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# Culture-sensitive Mathematics: The Walpole Island Experience

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## Introduction

Low enrolment in, and phobia toward mathematics, science, and related disciplines have been familiar issues in the academic world for a fairly long time (Ezeife 2004). The research literature is suffused with reports and findings indicating the sad state of affairs in the math/science field. For example, going a little further back to the eighties, the National Research Council, in its 1989 report, stated: "Mathematics is the worst curricular villain in driving students to failure in school. When math acts as a filter, it not only filters students out of careers, but frequently out of school itself" (7). In the same decade, Matthews' (1989, 5) report highlighted the disturbing enrolment and performance situation in science and math in American schools where there had been a dramatic "64% decline in the number of undergraduates entering science teaching ... [and] 30% of science teachers are unqualified to teach the subject."

The unflattering picture that depicted the state of math and science education in the eighties has persisted through the nineties up to the present time (Davison 1992; Backhouse, Haggarty, Pirie & Stratton 1992; Ma 2001; Ezeife 1999, 2003, & 2004; Matang 2001a, 2001b; Mel 2001). The low enrolment and poor performance in math and science that affect schools in several parts of the world assume alarming proportions in ethnic minority and aboriginal cultural populations. MacIvor (1995) has drawn attention to the low enrolment, substandard achievement, and high dropout rates in science, math, and the technological fields of Canadian Aboriginal students. Berkowitz (2001, 17) painted the picture of Aboriginal mathematics and science enrolment in Canadian tertiary education, thusly:

> According to Indian and Northern Affairs Canada, less than 3.2 percent of the 27,000 First Nations students going to university or college full-time on federal funding last year were enrolled in programs leading to careers in science (including agriculture and biological science, engineering and applied science, mathematics and physical sciences, and health professions).

Another researcher (Binda 2001), while studying the situation in schools under local control and jurisdiction (Canadian First Nations schools), observed that performance in mathematics and science is still far below expectation. The researcher noted that schools under provincial management recorded a mean score of 55.6% in mathematics in 1997, the mean score of Aboriginal schools was a meagre 19.6%. In 1998, the situation became even worse as the mean score of provincial schools rose to 61.2%, while the score of First Nations schools dropped to 14.4%. Similarly, O'Reilly-Scanlon, Crowe, and Winnie (2004) have pointed out that the educational attainment levels of Aboriginal students are lower than those of their colleagues from non-Indigenous populations.

The current low enrolment, substandard achievement, and general poor attitude toward school learning of Aboriginal students, especially in the realm of math and science, is a surprising development considering the historical fact that Aboriginal people of old were keen students of nature, astronomy, science, and math. Several authors (Cajete 1994; Hatfield, Edwards, Bitter, & Morrow 2004; Smith 1994) have cited the wealth of experience and accomplishment of various Indigenous populations worldwide. For instance, Smith (1994) narrated the case of the Skidi Pawnee—an Aboriginal group—who in ancient times were not just enthusiastic astronomers but were actually so accomplished that they went as far as identifying and describing the planet Venus. Also, by correctly tracking the movements of the stars and planets, the same group "conceptualized the summer solstice" [and] "... in this way they could predict reoccurring solar phenomena" (Smith 1994, 46).

## Why the Decline and Alienation?

So, if their progenitors were pace setters in the fields of math and science, why is it that current Aboriginal students shy away from these areas of study. And why do the few who enrol in math and science perform poorly in examinations? Many researchers have addressed this question, attempting to advance reasons from various perspectives to explain the situation. For example, Sloat and Willms (2000) point to the initial disadvantages that accompany many young Aboriginal learners to school—the lack of appropriate home support and relevant resources, especially scientific and technological toys and learning equipment like computers. Doige (2003) draws attention to the fact that "Aboriginal students are still marginalized in the public school and university systems, through Westernized curricula and pedagogy, even though Aboriginal educators have been overtly calling for a holistic education for their children" (Doige 2003, 145).

In the specific discipline of mathematics/science, several researchers (Cajete 1994; Ezeife 2003; Jegede & Aikenhead 1999: MacIvor 1995; Mel 2001) have all opined that the problem of low Aboriginal enrolment and poor performance arises due to the lack of relevance of mathematics and science taught in school to the Aboriginal learner's everyday life and culture. Drawing the same point, Smith (1994) noted that the mathematics and science taught in Canadian schools are bereft of Aboriginal cultural and environmental content. Thus, Aboriginal students fail to see the relevance of these fields of study to their culture, aspirations, or ways of life, and so they avoid them. In addition, they do not see how they would apply the mathematics and science they study in school to their environment or immediate community, or what benefits would accrue to them if they were to excel in these subjects, so the natural question that runs through their minds is: Why bother?

