CHAPTER 16

Mathematics as a Cultural Role Player in School Development: Perspectives from the East and West

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1 Background and Introduction

School development involves a wide-ranging series of appropriately planned activities and the coordinated efforts of several practitioners, functionaries, and stakeholders in the educational arena. Thus, adequate school development would entail the active involvement of school administrators, teachers, support staff, parents, guardians, and community members in creating a school climate and "environment that nurtures both students and adults" (Center for Effective Collaboration and Practice [CECP], 2001, p. 1). Essentially, a worthwhile or adequate school development program helps "schools focus their operations around effective child development and successful teaching and learning" putting "the

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development of ***all*** [emphasis in the original source] children at the centre of the educational process" (CECP, 2001, p. 1).

The emphasis on "all" children evokes the concept of inclusivity whereby learners from all cultural backgrounds are adequately provided for, and afforded an opportunity and learning climate, which would enable them to benefit maximally in school. Inclusivity, in turn, would entail developing and implementing a culture-sensitive curriculum that would address the specific, perceived, and prevalent needs of learners from non-mainstream cultural backgrounds in any school setting, thereby making every student feel valued and represented. This chapter will specifically address the issues of learners who are academically at risk in the subject area of mathematics with focus on Chinese ethnic minority mathematics students and their counterparts in Canada—mathematics learners of Canadian Indigenous cultural backgrounds.

2 Mathematics in Today's World

The importance of mathematics in today's world is widely acknowledged. Several authors, researchers, and research institutes have articulated the need and importance of robust mathematics education in contemporary society. For instance, the International Association for the Evaluation of Educational Achievement (IEA) stated pointedly in its 2012 report, which incorporated the 2011 Third International Mathematics and Science Study (TIMSS) results in mathematics, that:

> The world is becoming increasingly quantified and all students need to be well grounded in mathematical and technological thinking to live a productive life. To be effective future citizens, students need mathematics to understand daily news and grasp world events, often described through statistics, increases, and decreases […] Mathematics is the foundation for further study in a number of school subjects, most notably the sciences; and mathematics problem solving builds logical reasoning skills that can be applied in many situations. (Arora, Foy, Martin, & Mullis, 2012, p. 25)

Still dwelling on the importance of mathematics, the National Council of Teachers of Mathematics (NCTM) made the following emphatic statement: "In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. A lack of mathematical competence keeps these doors closed" (NCTM, 2000, p. 50).

Despite its well-articulated and widely acknowledged importance, a good number of students still shy away from mathematics, remain aloof to the need for it, perform poorly in it, and drop it at the earliest opportunity; they often pay a bitter price for this decision in their future careers. This mathematics phobia, with its attendant malaise—low enrolment in mathematics and related fields of study—has remained the unflattering state of affairs in high school education in many parts of the world for several decades, especially among students from minority and Indigenous cultural backgrounds (Binda, 2001; Gaskell, 2003; Snyder & Dillow, 2011). In the 1980s, the National Research Council (NRC) succinctly described the status quo when it lamented in its report: "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" (NRC, 1989, p. 7). This situation, so aptly described by the NRC in the 1980s, has stubbornly persisted and is even worsening, as confirmed by recent research findings in different regions of the world where authors and researchers report about the relatively low enrolment, difficulties experienced by learners, poor performance in examinations, and high dropout rates of high school students in mathematics, science, and other technologically oriented fields (Bourque, Bouchamma, & Larose, 2010; Friesen & Ezeife, 2009; Lauangrath & Vilaythong, 2010; among others).

Many of the authors/researchers have, therefore, called for a reorientation in school development programs—with specific attention to mathematics curriculum content, and a redirection in classroom implementation procedures and practices. The advocated reorientation is intended to make mathematics teaching and learning more meaningful, effective, and relevant to learners, especially at-risk learners from ethnic minority and Indigenous cultural backgrounds—so as to positively realign their disposition and attitude to mathematics education, with the overall goal of attaining a measure of parity with regard to their enrolment and performance in mathematics and related disciplines—with their counterparts from mainstream cultural backgrounds (Moreno-Garcia, 2012; Thomson, 2009). The relatively poor performance of many Indigenous students in mathematics has been a running trend dating back several years, as authenticated by research. For example, Binda (2001) revealed the following statistics from his study: In 1997, the mean mathematics performance of Manitoba Aboriginal students in First Nations' schools was 19.6% while the provincial average was 55.6%. In 1998, the mean score of Aboriginal students fell to 14.4% while the provincial average rose to 61.2%.

