping, and arts/design - enterprises that have sustained these communities over centuries, but which now desperately need the injection of newer techniques, tools, and equipment to remain viable.

The need for aboriginal students to participate in mathematics can also be addressed from a historical standpoint. It is known that indigenous people of old were enthusiastic students of nature, astronomy, and mathematics. Several authors (Cajete 1994; Smith, 1994; Hatfield, Edwards and Bitter 1997) have documented the wealth of knowledge and experience of these indigenous peoples around the world. Unfortunately, however, a lot of this knowledge suffered blows of expropriation during eras of colonization in areas of the world currently referred to as third world countries, and also in aboriginal societies. D'Ambrosio (1985) addresses this issue when he notes that there is:

... a very broad range of human activities which, throughout history has been expropriated by the scholarly establishment, formalized and codified and incorporated into what we call academic mathematics but which remains alive in culturally identified groups and constitutes routines in their practices.

Hatfield, Edwards, and Bitter (1997) documented specific examples where people of diverse cultural backgrounds had displayed mathematical and scientific ingenuity in the past. The same authors went further to cite instances of expropriation of some of these activities and knowledge throughout the history of the development of mathematics. For example, in Arithmetic, they wrote:

Many peoples contributed to the development of the modern system of numerals. Africans were the first to use numerals. Ancient Egyptians in Africa invented a symbol for ten that replaced 10 tally marks and a symbol for one hundred that replaced 100 tally marks. The Chinese invented negative numbers. Native Americans were the first to use a symbol for zero. Ancient Egyptians invented unit fractions.

On 'Algebraic concepts', the authors wrote as follows:

Students should know that Africans invented rectangular coordinates by 2650 B.C. and used them to make scale drawings, and starlocks. ...The word *algebra* is Arabic in origin. ...Europe received algebra as a gift from Asia and Africa.

And on 'Geometric concepts' and 'Applications', the same authors stated:

...the first concepts of congruence were developed in Africa and Asia. ...cotangents and similar triangle principles were used in the building of African pyramids.

...Eskimos built igloos in the shape of a catenary. Mozambicans built rectangular houses by using equal-length ropes as the diagonals. The Babylonians used the right angle theorem 1500 years

before Pythagoras was born. The term *Pythagorean theorem* is a misnomer. ...The modern method of using the *so-called* Pascal's triangle was actually invented in Asia by the Chinese and the Persians 500 years before Pascal was born.

Having observed the fact that in the olden days, people of indigenous cultural backgrounds displayed a high degree of expertise in mathematics and related fields, one would expect that the present generation of students from these backgrounds should also do well in such fields of study. Following that line of reasoning, one would expect contemporary aboriginal students to enroll, and participate enthusiastically in mathematics, not to run away from it. It seems that their current negative attitude toward mathematics arises from a number of factors - the lack of aboriginal content and culture in mathematics curricula used in schools, the way and manner mathematics is presented to the students, the lack of relevance of the mathematics learned to the students everyday life and worldview, the issue of learning styles, etc. Thus, my position is that injecting aboriginal content and culture into the curriculum, and introducing innovative mathematics teaching and learning approaches (as discussed later in this paper) would bolster enrolment of aboriginal students, and improve their performance in mathematics. My position on the issue is further strengthened when cognizance is taken of the fact that such approaches have been effective in boosting enrolment, retaining students, and improving performance in school settings and other learning environments where they have been tried out recently (Hanson, 1994; Semken and Morgan, 2000; Simard, 1994).

Issue of culture

The students' culture has been identified as one of the factors that strongly influence mathematics learning, particularly in respect of indigenous learners. What is culture? Hollins (1996) states that:

Culture is ... the essence of who we are and how we exist in the world. It is derived from understandings acquired by people through experience and observation (at times speculation) about how to live together as a community, how to interact with the physical environment, and knowledge or beliefs about their relationships or positions within the universe.

Barrett (1984) as quoted in Hollins (1996) defines culture as "the body of learned beliefs, traditions, and guides for behavior that are shared among members of any human society". Similarly, Erickson (1986) states: "Culture, as a social scientific term, refers to learned and shared standards for ways of thinking, feeling, and acting". However, it was Hall (1977) as quoted in Hollins (1996) who concisely described the function of culture, thus:

Culture is man's medium; there is not one aspect of human life that is not touched and altered by culture. This means personality, how people express themselves (including shows of emotion), the way they think, how they move, how problems are solved, how their cities are planned and laid out, how transportation systems function and are organized, as well as how economic and government systems are put together and function. ..."