## A Personal Experience

My personal experience as an Indigenous student studying science in high school several years ago in a tropical country exemplifies the frustration non-Western and minority learners face when they are taught science without reference to their culture, tradition, and environment. In my grade 10 physics class, we were learning about the concept of pressure, and its relation to force and area. The teacher used a textbook, obviously written for students in a temperate climate, to teach this topic, and drew his examples and illustrations from this text. I still remember that most of these examples did not make sense to me because they sounded like fairy tales, were foreign, distant, and hence irrelevant to us in the cultural, environmental, and climatic context in which we were learning. One example, in particular, is worth mentioning here. This example used the mechanism of ice skating to illustrate the inverse relationship between pressure and area. Using diagrams from the Western-oriented textbook, the teacher laboured to explain to us how the ice skater exerted a large force (his/her weight) on the skates which have narrow contact edges with the ice (hence, a small surface area), and how this gave rise to a large pressure, which in turn melted the ice, thus enabling the skater to glide smoothly on the ice surface. Once the skater passed a particular area on the ice, the teacher explained, the ice surface was relieved of the pressure, and due to the principle of "regelation" (refreezing), the ice quickly refroze.

Technically, the illustration was apt, but in the situation in which it was used, it was both geographically inappropriate, and culturally meaningless. All the students in my grade 10 physics class were born, and had lived all their life in a tropical, Sub-Saharan African country, where our school was located. None of us had ever seen snow, ice, skating rinks, ice-skaters, or skates. Skating, as a sport, was unknown in our culture, tradition, and environment. And yet we were being taught pressure, force, and area with illustrations and examples meant for students in a Western, temperate country and climate where skating was commonplace and popular. Having undergone that firsthand experience years ago, I can now see exactly what Aboriginal students face in a typical math and science classroom, where they are taught with curriculum materials and resources completely bereft of their culture and environmental content. It took me several years (it was actually when I moved to the Western world for graduate studies), to fully understand the link between pressure, force, and area on the one hand, and ice-skater, his or her weight, and the blades of the skates, on the other. For, it was only in a temperate climate when I saw a skating rink, snow, etc. that the illustrations in my grade 10 physics textbook, which my former teacher laboured in vain to explain so many years ago, made sense to me. However, my grade 10 classmates were prevented from developing an appreciation of physics, given how it was taught. We may have been persuaded to like it, if we had been taught with a culture-sensitive curriculum. This holds true for today's Aboriginal, and other Indigenous learners of science and math.

## The Walpole Island Schema-based Math Project

So, what can be done to change the status quo, attract more Aboriginal students to the study of mathematics, and hopefully improve their performance in the subject? Many Aboriginal scholars and Indigenous leaders have emphasized the need to reorient mathematics and science education in Aboriginal schools toward the development of culture-sensitive curricular materials and teaching strategies deemed appropriate for aboriginal students. In Canada for instance, the Assembly of Manitoba Chiefs (1999) suggested incorporating into the curriculum cultural practices, traditional values, ideas, phenomena, and beliefs that would relate the schools to the communities in which they exist and function. Supporting the call for a culture-sensitive curriculum, Kanu's (2002) study identified the Canadian Aboriginal student as a multi-dimensional learner whose competence peaks when instructional material is presented through stories, activities, and traditional practices drawn from the student's culture and schema. In other words, it is implied that Aboriginal students would learn better when a culture-sensitive curriculum is used in teaching them. Calls for an integrative Aboriginal curriculum are prevalent in the research literature (Cajete 1994; Jegede & Aikenhead 1999; Mel 2001, Smith & Ezeife 2000). However, there have not been sustained efforts, especially in the field of mathematics education, to address these calls. Ezeife's (2002) work with Aboriginal pre-service teachers reported the overwhelming interest generated by the culture-based curriculum unit utilized in the project. That study suggested a follow-up work that could integrate culture-sensitive materials into an existing mathematics curriculum, and try out the integrated curriculum in an Aboriginal classroom to determine the efficacy of such integration. This, in brief, is the thrust of the Walpole Island Schema-based Mathematics Project. The study focuses on the development of appropriate culture-sensitive curriculum materials, and their implementation in an Aboriginal setting. The specific objectives of the study are:

1. To compile a list of phenomena, materials, activities, and traditional practices from the culture and immediate environment of a target Aboriginal community (Walpole Island First Nation) that can be used for the teaching and learning of math in the Primary/Junior years (Elementary Grades).
2. To develop model math teaching units that can be incorporated into specific strands of the existing Ontario Grades 1–8 math curriculum, thereby producing an "integrated" curriculum.
3. To set up an experiment pitching the integrated (innovative) curriculum against the existing (regular) one in an Aboriginal school, with a view to determining what impact (if any) this approach would have on math teaching/learning in Aboriginal settings.