3 Why Do Many Students from Ethnic Minority and Indigenous Cultural Backgrounds Shy Away from and Perform Poorly in Mathematics?

One of the fundamental reasons given for the high dropout rate and poor mathematics performance of these at-risk learners is the lack of relevance of school mathematics content to the students' real-life experiences. In other words, the mathematics taught in school is bereft of ethnic minority and Indigenous cultural and environmental content (Sicat & David, 2011). Some other constraints or barriers to providing adequate mathematics education for ethnic minority and Indigenous students include the remoteness of several ethnic minority and Indigenous communities and settlements, inadequate teaching texts and related instructional materials, the language of instruction, and the way and manner mathematics is taught to these students, often by teachers who do not share the same cultural origins and values with the ethnic minority/Indigenous students they teach.

This is because there is usually a stark shortage of qualified minority teachers. Additionally, mainstream teachers' lack of local knowledge has also been identified as one of the obstacles to the meaningful education of minority students (Rong, 2006). Based on the findings of their study, Warren, Baturo, and Cooper (2004) commented on the issue of non-Indigenous teachers, especially those teaching Indigenous/minority students in remote rural areas:

> These non-Indigenous teachers and teacher-aides were not familiar with educational contexts in which Indigenous students learn and hence they tended to adopt traditional contextualised situations such as money, consumption, and measuring outside the classroom, and in many instances did not even reflect the remote and rural environments in which they were working. (p. 159)

4 Addressing Setbacks and Tackling Obvious Constraints and Barriers

To address the inadequacies and pitfalls, and thereby improve the status quo in the realm of ethnic minority/Indigenous education in general, and minority mathematics education in particular, several scholars, researchers, mathematics educators, and other practitioners in the field have stressed the need to integrate the learners' culture, environment, familiar everyday activities, and traditional practices into the mathematics curriculum. Following Ascher's (1998) ideas in her work on "Ethnomathematics," this chapter postulates that, for mathematics education to be really meaningful, effective, and relevant to students from ethnic minority and Indigenous cultural groups, the traditions of these learners and the ways they ascribe meaning to their environment and the social world in which they function must be fully reflected in the mathematics they are taught (and are expected to learn) in schools. Ascher stressed the importance of this approach to the teaching and learning of mathematics and affirmed that "mathematical ideas are cultural expressions."

This is the current and ever-growing discourse in the field of mathematics education, especially in countries and societies with multicultural populations, which include people of ethnic minority and Indigenous cultural origins. In their recent contribution to this discourse, Peng and Song (2014) stated,

> Given widespread concerns about equity in mathematics education, educators in countries with diverse multicultural populations have called for the recognition that mathematics is a cultural product, and, thus, mathematics education must take into account the growing diversity of students. (p. 172)

Both Canada and China—the two countries involved in the ongoing Reciprocal Learning Research Partnership Project—have diverse multicultural populations, of which ethnic minority and Indigenous peoples constitute a significant proportion. How can meaningful and effective mathematics education be incorporated into school development programs in these two countries under the auspices of the Reciprocal Learning Project? Essentially, what can researchers in the Mathematics Research Team of the Reciprocal Learning Project—in both China and

Canada—contribute toward the firm injection of the cultural mathematical practices and knowledge systems of ethnic minority and Indigenous students into Canada's and China's mathematics education programs? How can this integration goal be attained? These questions and the effort to seek answers to them fall squarely into one of the set goals—cultural perspectives—of the Mathematics Research Team. This chapter endeavors to seek answers to these important questions, providing supportive examples, illustrations, and projections for follow-up work, as appropriate.

5 What Can Be Done? How Can It Be Done?

Contemporary mathematics education research embarked upon by researchers in both the East–West educational systems has yielded a wealth of information with regard to the mathematics-oriented practices of ethnic minority/Indigenous mathematics learners. For example, in their recent work, Peng and Song (2014) stated, "There are various forms of mathematics underlying cultural practices of ethnic minorities in China, evident in architecture, dress, drawings, counting units, chronometers, methods of calendar calculation, and religious beliefs" (p. 176). The authors proceeded to give several examples of mathematics-related equipment and tools associated with, and traditionally used by the Uygur and Tibetan Chinese ethnic minorities:

> …distinct forms of mathematics have…been discovered in the everyday life practices of Uygur people. For example, the stove for cooking food constitutes a typical abutment structure; geometrical designs can be found in everyday tools such as the Ketman (a tool for digging) the Kariz (an irrigation system) and typical Uyghur (sic) cave houses. (p. 177)