Looking closely at the above discourse, we can decipher that culture would have a pervading influence on how a group of people live and learn. The culture of aboriginal populations, for instance, would affect how they learn and retain what they are taught in school. It is culture that shapes their learning styles in mathematics, for example, determining to a large extent, to what use they put the mathematics knowledge they acquire in school.

LEARNING STYLES OF ABORIGINAL STUDENTS

Alonge (1982) compared the teaching and learning styles in indigenous cultures with the Western model. For indigenous societies, he said that the methodology consists essentially of:

Oral tradition (listening, watching, and doing). Individualised instruction. Group work. Apprenticeship. Teaching materials are real, physical objects...

In contrast, the Western model consists of:

Group instruction in classrooms; Use of sophisticated gadgets and of instructional materials, e.g. books, film, radio, television.

Several other authors and researchers have also addressed the matter of teaching and learning styles in aboriginal societies. For instance, Cajete (1994) stated:

...American Indian education historically occurred in a holistic social context that developed the importance of each individual as a contributing member of the social group. Tribal education sustained a wholesome life process. It was an educational process that unfolded through mutual, reciprocal relationships between one's social group and the natural world. This relationship involved all dimensions of one's being, while providing both personal development and technical skills through *participation* in community life. It was essentially a communally integrated expression of environmental education.

Stairs (1995) is another author who contrasted Aboriginal and Western models of education. Referring to the work of Wenzel (1987), Stairs (1995) used the Inuit words '*Isumaqsayuq*' and '*ilisayuq*' for aboriginal education and Western-style education respectively. The author goes on to describe these two models, thus:

Isumaqsayuq is the way of passing along knowledge through the observation and imitation embedded in daily family and community activities, integration into the immediate shared social structure being the principal goal. The focus is on values and identity; developed through the learner's relationship to other persons and the environment.

In contrast, *ilisayuq* is teaching which involves a high level of abstract verbal mediation in a setting removed from daily life, the skills for a future specialized occupation being the principal goal.

It seems appropriate to conclude from the foregoing that there are obvious differences between the teaching, learning and cognitive styles of people from aboriginal cultures and those from mainstream Western cultures. These differences would surface and influence learning, positively or negatively, wherever students from these two cultures are subjected to the same instructional approaches, and are expected to learn – using the same cognitive styles. If the instructional method favours the learning styles of students from Western cultures (as seems to be the case in contemporary formal school settings), then these students would perform quite well, while the performance of the disadvantaged students from indigenous cultures would not be as good. However, if indigenous students are given the opportunity to learn through an instructional medium that favours their learning or cognitive styles, then the likelihood is that learning would be facilitated and enhanced. It seems reasonable to suggest, therefore, that a good way to teach aboriginal students would be to adopt a strategy that conforms to the age-old methodology of educating the young in indigenous, traditional settings, that is, culturally and environmentally based education. The rest of the paper would suggest and discuss this strategy, focussing on the discipline of interest, that is, mathematics.

Use their culture, teach them better

Davison (1995) strongly discourages teaching mathematics to students from indigenous cultures through instructional methods that emphasise the abstract, as opposed to the concrete, the imaginary rather than the real. He stated: "The abstract, decontextualized teaching of mathematics has affected many American Indian students' school success". To remedy the situation, he suggests:

Wherever possible, mathematics concepts should be presented in a culturally relevant manner, using situations that the students find interesting and familiar. Above all, the presentation of

mathematical ideas needs to be consistent with how students learn. The use of a tactile or visual approach assists students to form meaningful images.

How will linking math with the students' culture help improve participation?