# Methodology

## Phase 1: Compilation of Phenomena, Materials, Activities, Traditional Practices, Folklore, etc.

During this phase of the study, selected elders and educators in the Walpole Island community were interviewed and asked about traditional practices in their culture and environment that have relevance to math. The interview was prompted by the fact that elders in Indigenous communities are known to possess valuable traditional knowledge defined by Bedeau (2006) as "the condition of knowing something with familiarity gained through association and experience" (26). Sites of mathematical interest on the Island were visited and photographed during this phase of the study. Additionally, archives and holdings of the Walpole Island Heritage Centre (Nin Da Waab Jig), a research centre that was set up in 1973, (Jacobs 1992) were thoroughly examined to glean data about past traditional practices in the First Nations community that have relevance to mathematics teaching and learning.

***Process of Interview*:** Most of the interviewees were members of the Walpole Island "Language Advisory Group"—a group of community elders and educators with a high stake in the preservation and transmission of their culture, heritage, and traditional knowledge. Others were distinguished academics on the island, including the then Chief of the community, and the Director of the Heritage Research Centre (Nin Da Waab Jig), which focuses on the preservation of Anishnaabe culture, knowledge, and traditions. All the interviewees willingly and enthusiastically participated in the study.

***Interview Format*:** The interviews were structured in a non-restrictive, open-ended format with leading questions designed to guide the interviewees, and draw them to talk about and comment on certain broad math concepts and topics that relate to Aboriginal (Anishnaabe) counting, record keeping, housing and space allocation, building plans, dimensions of farmlands, hunting and fishing, games, recreational and outdoor activities, and so on. So far, a total of eleven people have been interviewed. The audiotaped interviews were transcribed, and the transcripts given back to those interviewed to read, confirm, or modify as they saw fit, thereby confirming the accuracy of the transcriptions.

***Enthusiasm*:** Some of the interviewees added new material when the transcribed interviews were given back to them. This revealed that they were not only enthusiastic about the project, but were also eager to record and transmit their culture and traditional math knowledge, and most important, see this rich knowledge reflected in the curriculum used to teach math to their children in school. Thus, they expressed immense interest in the study, and volunteered to help in whatever way may be needed to ensure the project is successful.

**Table 3.1: Sample Categorizations of Analysed Interviews into Math Strands, Teaching Topics, and Concepts.**

| Relevant Math Content Gleaned from Interview | Corresponding Math Strand | Applicable Math Topic/ Concept |
|---|---|---|
| Farmers picking strawberries with large bowls | Measurement | Capacity and volume: Different amounts in different shapes and sizes, for examples, the volumes/ capacities of household utensils, cans, cups, cottles, and other everyday containers. |
| Use of willow to make a "dream catcher" frame | Geometry and spatial sense | Construction; angles involved in the frame; types and measures of angles. |
| Beadwork, and beads worn by the Anishnaabe | Patterning and algebra | Patterns (in the beadwork, colours and ordering of beads). |
| Making moccasins—"sometimes requires measuring the feet of someone standing on the hide" | Measurement | Units and standards of units, conversion between different systems of units—The SI system, fps, etc. |
| "Many," according to the Anishnaabe language "means a whole bunch of something." For example, "in case of berries, it could be a pail full of berries." | Number sense and numeration | Counting, basic units of counting, different base systems. |
| Flowers in the environment: "Sometimes, we picked flowers and counted the petals." | Number sense and numeration; patterning and algebra | Numeric skills, naturalistic intelligence (Gardner's Multiple Intelligences); patterns in the arrangement of the petals. |
| Hunting: "The rounded tipped arrows are used for hunting smaller game, while the sharpened tips are used for hunting larger game." | Geometry and spatial sense | Angles, shapes, and velocity of motion. (link the "V" or tip of the arrowhead, which leaves a wake that follows the rest of the arrow to flight of birds in "V" formation—the other birds follow the lead "squad" with less effort). |
| Housing: "The shape of the lodges is usually circular." "The construction of the lodges is symbolic. At the centre of the lodge is a hold for the fire, and at the top of the roof is a circle for smoke exit. The doorways of the lodges agree with the four directions—East, West, North, and South." | Geometry and spatial sense | Coordinate Geometry: Directions and locations in space. The four cardinal points and the formation of the four quadrants. |