Proceeding further, Peng and Song went on to discuss the situation for Tibetan minorities:

> Similarly, with the Tibetan tradition, distinct forms of mathematical systems are also evident… Examples include the prayer beads and abacus which are still used today as tools for calculation by many Tibetan people. Other tools specific to the Tibetan minority are wooden counting frames, which are used for calculating the time of the solar eclipse, lunar eclipse, and increscence. (p. 177)

Similar to the above examples, which dwell on the mathematics-related cultural practices among Chinese ethnic minorities, there are various mathematics-related activities, traditional everyday environmental practices, phenomena, and socially valued mathematical knowledge identifiable among Canadian Indigenous (Aboriginal) populations. Some of these, drawn from the Cree and Anishnaabe Aboriginal cultural groups, are shown in Table 1. Table 1 gives details of these identified traditional activities, environmental phenomena, everyday materials, and matches them with the mathematics concepts or topics to which they apply, based on the five mathematics strands of the Ontario (Canada) provincial mathematics curriculum, Grades 1–8 (2005).

6 Building Mathematics Education on Identified and Available Cultural Resources

Awareness has been created through research about the existence of mathematics-related traditional practices, everyday phenomena, and activities among ethnic minority and Indigenouscultures. The creation of this awareness amounts to surmounting the first of three hurdles usually encountered in developing a suitable curriculum, and then utilizing the developed curriculum to make mathematics education more meaningful, effective, and hence relevant for learners from these cultural backgrounds. The second hurdle centers on the effective integration of the compiled traditional cultural resources into a mathematics curriculum targeted on at-risk mathematics learners.

The advantages of such a curriculum are numerous. First, the curriculum would evolve naturally from, and build solidly on, the learners' lifeworld mathematical knowledge and experiences accumulated over time from their homes, the environment they live in, everyday activities, peer interactions, etc. From this solid mathematics premise acquired from their lifeworld, the learners would then transition to the subculture of school mathematics. If the mathematics curriculum is appropriately developed, such that this transition from the students' lifeworld mathematics to school mathematics is seamless, then a solid mathematics foundation would have been laid for the young learners from ethnic minority/Indigenous cultural backgrounds.

Aikenhead (1996) proposed and utilized the construct—cultural border crossing—to conceptualize the transition between the learners' lifeworld experiences and school learning. Applied to this particular

Table 1 Examples of traditional practices, environmental phenomena, everyday activities/materials (among the Cree and Anishnaabe) that apply to, and can be used for math teaching/learning (Ezeife, 2013a)

Traditional practice, everyday activities and materials, and phenomena	*Mathematics strand (Ontario curriculum) to which they correspond*	*Math topics or concepts where they (traditional practice, everyday activities, etc.) can be applied*
Flowers in the environment: While playing in the fields, young Aboriginal children would pick flowers and count the petals	Number sense and numeration; patterning and algebra	Numeric skills—counting, basic units of counting, different base systems. Naturalistic intelligence (Gardner's multiple intelligences); Patterns in the arrangement of the petals
The Spider Web—often seen in the usually rural environment of Aboriginal communities. The "Web" concept, the shape, and patterns in the "Web" relate to these traditional activities: Weaving of fabric, straw (for hats), and reeds (for traditional arrows and baskets)	Geometry and spatial sense; patterning and algebra	Geometrical shapes, areas of two-dimensional figures; operations on fractions—addition and subtraction; equivalent fractions and ratios
Ice holes and Ice Fishing	Measurement, data management and probability	Estimation/measurement of depth, probability of catching fish, volume of water in hole, problem solving, and reasoning/logic
Beadwork and beads strung and worn by the Anishnaabe	Patterning and algebra	Patterns in the beadwork, colors and ordering of beads
Traditional log cabins (called ***Os-ka-nsa***, in Cree language)	Geometry and spatial sense; Number sense and numeration	Width/length, areas, geometric figures, accounting—costs, money (counting/conversion)
The component groups of the "3 Fires Confederacy—(***Odawa***, ***Ojibwa***, and **Pottawatomie**)	Number sense and numeration	Set theory—set descriptions and symbols/notations, the universal set, complements and subsets