In discussing issues related to the psychology of learning, Ausubel (1968) stated emphatically:

If I had to reduce all of educational psychology to just one principle, I would say this: the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

Every educator is aware of the fact that young children acquire knowledge early in life from their parents and family members, from their homes, playmates, and peers. This early knowledge acquired by youngsters is inter-twined with the cultural milieu and environment in which the children are born and grow up. Hence, by the time the children get to school, they already have a considerable amount of experience and prior knowledge ingrained in them through their home and peer group interactions. If the school culture reinforces the students' home cultures, prior knowledge and learning experiences, then learning is facilitated for these students; if not, learning is drastically inhibited. The situation described here holds true, to a greater or lesser degree, for all students, but is more cogent for aboriginal students most of whom live in remote and secluded reserves in North America. When these aboriginal students get to school, and encounter a subject like mathematics, they find themselves disadvantaged because the mathematics curriculum currently in use in most schools is alien to them, and so are the teaching and learning styles, and illustrations adopted. Shirley (1995) addressed this issue, stating:

The problem for many teachers is that most of the mathematics in our academic curriculum has been derived from the developments in European mathematics, and they have difficulty finding examples that do not seem Eurocentric.

Continuing, the same author noted:

Since our schools have increasingly heterogeneous populations from many different cultures around the world, an apparently European-based curriculum can be counterproductive to our interest in recruiting members of underrepresented groups into mathematics. If children see mathematics only from a European perspective, they may believe that non-European cultures have not worked with mathematics and, even worse, that these people cannot work with mathematics. If the child comes from a non-European cultural heritage, this belief may be dangerously extended to "*I cannot work with mathematics.*"

Thus, a culture-sensitive curriculum would go a long way toward rectifying the errors that currently exist, and making mathematics attractive to all students, especially students from the under-represented aboriginal block. The utilisation of a culture-sensitive approach to teaching has resulted in success in some recent cases. For instance, Simard (1994) reported the impressive outcome of an integrative, culture-based approach employed at a Winnipeg high school in the province of Manitoba, Canada, thus:

Children of the Earth High School is an example of an urban school that teaches the regular Manitoba curriculum from a cultural perspective. One day is set aside each cycle for what is called the cultural program. Between 15 and 20 courses are offered during that day to 250 students. The courses range from outdoor education to traditional dance instruction. This is an example of a school initiated course of study. The aboriginal languages of Cree and Ojibway are compulsory at Children of the Earth School. The school has been very successful in graduating students from the grade 12 program into post-secondary institutions. The use of community people and their wide array of talents helps put back meaning into education.

Several researchers and pioneers in this field (Cajete, 1994; D'Ambrosio, 1980; Davison, 1992) have advocated the use of holistic and multisensory approaches to mathematics and science teaching. For aboriginal students in particular, teaching mathematics by the use of methods and instructional designs that glorify the familiar explain-example-exercise pattern of expository teaching (Matang, 2001), has led to the high dropout rates from mathematics and associated science courses. For such students, "rules without reasons", frequently used in mathematics teaching, as exemplified by "change side, change sign" (Backhouse, Haggarty, Pirie, and Stratton, 1992), have often led to confusion, not comprehension.

THE MATHEMATICS AND CULTURE NEXUS

Having gathered from relevant literature that an effective method of teaching mathematics to indigenous students would entail injecting elements of their schema (prior life experiences that have saliency for them), culture and environment into mathematics teaching, I set out to experiment with a group of aboriginal pre-service teachers in my Mathematics Methods class. This was done in a Cree-speaking aboriginal community in Northern Manitoba, Canada. As a first step, the pre-service teachers were sensitized to the wisdom in, and potential benefits of using this approach (injecting students' schema, culture, and environment) into mathematics teaching. This sensitization was done through a series of lectures and laboratory sessions that examined several programs that have attempted to incorporate into instruction "the four essential elements of learning for underserved populations of students" (Hollins, 1996). These "essential elements" of meaningful learning as identified by Hollins (1996) consist of "culturally appropriate communicative patterns, social interaction patterns, information processing strategies, and culturally valued knowledge and skills". One of the programs discussed with the pre-service teachers was the "Algebra Project" which, as cited in Hollins (1996), was developed by Moses et al (1989). A detailed description of this project is given by Hollins (1996), thus:

In the Algebra Project, instruction is based on motivation rather than ability as a prerequisite for intellectual development and achievement. ...Instruction in the Algebra Project employs the third dimension of meaningful learning for a specific population by building upon the students' learning preferences and strengths derived from their cultural and experiential background to extend their knowledge and skills. That is, the students use the familiar to extend their knowledge and understandings. The instruction begins in the expressive domain with the students gathering informal knowledge in familiar places, developing questions, identifying relationships and moving to the descriptive domain to construct formal knowledge that is procedural and empirical-analytical. This is most evident in the five-step teaching and learning procedure for supporting sixth graders in their transition from arithmetic to algebra. The five-step approach includes the following:

1. Physical event,
2. Picture model of this event,
3. Intuitive (idiomatic) language description of this event,
4. A description of this event in regimented English, and
5. Symbolic representation of the event.