**Table 3.1: Sample Categorizations of Analysed Interviews into Math Strands, Teaching Topics, and Concepts. (continued)**

| **Relevant math content gleaned from interview** | **Corresponding math Strand** | **Applicable math topic/ concept** |
|---|---|---|
| Fishing: The technique the Anishnaabe use is to make "marsh grass in a circular formation. A hole inside the formation is lined with tunnels; often six or more tunnels are linked to the hole." | Data management and probability | Probability: Its example and application in an everyday life situation. The Anishnaabe technique involves running the fish through several tunnels until they are captured in one. This strategy adopts, and exemplifies the principle of probability. |
| Burial Traditions: "Burying of a loved one is usually on the 5th day, the body is positioned to the East which symbolizes a new beginning—where the sun rises." | Number sense and numeration | The decimal system of counting contrasted with the base 5 system; the concept and use of "place holder" in counting; cycles and rotations; directions—sunrise and sunset. |
| Games: "Gaming was a traditional activity, almost like present-day casinos. There were shell games, slide-of-hand [sic] tricks, the moccasin game, etc. In the moccasin game, the target is for each player to correctly guess in which pouch a specially marked marble was hidden." | Data management and probability | Principle of Probability: Games of chance, raffles, lotteries—odds of winning. |

***Interview analysis*:** This was a delicate task—to decipher the math content and concepts from the open-ended, free-flowing interviews, and categorize the content and concepts into one or more of the five strands of the Ontario Mathematics Curriculum, Grades 1–8, namely, Number Sense and Numeration, Patterning and Algebra, Geometry and Spatial Sense, Data Management and Probability, and Measurement. The analysis was first undertaken by the Aboriginal graduate students in the research team who were assigned to glean and itemize the math content and concepts into relevant strands, and make a case why they thought each content/concept should belong to the specific strand or strands into which it was put. The final and confirmatory phase of the analysis was done by the researcher who went carefully through the submissions of the graduate research assistants, and made modifications as deemed necessary. Some sample categorizations resulting from the interview analysis are shown in **Table 3.1**.

**Figure 3.1–i, ii, iii: Venn Diagram (i), Symbolic Representation (ii), & Composition Chart (iii)**

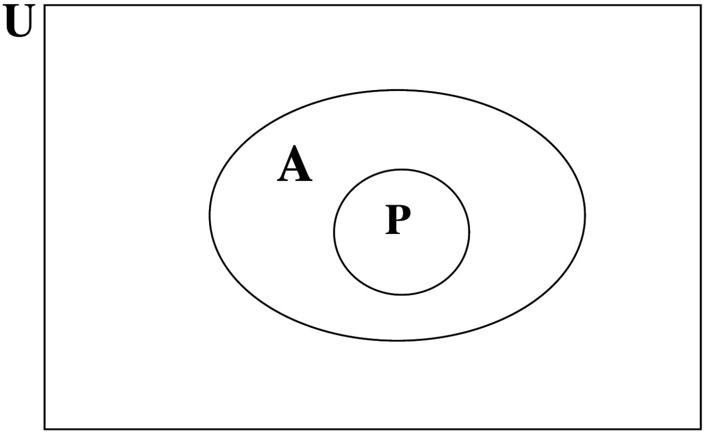


Figure 3.1 i

$$P \subset A \text{ SINCE } P \subseteq A\text{, AND } P \neq A$$

$$\text{THUS, } \exists\, D = \{x \mid x \in A\text{, and } x \notin P\}$$

Figure 3.1 ii

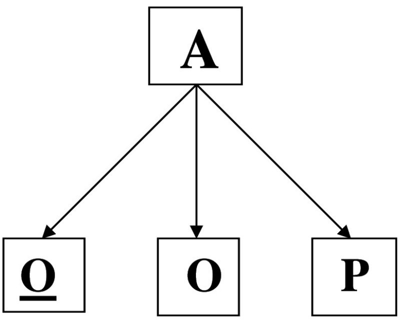


Figure 3.1 iii

U is the universal set (which, in this case, stands for all Canadian Aboriginal people); A (Anishnaabe) is a set in the universal set; and P (Pottawatomie) is a set within the set A.

## Phase 2: Integration of Compiled Materials into Existing Curriculum

The integration of cultural and traditional materials into units of the existing Ontario Mathematics curriculum has been done, and actual classroom implementation has started in grades 5 and 6 in the community school on Walpole Island. The implementation will be done in short, interrelated, three-week teaching blocks, taking into cognisance the need to avoid undue, prolonged disruption of the regular school curriculum and class schedules. The unit on Number Sense and Numeration with emphasis on Set Theory has been completed, and the Geometry and Spatial Sense started early in the spring of 2006. Part of the Geometry unit was done in a traditional log house in the island which was made available by a community elder. In teaching the unit on Set Theory, students' prior knowledge and environment, including local examples and illustrations, were used in definitions, and the development and application of math concepts and principles. For instance, for the lesson on ***Subsets, Proper Subsets,*** and ***Complements of a Set,*** the typical textbook explanation of these concepts was avoided, and instead local examples and ideas were used. The textbook explanation (Long & DeTemple 2000), which often confuses students, runs like this:

> If two sets A and B have precisely the same elements then they are equal and we write $A = B$. If $A \subseteq B$ but $A \neq B$, we say that A is a proper subset of B and write $A \subset B$. If $A \subset B$, there must be some element of B which is not also an element of A; that is, there is some x for which $x \in B$ and $x \notin A$ (84).