Traditional practice, everyday activities and materials, and phenomena	*Mathematics strand (Ontario curriculum) to which they correspond*	*Math topics or concepts where they (traditional practice, everyday activities, etc.) can be applied*
Making of moccasins. Traditionally, this usually involves measuring the feet of someone standing on the hide	Measurement	Units and standards of units, conversion between two different systems of units—the S.I. and the F.P.S. systems
The Bannock cake (called **Pah-ke-sikun** in Cree language) is a staple Aboriginal food	Geometry and spatial sense	Fractions, decimals, percents, concepts of symmetry and division
Traditional hunting using two types of arrowheads—round tips and sharpened tips. The round tipped arrows are used for hunting smaller game, while the sharpened tips are reserved for hunting larger game. Optimal hunting seasons/periods	Geometry and spatial sense; data management and probability. Number sense and numeration	Angles and shapes, speed and velocity of moving objects. Probability of catching hunted animals. Seasons of the year and their durations
Traditional housing—Lodges are usually shaped in a circular formation. The construction of the lodges is symbolic. At the center of the lodge is a hold for the fire, and at the top of the roof is a circle for smoke exit, while the doorways align 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 formation of the four quadrants
Traditional fishing: The Anishnaabe make marsh grass in a circular pattern. A hole inside the circular formation is lined with tunnels for trapping fish. Often, six or more tunnels are linked to the hole	Data management and probability	Probability—its example and application in everyday life. (the Anishnabe technique involves running the fish through several tunnels until they are captured in one. This strategy adopts and exemplifies the principle of probability)

(continued)

Table 1 (continued)

Traditional practice, everyday activities and materials, and phenomena	*Mathematics strand (Ontario curriculum) to which they correspond*	*Math topics or concepts where they (traditional practice, everyday activities, etc.) can be applied*
Burial traditions: Burials are usually done on the 5th day after death, and the body is positioned to face the East. This tradition symbolizes a new beginning—the sun rises in the East	Number sense and numeration	The decimal (base 10) system of counting contrasted with the base 5 system, and base 2 system used in computer technology. The concept and use of the "place holder" in counting. Cycles and rotations. Directions—sunrise and sunset
Fish nets (called ***Anapi*** in Cree language), Canoes	Measurement; number sense and numeration	Principles of mass and weight, counting—number of fish a canoe can hold
Games and Sports—Running as a form of exercise, and in pursuit of hunted animals. Also, there are a lot of traditional Aboriginal games such as shell games, the campfire game, slide-of-hand tricks, the moccasin game, etc. In the moccasin game, for example, the target is for each player to correctly guess in which pouch a marked marble is hidden	Data management and probability, measurement	Principle of probability—Games involving chance, such as raffles, lotteries, and bingos. Determination of odds of winning. Measuring distances covered in a race, or during a hunting expedition

context, it means the transition from the students' lifeworld mathematics experience/knowledge to school mathematics experience. The seamless transition which is attained or accomplished if or when the students' lifeworld culture is in accord with, and supports the school mathematics culture, is referred to as smooth border crossing (Aikenhead & Jegede, 1999). This should be the desirable goal in the preparation of mathematics curricula in multicultural nations like Canada and China as they embark on all-inclusive school development programs for their citizens.

With an adequately developed mathematics curriculum in place, the third and final task to accomplish (that is, hurdle to surmount) is the effective classroom implementation of the developed curriculum. This goal will be attained if mathematics teaching and classroom learning experiences are selected such that they reflect the contents of the developed curriculum which, in turn, had taken into account, and built its foundation on, the lifeworld culture of ethnic minority and Indigenous learners. Apart from appropriate teaching/learning classroom experiences, there are other tangible factors to consider, such as teacher quality, quality of mathematics instructional practices (Cheng, 2014), and of course, an understanding by the teacher of the learning characteristics of the students being taught (Greenwood, de Leeuw, & Fraser, 2007). The issue of learning characteristics, which subsumes such contiguous concepts or factors as students' attitudes and habits, is an important issue with respect to the education of ethnic minority and indigenous learners. Research has shown that:

> 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, [while] low-context cultures use a linear, sequential building block (bottom-up) approach to information processing in which meaning is "constructed". (Hollins, 1996, p. 134)

Since ethnic minority and Indigenous learners essentially belong to the high-context culture group (Hollins, 1996), their learning styles are strongly supported by the use of environmental traditional practices, phenomena, everyday activities, artifacts, stories, and familiar flora and fauna in mathematics teaching, as advocated in this chapter.