This is a student-centred approach to mathematics teaching that gradually builds up students' learning from the known (familiar) to the end product (target) of instruction. This is in line with Silberman's (1971) assertion that "A teacher must start where his students are, if he is to take them someplace else". Stairs (1995) described another example of an integrated approach to instruction of indigenous students, as follows:

In northern Alaska, the Inupiaq *qargi* – the community house where youth traditionally went to listen to and learn from elders – is being reestablished on a trial basis as a parallel to the modern formal school. This is a response to almost fifty years of assimilationist education which has resulted in a generation of children who are virtual strangers to the Native culture. In the new *qargi*, in Native language, a young professionally trained Native teacher would work side by side with the elders of each community, thereby allowing the teacher to absorb both the knowledge

possessed by the elder(s) and the manner in which the children were taught. ...Skills learned in school, such as mathematics, could be applied in *qargi*, where children are building sleds or boats, for example.

Apart from the innovative, culturally oriented programs exemplified by the Algebra Project and the “Inupiaq *qargi*”, the pre-service teachers in the study were also introduced to approaches that utilise the multisensory strategy for mathematics instruction. In this context, Gardner’s eight multiple intelligences, as discussed by Hatfield, Edwards, and Bitter (1997) was given prominence. The theory states that there are eight basic intelligences (Linguistic, Logical-mathematical, Naturalist, Bodily-Kinesthetic, Spatial, Interpersonal, Musical, and Intrapersonal) that human beings use for the purpose of processing information. As Hatfield, Edwards, and Bitter (1997) stated:

Gardner believes that people of all ages learn better if the material is presented through areas of intelligence in which they are most gifted.

Citing Armstrong (1994) and Lazear (1991), Hatfield, Edwards, and Bitter (1997) noted that the appeal of the theory lies in the fact that “all teachers know that they can reach some children better through one medium than another”.

TERM PROJECT

After the theoretical discussion of the programs and approaches, the pre-service teachers were given a major term project that required them to compile a list of phenomena, materials, activities and traditional practices from their schemata, culture, and immediate environment that could be used to teach mathematics in the elementary and middle Grades. As part of the project, the teachers were asked to state and briefly explain the mathematics topics, concepts, or principles that could be taught using the materials, phenomena, and traditional practices. Finally, each of the teachers was required to prepare and present a mathematics lesson that not only incorporated the cultural background of the learners, but also utilised at least three of the eight Gardner’s multiple intelligences. They were also asked to ensure that the instructional materials and planned activities for the lesson would cover the broader classification of mathematics suggested by Shirley (1995). The adapted version of Shirley’s (1995) broader classification of mathematics is given in Table 1.

Table 1. Broader classification of mathematics

Mathematics	Pure	Applied
Formal	Academic	Occupational
Informal	Recreational	Everyday

Observed outcome

The interest generated by the project in the Mathematics Methods class was overwhelming. The immense possibilities of what could be achieved in a mathematics teaching and learning situation by adopting and adapting culturally relevant experiences, common everyday materials, events, and artefacts in the locality, seemed to dawn suddenly on the pre-service teachers. The enthusiasm and promptness with which they handed in their projects, the depth of research that went into the preparation of instructional materials, and the vivacity that characterised the presentation sessions were eloquent testimonies that the approach struck a chord. The students felt happy to be operating on familiar, home turf. It seemed that the teachers suddenly discovered that mathematics is, after all, part and parcel of their everyday life, that it is a familiar, close-to-home subject, not a far-off foreign invention. Some of the traditional practices, materials, activities, and phenomena adapted from the students’ compilation are listed in Tables 2 (Ezeife, 2000).