Even for the mathematics student who knows the meanings of the symbols used above and understands that $A \subseteq B$ means "The set A is a subset of the set B", it is usually not easy to fully understand, remember, and apply the concepts as explained in textbooks. Bearing this in mind, I decided to use the Anishnaabe students' prior knowledge and environment in presenting the concepts. The Anishnaabe are an Aboriginal group among Canadian First Nations (Indigenous peoples of Canada). The component groups that make up the Anishnaabe are the Ojibwa (**$\underline{\text{O}}$**), the Odawa (**O**), and the Pottawatomie (**P**), thus forming the "Three Fires Confederacy" of the Anishnaabe group. This is represented in the composition chart, **Figure. 3.1 (iii)**, where:

A = Anishnaabe

$\underline{\text{O}}$ = Ojibwa

O = Odawa,

P = Pottawatomie.

Thus, in the Venn diagram (pictorial representation of sets) shown in **Figure. 3.1 (i)**, U is the universal set (which, in this case, stands for all Canadian Aboriginal people); A (Anishnaabe) is a set in the universal set; and P (Pottawatomie) is a set within the set A.

**Table 3.2: Pre-test Mean Scores of Subjects in Instructional Groups (N = 28)**

| Groups | Number of Subjects | Curriculum Type | Mean Score |
|---|---|---|---|
| A | 14 | Regular curriculum | 33.85 |
| B | 14 | Integrated curriculum | 35.85 |
| Total | 28 | | 34.85 |

**Table 3.3: ANOVA Summary for Pre-test Scores – F is not significant at 0.05 l.o.s. (Critical value = 4.23)**

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Between Groups | 28.00 | 1 | 28.000 | 0.284 |
| Within Groups | 2,559.429 | 26 | 98.440 | |
| Total | 2,587.429 | 27 | | |

**Table 3.4: Post-test Mean Scores of Subjects in Instructional Groups (N = 28)**

| Groups | Number of Subjects | Curriculum Type | Mean Score |
|---|---|---|---|
| A | 14 | Regular Curriculum | 23.85 |
| B | 14 | Integrated Curriculum | 26.42 |
| Total | 28 | | 25.14 |

So, it follows that P is a proper subset of A, since P is not equal to A. Simply, this means that every Pottawatomie is an Anishnaabe, but not every Anishnaabe is a Pottawatomie (recall that there are also the Ojibwa, and Odawa groups).

As expected, the students caught on very quickly to the approach used here in introducing and explaining the concept, because it refers directly to what they are already familiar with as Aboriginal people. Even the mathematical representation of the concepts (as shown in **Figure.3.1 (ii)** – page 60), gave them no problems at all, as they easily moved from the verbal explanation to the symbolic representation of the concept. Subsequently, the same diagram and ideas were used to teach ***complement of a set***, and to show the distinction, in a strict sense, between the terms ***subset*** and ***proper subset***. For the major project, a total of five teaching blocks corresponding to the five Ontario math curriculum strands will be used for classroom implementation, which will be done by the same certified teacher, thereby controlling for teacher variability and instructional style.

## State of Study and Interim Results

Since the classroom implementation of the integrated curriculum materials for the major project is still ongoing, this paper will only highlight the results of the pilot study that preceded the major project, as reported in Ezeife (2004). As is being done in the ongoing major project, during the pilot study a convenience sample of 28 research subjects was composed from two existing grade 5 classes, and the sample was then divided into two groups, with 14 students in each group. Each of the two groups was then randomly assigned a treatment (curriculum type regular, or integrated curriculum), with the students in the regular curriculum constituting the Control Group (Group A), while their integrated curriculum counterparts formed the Experimental Group (Group B). Subsequently, the two groups were given the same pre-test, and then exposed to treatment as follows: The students in Group A were taught with the existing grade 5 Ontario math curriculum, while those in Group B were taught with the integrated curriculum, which contained culture-prone materials, examples, and illustrations taken from the Walpole Island environment and incorporated into the grade 5 math curriculum. Each of the groups was taught for four weeks by the same instructor. After instruction, each group was given the same post-test. The results of the pilot study are summarized in **Tables 3.2–3.5**.