In pursuance of the current trend to build effective mathematics education for at-risk learners based on their culture, some researchers and educators in both the East (China) and the West (Canada) have developed teaching materials and produced well-researched textbooks geared toward meeting the specific needs of these learners. During his recent (2014) research field trip to Southwest University (SWU) in Chongqing, China, under the auspices of the University of Windsor-Southwest University Exchange Program, Ezeife interacted with mathematics educators and researchers in SWU, and mathematics teachers in several affiliated schools in the city of Chongqing and its environs. In the course of these highly productive interactions, mathematics education, especially for at-risk learners, was extensively discussed, and a new book series for mathematics teaching at the elementary school level became the focal point of discourse (Ezeife, 2014).

The series, aptly entitled, *Elementary mathematics-culture book series*, edited by Song and Zhang (2014), contain ten subvolumes (books) with the respective titles (translated into English from the original Chinese language), thus:

> Nature and Mathematics, Games and Mathematics, Environment and Mathematics, Life and Mathematics, Health and Mathematics, Science and Mathematics, Economics and Mathematics, History and Mathematics, Art and Mathematics, Mathematicians and Mathematics.

The appeal of the mathematics-culture book series is that the series drew on the day-to-day life experiences and the environment of mathematics learners and used these experiences as building blocks on which mathematics education is firmly anchored. This is the approach advocated by contemporary researchers and mathematics educators for eliminating the lacuna or chasm—often perceived by ethnic minority and Indigenous students between their lifeworld and the world of school mathematics, a situation that usually puts them at risk in their study of mathematics.

Some detailed contents of the mathematics-culture book series from two subvolumes of the series, namely “Life and Mathematics” and “Games and Mathematics,” are shown in the first column in Appendix I, while the researcher’s (Ezeife’s) comments on the concepts and the areas of mathematics to which the specified contents could be applied in actual classroom teaching situations, and the cultural, environmental mathematics knowledge inherent in, and discernible from the contents, are also given (shown in the second column, in Appendix I). In Appendix II, the researcher provides a sample lesson suited to the environmental outdoor life in typically rural Indigenous communities in Canada. The lesson notes and learning experiences dwell on activities specifically designed to engage the students in see-mathematics-in-your-environment, learn-as-you-do sessions. Appendix III shows the use of the "Spider Web" concept (which is relatable to the concept of *Partitioning* in mathematics) in teaching Operations on Fractions, Areas of two-dimensional figures, etc., as earlier specified in Table 1.

7 Next Phase

This chapter has engaged in a research-based discourse of the status quo in contemporary mathematics education for at-risk mathematics learners in China (ethnic minority students) and Canada (Indigenous/Aboriginal students). The chapter postulated that these ethnic minority and Indigenous students will be more attracted to the study of mathematics and fare better in examinations, if mathematics is presented to them as part and parcel of their lifeworld, by using their culture, environment, mathematics-related activities/practices, and ways of knowing, to teach them. The chapter went further to present and discuss some curriculum development efforts that have been made by current mathematics educators/researchers, and the culture-oriented teaching/learning materials and texts developed by these researchers.

Since these materials are widely available for use, it is hoped and expected that future studies and projects of this nature—based on the "Cultural Perspectives" goal of the Mathematics Research Team of the Reciprocal Learning Project—will engage in extensive fieldwork in both Canada and China to try out the efficacy or effectiveness of the developed materials in an experimental/empirical field setting. "Sister Schools" (Connelly & Xu, 2014) and available ethnic minority/Indigenous mathematics learners from both countries (China and Canada) would be the feasible targets and would hopefully be fully involved in this anticipated follow-up work.

8 Summary, Suggestions, and Conclusion

This chapter drew attention to the yearning need for mathematics education in general, and in particular, meaningful and relevant education for ethnic minority and Indigenous learners of mathematics. It is strongly suggested that, in School Development Programs in all climes and societies, mathematics education should be embarked upon with the infusion of a high dose of cultural content. This is in recognition of the visible and tangible role culture plays, not just in relevant and effective mathematics learning in schools, but also in ensuring the establishment of all-inclusive, equitably developed and implemented school programs for all students, irrespective of their cultural backgrounds (Dei, 2015).

It is further suggested that school programs, especially mathematics education programs, be developed and implemented in such a way that schools continue to sustain their age-old role of overall societal development and regeneration. In making this suggestion, this chapter took cognizance of the fact that such revered structural edifices as the *CN Tower* in Canada and the world-famous *Great Wall* in China are mathematical, architectural, and technological wonders which owe their emergence to deeply rooted ingenuity, creative school development, and other contiguous factors in East–West societal civilizations that serve as shining pointers to, and strong indicators of, the ever-growing cultural role which mathematics plays in modern-day global human existence.