Table 2. Examples of environmental phenomena, materials and practices in traditional Cree settings that could be used in mathematics teaching

Phenomenon, material, activity, or traditional practice	How or where it can be applied in mathematics teaching and learning
Forest fire <i>*(Epasitek nocimihk)</i>	Heat – Measurement of Temperature, Ratios - Conversion between temperature scales, wind direction, land areas
Bannock lunch <i>*(Pah-ke-sikun)</i>	Fractions, Decimals, Percents, Concepts of division and Symmetry
Log cabins <i>*(Os-ka-nsa)</i>	Width, Length, Areas, Geometric figures; Accounting – Costs, Money (Counting/Conversion/Units)
Bow and Arrow <i>*(Achabi ekwa akask)</i>	Speed and Distance, Direction and wind effects
The ‘square’ dance <i>*(Neem-o-win)</i>	Geometrical patterns depicted by various dances; Angles, Slopes
Fish nets <i>*(Anapi)</i> , Fishing; Canoe <i>*(Chee-man-is)</i>	Probability, Mass and Weight, Geometrical shapes, Balances, Use of scales
Snowshoes <i>*(Asamak)</i> ; Moccasins <i>*(Pakek-ine-skisina)</i>	Ratios and Proportions – relationship between shoe size and height; Estimation/measurement of length and width; Areas and Perimeters; Use of (linear) measuring instruments; Metric units; Patterns (beadwork in shoes)
Population on "Reserve" lands <i>*(Inni-no-wak)</i>	Statistics and Probability; Numeration – Census; Classification and analysis of data; Measures of Central Tendency (Mean, Median, Mode) to be calculated using the ages of community members, Graphing – histograms and bar graphs [Age could be used as categorical (non-numerical data) for bar graphs]
Paddles <i>*(Apoyak)</i>	Construction and Measurement; Mass and Weight; Areas and Volumes; Angles and their measurement – various angles made by paddles on contact with water
Moose-hide mitts <i>*(Astisak)</i>	Shapes and Patterns (beadwork); Symmetry
Dog team sleds <i>*(Otapahistiman)</i>	Distance, Speed, and Time – Measurements and calculations involving these
The “red” sunset <i>*(Mi-kwa-yow)</i>	Probability and Weather Forecasting; Using natural phenomena as indicators/predictors of future events
Berry picking <i>(Mominewin)</i>	Mass, Weight, and Volume measurements; Metric units – the kilogram – its multiples and sub-multiples
Cradle board (for carrying babies at mothers’ back) <i>*(Tikinakun)</i>	Shapes and Angles; Mass and Weight; Length and Width (dimensions) and their measurement
Ice holes <i>*(Toyhikun)</i>	Estimation and measurement of depth. Ice fishing – Probability of fish caught; Volume (of water in hole); Problem solving and reasoning/logic
The campfire game <i>*(Isk-koo-jekan)</i>	Mathematical Operations – Concept of Subtraction as reduction/'elimination', Number games; Addition as the reverse operation of Subtraction.
Thunderstorm <i>*(Pine-siwun)</i>	Statistics and Probability; Speeds of Sound and Light – Ratios and Proportions (Comparison of speeds).

* Words in parentheses and italics in the first column of Table 2b are Swapy Cree dialect

Trial of model

As part of the research study in the same community, a model mathematics lesson incorporating culturally relevant materials was developed and tried out on a study sample of 20 Fifth Grade students on an informal basis. The lesson was on Geometry and the topic was Angles and their Measurement. The environment, students’ everyday activities, events and