## Summary and Discussion of Results of Pilot Study

**Table 3.2** shows that the mean pre-test score of Group A (Control Group) was 33.85, while Group B (Experimental Group) recorded a mean of 35.85 on the same pre-test. An analysis of variance (as summarized in **Table 3.3**) showed that there was no statistically significant difference between these mean scores. The implication of this finding was that there was no significant difference between the mean pre-test score of Group A (Control Group) and that of the Group B (Experimental Group). Thus, on average, the two groups were of the same standard in terms of their "Entry Behaviour," that is, at the time they started the study. No group was at an initial advantageous position over the other because of its mathematics attainment or preparedness. Hence, it was concluded from this finding that the groups were equivalent at the beginning of the study.

From the results in **Table 3.4**, it is seen that the mean post-test score of the Control Group (Group A), taught using the regular/existing curriculum, was 23.85, compared with a mean score of 26.42 for the Experimental Group (Group B), which was taught with the integrated/innovative curriculum. Thus, there was a marginal difference between the means of the two groups in favour of the Experimental Group. One of the null hypotheses to be tested in the ongoing major project would be to see if there would be a significant difference in the achievements of the two groups after sustained teaching that would cover all the strands in the Ontario Grades 1–8 math curriculum. The results of the pilot study, though based on just one out of the five course units that would be used for the major project, are encouraging in that they reveal the fact that the Experimental Group performed better, even if marginally, than the Control Group. The descriptive measures shown in **Table 3.5** (page 64) give more insight into the performance of the two groups. Thus, whereas the standard deviation of the Control Group was 13.4, that of the Experimental Group was 8.6, indicating that the post-test scores of participants in the Experimental Group were closer together than those of the Control Group.

**Table 3.5: Descriptive Measures for Post-test Scores by Group (N = 28)**

| Scores | Group | Measures | Statistic | Std. Error |
|---|---|---|---|---|
| Post-test Scores | Group A | Mean | 23.8571 | 3.5855 |
| | | 95% Conf. Int. for Mean Lower B | 16.1112 | |
| | | Upper B | 31.6031 | |
| | | 5% Trimmed Mean | 23.6190 | |
| | | Median | 24.0000 | |
| | | Variance | 179.978 | |
| | | Std. Dev | 13.4156 | |
| | | Minimum | 4.00 | |
| | | Maximum | 48.00 | |
| | | Range | 44.00 | |
| | | Interquartile Range | 20.50 | |
| | | Skewness | 0.290 | 0.597 |
| | | Kurtosis | - 0.704 | 1.154 |
| Post-test Scores | Group B | Mean | 26.4286 | 2.2984 |
| | | 95% Conf. Int. for Mean Lower B | 21.4632 | |
| | | Upper B | 31.3939 | |
| | | 5% Trimmed Mean | 26.1429 | |
| | | Median | 28.0000 | |
| | | Variance | 73.956 | |
| | | Std. Dev | 8.5998 | |
| | | Minimum | 14.00 | |
| | | Maximum | 44.00 | |
| | | Range | 30.00 | |
| | | Interquartile Range | 16.00 | |
| | | Skewness | 0.188 | 0.597 |
| | | Kurtosis | -0.148 | 1.154 |

This suggests that on the whole, the scores of participants in the Experimental Group—those taught using the integrated/innovative culture-sensitive curriculum—were closer to the mean score of the group, while the scores of participants in the Control Group (taught with the existing/regular curriculum) were more scattered and farther from the group mean. The implication of this is that the Experimental Group showed more consistency and uniformity in the mastery of course content as opposed to the Control Group which displayed heterogeneity, with several cases of high and low scores associated with the group. A comparison of the values of the ranges (30.0 for the Experimental Group, and 44.0 for the Control Group), and interquartile ranges (16.0 for the Experimental, and 20.5 for the Control) further confirms that the post-test scores of participants in the

Experimental Group are closer together than the scores of their counterparts in the Control Group. This implies that on the whole, the integrated/innovative curriculum produced a more homogeneous group, in terms of mathematic achievement, than the regular/existing curriculum. Also, comparing the median scores of the two groups, it was seen that the median of the Experimental Group was 28.0 which was higher that the median of 24.0 for the Control Group. This further points to the situation at the centres of the sets of scores for the two groups—the middle-of-the-pack student in the Experimental Group performed relatively better than a similarly positioned student in the Control Group.

## Conclusion

This paper has drawn attention to the low representation, and relatively poor performance of students from Indigenous cultural backgrounds in math and science courses. In the specific example of Canada, Aboriginal students shy away from these courses, and a high percentage of the few brave ones who enrol often drop out, not just from math and science, but eventually out of school itself. The dropout rate has assumed alarming proportions as can be inferred from the statistics cited by Katz and McCluskey (2003, 117), thus:

> In one Manitoba school in 1996, although about 10% of the 700 students were Aboriginal, less than 4% finished grade 12. Of the 23 Native youth who had entered that system in kindergarten, only 1 completed high school. In the same year in another district, only 1 of 25 students who had transferred from northern reserves graduated.