By harping on the need for the utilization of culture and adopting culture-sourced content and procedures that would make mathematics relatable, meaningful, and hence, relevant—as suggested in this chapter, it is projected that students' attitudes toward mathematics, particularly at-risk learners, would change for the better. The culture-sourced content and procedures may actually be drawn from the liberal arts because as research has revealed, a firm grounding in the liberal arts could "give shape and humanistic substance to mathematics and science education" (Kotsopoulos, 2015, p. 35). The "shape and humanistic substance" may serve as possible catalysts that could help alter students' prevalent negative attitudes toward mathematics. This profoundly negative perception of mathematics that has, unfortunately, persisted over the years is reflected in the statement by the National Research Council (NRC, 1989), in these words:

> 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. (p. 10)

It is hoped that this study, along with other research engagements undertaken by the Mathematics Research Team of the Reciprocal Learning Project (RLP) between Canada and China, will contribute significantly to the improvement of mathematics education, more so for at-risk learners from ethnic minority and Indigenous cultural backgrounds in both countries—Canada and China—within the seven-year duration of the Reciprocal Learning Project.

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Appendix I

See Tables 2 and 3.

Appendix II

A lesson on mathematics in the community, entitled, Outdoor Mathematics [Mathematics in the Park] (Ezeife, 2013b)

A schedule of timed mathematics learners' activities (Targeted to Grades 5–8 Ethnic minority/Aboriginal students).

1. **Activity 1: Look and Write** (15 minutes)

Study (look closely at) this field/park and write down whatever you see in the park that reminds you (tells you) about any part of mathematics you have learned in your class.

Note: Write this in the small notebook given to you for outdoor mathematics activities.

Activity 2: Count and Record (10 minutes)

Table 2 Elementary mathematics-culture book series: Life and Mathematics sub-volume (Song & Zhang, 2014)

Some contents of the book (translated from the original Chinese language)	*Researcher's comments on (and insight into) the mathematics concepts/areas to which the contents could apply; and their cultural significance in mathematics teaching*
Calculating (managing) your time before going to school	This suggests 'waking up with mathematics'- mathematics (the clock) as the day's guide—learner's culture. Start of the child's day and preparation for school are typical day-to-day activities of the child. Thus, the child sees mathematics as part and parcel of his/her day, and hence, an integral part of life
Time management on your way to school	Here, again mathematics is the day's guide. Thus, the child is 'thinking mathematics' as s/he walks to school
How to use "Coordinates" in mathematics to get a seat in class	Coordinates (hence, Coordinate Geometry/Cartesian System). This is a direct application of the mathematical knowledge that the student has acquired
Nutrition facts about the food in your (student's) lunch box	Calculating (and thus, knowing the components and percentages of the food items in a typical student's lunch box/snack box). This deals with the important topic—nutrition facts and their bearing on the health/life of a student
The patterns and shapes on the blackboard	Patterns and shapes on the class blackboard may likely relate to mathematics teaching/learning tools and manipulatives.
Calculations in a farm	Farm work, which will most likely be one of a typical student's after-school activities/engagements (chores) would entail a lot of mathematics-associated exercises. For instance, the child may be involved in picking (and most likely, counting) apples, tomatoes, etc.; plucking oranges, and pears and heaping them into baskets or containers for weighing. Thus, the child learns the use of scales, weights and measures (in mathematics) as s/he engages in typical everyday chores and activities.
Doing the laundry	The concept of counting—Number (and types) of clothes washed. Weight of clothes. Volume of water used

Some contents of the book (translated from the original Chinese language)	*Researcher's comments on (and insight into) the mathematics concepts/areas to which the contents could apply; and their cultural significance in mathematics teaching*
Using knowledge about angles in playing soccer	This concerns the mathematics in school games like soccer, hockey, tennis, ping-pong, and other popular games students play. Angles and trajectories could be discussed in this context
A birthday gift for Dad	Mathematics in family life: Birthday gifts for family members; sizes of clothes, shoes, and hence the concept of measurement. Wrist sizes, circumferences of the head, arms spans, etc. of family members could be measured
The mathematics in toys	Young mathematics students should be guided to look at every toy they use as a mathematical contraption (device). This should naturally lead them to ask the question: Where is the mathematics in this toy?
How to draw a map	Scales and measures, distances, plans and elevations could be covered effectively under this topic, making effort to relate these to the day-to-day life of the students
Shopping with your Mom	The growing child comes in contact with money at some stage. This should be a good opportunity to relate money to mathematics, by discussing money denominations and their relative values; and thus, their ratios with respect to one another
The "magic" mirror.	Generally, young students love mirrors and mirror games. This situation can be beneficially tapped when mirrors are used to teach the mathematics concepts of reflection, angles associated with reflection, distances of objects and images to/from mirrors, and the concept of lateral inversion. The kaleidoscope (a popular children's toy) could be shown in class/discussed in relation to its mathematics content
The mathematics in climbing a mountain	Mountain climbing is usually an enjoyable outdoor activity for students. The mathematics in this exercise—tangents and slopes, angles, curves, tracks, and elevations, should be harped upon as/when children engage in the exercise/activity