infrastructure in the community were utilized to make the lesson true to life, relevant, and hence meaningful to the students. For instance, a log house in the community was used for instruction. As expected, the young students' response was exhilarating, as they enthusiastically participated in the activities used in the lesson, and even suggested innovative activities of their own. Apart from active student participation in class, another pointer to the fact that the approach adopted in the lesson struck a positive chord with the students was the fact that when two follow-up lessons were arranged some weeks later for the same group, all previous participants promptly showed up, even though these follow-up sessions were held on weekends. Even the four "recognized truants" who reportedly previously invoked any imaginable excuse just to stay away from regular school mathematics classes, never missed any of the research lessons (Ezeife, 2000). Furthermore, two of these hitherto truant students actually volunteered to lead their groups during small-group class discussions and field activities in the follow-up lessons. That attests to the efficacy of the approach used, and the interest and willingness to participate, it generated amongst the young, aboriginal learners. These informal sessions and activities seem to suggest a follow-up study that could be carried out later in a formal, experimental setting to compare the integrated cultural model (mathematics and culture nexus approach) with existing methods of mathematics instruction in regular school settings. Detailed curriculum materials would be developed for instruction along the mathematics and culture nexus model for a Middle Years Grade (for example, Grade 7). When developing curriculum materials for instruction in the project, Shirley's (1995) broader classification of mathematics would be used to ensure that the narrow academic orientation given to mathematics in formal school curricula – a situation that, in itself, has driven many students away from mathematics – is broadened, so that students would appreciate mathematics in its entirety. The proposed follow-up study, which would be empirical in nature, would essentially evaluate the hypothesized approach suggested in this paper in relation to the regular method currently adopted in teaching mathematics to aboriginal students. One of the goals of this paper was the laying of the foundation for the proposed, detailed, experimental work.

SUMMARY AND CONCLUSION

This paper has examined the issues of culture and mathematics teaching/learning, enrolment and performance in mathematics, of aboriginal students. The paper has taken the position that both enrolment figures and performance standards can be improved upon if indigenous students are taught mathematics using culturally oriented approaches and practices. With most aboriginal students, mathematics receives superficial attention because there is no linkage between it and their cultural values, little or no relevance to their daily life, and so no connection is established. The resultant poor performance in mathematics is, therefore, a foregone conclusion. As Hollins (1996) correctly stated, "Information receiving superficial attention may enter short-term memory or be immediately discarded".

The paper drew attention to the fact that the aboriginal culture is holistic, not linear, interconnected with nature, not in control of it (Hanson, 1994). Holistic oriented learners tend to learn best by focussing on how things are interrelated. They prefer to see the whole picture before them, and then analyze and make meaning of it. Thus, Aboriginals belong to what Hollins (1996) refers to as high-context culture groups. Dwelling on this, Hollins (1996) states:

High-context cultures are characterized by a holistic (top-down) approach to information processing in which meaning is "extracted" from the environment and the situation. Low-context cultures use a linear, sequential building block (bottom-up) approach to information processing in which meaning is constructed.

The conclusion to draw from this analysis is that if there is no input from the environment and culture in teaching and learning situations, the students who utilize the top-down (holistic) thought processing mode are disadvantaged. This, to my mind, is one of the obstacles that has affected the performance of indigenous students in mathematics over the years – there is a conflict between how they learn, and how mathematics has been presented to these students. If the teaching approach is changed, the curriculum made culture-sensitive and environmentally oriented, we may look forward to producing aboriginal world-beaters in the discipline of mathematics. Gladly, some recent efforts have been made to develop culturally oriented instruction models for teaching aboriginal students, not just in mathematics, but also in science-related disciplines. The work of Semken and Morgan (2000), which deals with the “parallel use of Din and Euro-American scientific concepts” in a physical geology course at Navajo Community College, United States of America, is a bold step in this direction. No doubt, the call made several years ago by pioneers like D'Ambrosio (1985) and Cajete (1994) for the injection of socio-cultural activities specific to indigenous societies around the world, into the teaching of mathematics and science is progressively being hearkened to, as several research centres have sprung up with a view to developing culture-sensitive curricula for teaching indigenous students. One such viable research establishment is the Walpole Island Heritage Centre on the Walpole Island First Nation in the province of Ontario, Canada. Referring to the significance of the work of the Centre, its executive director, Jacobs (1992) stated:

The wisdom of our elders must be recognized and respected. To the extent possible, traditional knowledge should be documented and codified. Regional centres of traditional knowledge should be established in native communities and supported by all sectors.

The opening of the Glen Lean Ethnomathematics Centre (GLEC) on June 20th 2001, is another major milestone in the effort to inject indigenous knowledge, culture, and environment into the teaching and learning of mathematics. As Matang (2001) explained, it is "a research centre committed to promoting the advancement of indigenous mathematical knowledge through research and preservation of ethnomathematical knowledge". Such efforts, reinforced as the years progress, would surely bring a positive wind of change with respect to enrolment and performance of indigenous students in mathematics, science, and technological fields. The ultimate goal, of course, would be to develop rich mathematics and science curricula specifically and entirely tailored to the needs of indigenous students.

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