Several researchers have adduced reasons to explain the high dropout rates and poor performance in school of Aboriginal students (Kanu 2002; Simard 1994; Stairs 1995). These studies suggest that the students drop out of school, or perform poorly in some subjects because of their estrangement from the school system, and alienation from subjects such as mathematics, which is completely bereft of their schema, cultural and environmental content, and real-life experiences. It seems to me that many of the Aboriginal students display their frustration with the school system and some school subjects like mathematics and science by purposely engaging in "self-handicapping" tendencies. Dorman and Ferguson (2004) gave some examples of self-handicapping strategies which include "putting off study until the last moment, and deliberately not trying in school" (70). It is my contention that most Aboriginal students are dissatisfied with mathematics, science, and probably many other subjects they are taught in school—they do not see any relevance between these school subjects and their daily lives and aspirations, and so they do not try hard enough, hence they perform poorly, and eventually drop out. A good way to address this problem is to adopt culture-sensitive and holistic curricula in teaching these students—an approach that was initiated in the pilot study of the Walpole Island schema-based math project, and an effort the ongoing major project is continuing with. My decision to involve community members in the project is informed by Gaskell's (2003) well-reasoned stance, articulated as follows: "Broad elements of the community must be engaged in dialogue concerning what knowledge about the natural world is important to whom, and for what purposes" (235). The enthusiastic participation of elders, educators, and other community members of Walpole Island in my project, lends credence to this stance. It is my view that a lot of knowledge, including ethnomathematical knowledge (D'Ambrosio 1985; Shirley 1995), is hidden in most indigenous cultures around the globe. There is urgent need to tap, document, and utilize this abundant knowledge before their possessors, usually community elders, pass away, carrying with them what would, otherwise, have been extremely beneficial to the schools, generations of Indigenous learners of math and science, and indeed, the whole of humankind. My study—the schema-based math project—is engaged in the recovery, tapping, and utilization of the ethnomathematical knowledge of the Anishnaabe people of Walpole Island First Nation.

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## References

Assembly of Manitoba Chiefs (1999). *Manitoba First Nations Schools Needs Assessment Report*. Winnipeg: Author.

Backhouse, J., Haggarty, L., Pirie, S., and Stratton, J. (1992). *Improving the Learning of Mathematics*. Portsmouth, NH: Heinemann Educational Books, Inc.

Bedeau, K. (2006). Perceptions of Environmental Pollution Amongst Aboriginal Peoples on the Aamjiwnaang First Nation Reserve. An unpublished MA thesis, Department of Sociology, University of Windsor.

Berkowitz, P. (2001). "Western Science Meets Mi'kmaq Knowledge." *University Affairs,* 42(10), 16–20.

Binda, K. (2001). "Aboriginal Education in Comparative and Global Perspectives: What has Research and Practice Done for Aboriginal Education in Canada?" *Canadian and International Education*, 30(1), 1–16.

Cajete, G.A (1994). *Look to the Mountain: An Ecology of Indigenous Education*. Skyland, N.C.: Kivaki Press.

D'Ambrosio, U. (1985). Ethnomathematics and its Place in the History and Pedagogy of Mathematics. [Online]. Available: <**www.enc.org/topics/equity/articles**>

Davison, D.M. (1992). "Mathematics." In J. Reyhner (Ed.), *Teaching American Indian Students,* 241–250. Norman: University of Oklahoma Press.

Doige, L.A. (2003). "A Missing Link: Between Traditional Aboriginal Education and the Western System of Education." *Canadian Journal of Native Education*, 27(2), 144–160.

Dorman, J.P. & Ferguson, J.M. (2004). "Associations Between Students' Perceptions of Mathematics Classroom Environment and Self-handicapping in Australian and Canadian High Schools." *McGill Journal of Education*, 39(1), 69–86.

Ezeife, A.N. (1999). "Using the Schema Theory in Science Teaching: The Challenge Before the Aboriginal Science Teacher." *WESTCAST conference proceedings,* 43–56. Brandon: Faculty of Education, Brandon University, Manitoba.

Ezeife, A.N. (2000). Middle Years Mathematics Methods course notes. Brandon University Northern Teacher Education Program (BUNTEP), Faculty of Education, Brandon University, Brandon, Manitoba.

Ezeife, A.N. (2002). "Mathematics and Culture Nexus: The Interactions of Culture and Mathematics in an Aboriginal Classroom." *International Education Journal*, 3(3), 176–187.

Ezeife, A.N. (2003). "Using the Environment in Mathematics and Science Teaching: An African and Aboriginal Perspective." *International Review of Education*, 49(3), 319–342.