Table 3 Elementary mathematics-culture book series: Games and Mathematics sub-volume (Song & Zhang, 2014)

Some contents of the book (translated from the original Chinese language)	*Researcher's comments on (and insight into) the mathematics concepts/areas to which the contents could apply; and their cultural significance in mathematics teaching*
The mathematics in planting trees	Applicable mathematics teaching concepts include land areas and distances, map drawing, spaces between trees. The knowledge acquired while studying this topic in a mathematics class early in life could become useful in a future farming career or landscaping
The Chinese paper cut	'Paper cutting' is a cultural play activity that has a good deal of mathematical implications
The mathematics in "clocks"	The clock should be presented as a commonly used cultural instrument in which a lot of mathematics can be seen. The use of the clock in modern time-telling should be contrasted with the traditional time-estimation in ancient times (for example, by observing the varying lengths of shadows)
How much juice can you have?	Students encounter fluids and liquids in their environment on a daily basis. The mathematics of 'volumes' would come up naturally in class as liquids and the containers/vessels that hold them are discussed
The mathematics in gambling	Gambling is a common activity in many cultures which students will encounter when they come of age. Mathematics should be used to reveal the odds of winning/losing under the concepts of Permutations and Combinations. Problem gambling and addiction should be mentioned and discouraged
The "Bumper Car" and numbers	Various number games, usually played by children in table formats, such as mathematical games involving the "addition truth table" and "multiplication truth table" fall into the "Bumper Car" category

How many trees are there in this park?

Activity 3: Observe and Sort (20 minutes)

3(a) In this activity, you will put the trees you counted in three categories or groups, according to their size—small, medium, large.

i. How many of the trees are small in size?
ii. How many trees are of medium size?
iii. How many trees are large?

3(b) If you are asked to draw a graph to show the number of trees in the park based on their sizes (small, medium, large), what type of graph will you draw?

Note: Choose **one** type of graph from the list below:

1. Line graph
2. Straight line graph
3. Stem-and-Leaf plot
4. Bar graph
5. Pictograph

Activity 4 (Group Activity): Measure and Record (25 minutes)

In this activity, you will work in pairs, that is, each person will work with a partner.

4(a) Choose any three trees in the park such that one tree is small, one is medium, and one is large.

4(b) Using the tape given to your group, measure the circumference of (distance around) each of the three trees, and record your results:

i. The circumference of the small tree is?
ii. The circumference of the medium tree is?
iii. The circumference of the large tree is?

4(c) Measure the diameter of each of the three trees and from your measurements, calculate (find) the radius of each type of tree, and record your results:

i. What is the radius of the small tree?

ii. What is the radius of the medium tree?
iii. What is the radius of the large tree?

Activity 5: How many trees (2 minutes)

If you are taken to a park two times the size of this park, about how many trees do you think that park will have? (Assume that trees in all parks have the same spacing, that is, the same distances from one tree to another, just as the trees in this Particular Park in which you did today's outdoor mathematics session).

Activity 6: General Comments (10 minutes)

5(a) Did you enjoy today's mathematics class that you did outdoors (that is, outside your regular classroom)?

5(b) Give a reason for your answer. That is, state why you enjoyed or did not enjoy today's outdoor class.

5(c) Do you think mathematics is part of your daily life, or is it just something you do in the classroom?

5(d) From now on, will you try to think of examples of mathematics in your environment or community:

i. When you are going to school? Yes or No ---------
ii. When you are going back to your house after school? Yes or No ----------
iii. When you are at home? Yes or No ----------

Activity 7: Project Work

7(a) **Estimating the ages of trees in the park (For Grade 8 students only).**

Based on your measurements of the diameters of the trees in Questions 4(b) and 4(c) for the small, medium, and large trees, estimate:

I. The age of the medium tree (that is, how old is the medium-sized tree?)
II. The age of the large tree.

[**Hint/Clue**: Assume the small tree in Questions 4(b) and 4(c) is 4 years old. Then use the **ratio** approach (proportions) to find (estimate) the ages of the medium and large trees. Thus, you have to form ratio equations (involving the diameter of the small and medium trees first, and after that, the diameters of the small and large trees) to enable you do the estimation].

7(b): **Designing an Aboriginal-oriented park**

As a hands-on, learn-as-you-do project exercise for this outdoor mathematics class (Mathematics in the Park), design your ideal Aboriginal park that should take into consideration some specific design issues/characteristics, and which will include the following items:

I. The **spacing** (that is, the distances) between the trees in the park. These distances should be labeled in your completed design.
II. The ideal **number** of trees in the park.
III. The **mix** of trees in the park (that is, the number of small, medium, and large trees).
IV. The **type** of trees in the park. Here, you should think of trees that reflect the Aboriginal culture, and are traditionally planted and used in Aboriginal societies and communities in Canada.
V. An **orchard** (a fruit garden) in the park. Here, think of the type of fruits that are symbolic of, and important to Indigenous peoples of Canada. (You can ask your parents, guardians, older siblings, and community Elders to give you some ideas and hints about such traditionally meaningful trees).

Note: We hope you enjoyed today's outdoor mathematics class which has the goal of bringing out clearly the fact that mathematics is part and parcel of your everyday life, and has been done and practised by Aboriginal people, and other Indigenous cultures, for many centuries.

Note: This outdoor mathematics class (Ezeife, 2013b) was designed and utilized for teaching Indigenous (Aboriginal) students (Grades 5–8) in the University of Windsor's 4-Winds STEM (Science, Technology, Engineering, and Mathematics) Project, 2012–2014. The project was launched to attract Aboriginal students in Windsor and its environs to STEM fields of study by presenting course contents to them using culture-oriented and environmentally sourced materials from their life-world.

Appendix III

Teaching mathematical "Operations on Fractions", Equivalent Fractions, and Areas of two-dimensional figures using the 'Spider Web' concept

Example problem: Find 3/4 + 5/6

Solution using the 'Spider Web' concept: 3/4 + 5/6 = 18 rectangles + 20 rectangles (obtained by directly counting the number of rectangles that make up the fractions 3/4—three quarters, and 5/6—five sixths, respectively, in Fig. 1)

= 38 rectangles

But, the total number of rectangles in the Spider's Web

= 24 (6 columns x 4 rows)

Thus, 3/4 + 5/6 = 38 rectangles

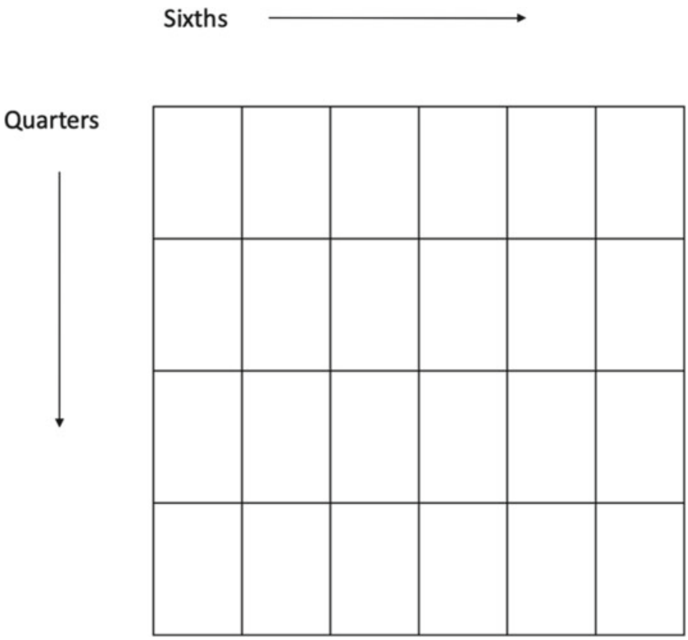

Fig. 1 The Spider's Web

Now, when this number (38) is compared to the total number of rectangles (24) in the Spider's Web, then we see that this implies 38/24 = 19/12 = 1 ^{7}/12

Hence, 3/4 + 5/6 = 1 ^{7}/12

Follow-up exercise and consolidation: Find 1/4 + 1/6, using this method (the 'Spider Web' concept)

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