Ezeife, A.N. (2004). "The Impact of a Culture-sensitive Curriculum on the Teaching and Learning of Mathematics in an Aboriginal Classroom." *Paper presented at the 12th World Congress of Comparative Education Societies (WCCES),* Havana, Cuba, Oct. 25–29.

Gaskell, J. (2003). "Engaging Science Education Within Diverse Cultures." *Curriculum Inquiry*, 23 (3), 235–249.

Hatfield, M.M., Edwards, N.T., Bitter, G.C, & Morrow, J. (2004). *Mathematics Methods for Elementary and Middle School Teachers*. New York: John Wiley & Sons Inc.

Jacobs, D.M. (1992). "Sustaining the Circle of Life." *Proceedings of the Thirteenth North American Prairie Conference,* 1–5. Windsor, Ontario, Canada.

Jegede, O.J. & Aikenhead, G. (1999). "Transcending Cultural Borders: Implications for Science Teaching." *Journal for Science and Technology Education*, 17, 45–66.

Kanu, Y. (2002). "In Their Own Voices: First Nations Students Identify Some Cultural Mediators of Their Learning in Formal School System." *The Alberta Journal of Educational Research*, XLVIII (2), 98–121.

Katz, H. & McCluskey, K. (2003). "Seeking Strength-based Approaches in Aboriginal Education: The 'Three Stars and a Wish' project." *McGill Journal of Education*, 38(1), 116–134.

Long, C.T. & DeTemple, D.W. (2000). *Mathematical Reasoning for Elementary Teachers*. Reading, MA: Addison-Wesley.

Ma, X. (2001). “Stability of Socio-economic Gaps in Mathematics and Science Achievement among Canadian Schools.” *Canadian Journal of Education*, 26 (1), 97–118.

MacIvor, M. (1995). “Redefining Science Education for Aboriginal Students.” In M. Battiste and J. Barman (Eds.), *First Nations Education in Canada: The Circle Unfolds,* 73–98. Vancouver: UBC Press.

Matang, R.A. (2001a). *An Information Brochure on Glen Lean Ethnomathematics Centre*. Papua New Guinea: University of Goroka.

Matang, R.A. (2001b, July). “The Role of Ethnomathematics in Mathematics Education: Implications for Mathematics Curriculum in Papua New Guinea.” *Paper presented at the 11th World Congress of Comparative Education Societies (WCCES),* Korea National University of Education, Chungbuk, South Korea.

Matthews, M.R. (1989). “A Role for History and Philosophy in Science Teaching.” *Interchange,* 2(2), 3–15.

Mel, M. (2001, July). “Teacher as Caregiver: The Introduction of Values Education Through Indigenous Education in Teacher Education at the University of Goroka.” *Paper presented at the 11th World Congress of Comparative Education Societies*, Korea National University of Education, Chungbuk, South Korea.

National Research Council (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, D.C.: National Academy Press.

O’Reilly-Scanlon, K., Crowe, C., & Weenie, A. (2004). “Pathways to Understanding: “Wahkohtowin” as a Research Methodology.” *McGill Journal of Education*, 39(1), 29–44.

Shirley, L. (1995). “Using Ethnomathematics to Find Multicultural Mathematics Connections.” In P.A. House and A.F. Coxford (Eds.*), Connecting Mathematics Across the Curriculum,* 34–43. Reston, Virginia: The National Council of Teachers of Mathematics, Inc.

Simard, L. (1994). “Curriculum Adaptation: Just Do It.” In K.P. Binda (Ed.), *Critical issues in First Nations Education,* 78–86. Brandon: BUNTEP, Faculty of Education, Brandon University, Brandon, Manitoba.

Sloat, E. & Willms, J. (2000). “The International Adult Literacy Survey: Implications for Canadian Social Policy.” *Canadian Journal of Education*, 25(3), 218–233.

Smith, M.R. & Ezeife, A.N. (2000, May). “Using the Environment in Science Teaching: A Cross-cultural Perspective.” *Paper presented at the Canadian Society for the Study of Education (CSSE) Conference,* University of Alberta, Edmonton.

Smith, M.R. (1994). “Scientific Knowledge and Cultural Knowledge in the Classroom**.”** In K.P. Binda (Ed.), *Critical Issues in First Nations Education,* 38–54. Brandon: BUNTEP, Faculty of Education, Brandon University, Brandon, Manitoba.

Stairs, A. (1995). “Learning Processes and Teaching Roles in Native Education: Cultural Base and Cultural Brokerage.” In M. Battiste and J. Barman (Eds*.), First Nations Education in Canada: The Circle Unfolds,* 139–153. Vancouver: UBC Press.

*The Ontario Curriculum, Grades 1–8*: *Mathematics* (2005). Toronto: Ministry of Education and Training.