INUIT MATHEMATICS, A COLLABORATIVE RESEARCH

Louise Poirier
Université de Montréal

“Knowledge is the condition of knowing something with familiarity gained through experience or association. The traditional knowledge of northern aboriginal peoples has roots based firmly in the northern landscape and a land-based life experience of thousands of years. Traditional knowledge offers a view of the world, aspirations, and an avenue to « truth » different from those held by non-aboriginal people whose knowledge is based largely on European philosophies” (Department of Culture and Communications, Government of the Northwest Territories, 1991

Please note…
I am not an Inuk and I do not pretend to know and understand the Inuit’s culture. My own perception and understanding of the Nordic situation will color this paper. I would like to present a collaborative project with members of the Inuit community of Nunavik and to sketch in an impressionistic fashion the mathematics built by the Inuit to answer their needs. I will also expose the challenges that this community faces in going from their traditional mathematics to, as they call them, the « southern mathematics ».

1. HISTORY OF THIS PROJECT

This project is an ongoing collaborative research with several women from the Kativik School Board (teachers, teacher trainers, curriculum developers, …). In the spring of 2000, the Inuit community and the Kativik School Board were wondering about the reasons behind the students’ difficulties in mathematics: how could these difficulties be explained and what could we do to help the students? The Kativik School board presides over a territory named Nunavik in the most northern part of the province of Québec. Nunavik includes 14 villages from west to east spread on the banks of Hudson’s Bay, of Hudson Straight and of Ungava Bay. In all, 11 000 people live in Nunavik, a vast majority of them being Inuit.

In the spring of 2000, I was offered the opportunity of a series of visits in Inuit villages. I visited classrooms, meeting with the teachers and their students. Several observations were then made, observations that could explain at least in part their difficulties in learning mathematics:

Mathematics and language: Inuit children’s first language, Inuktitut, is also the only language they learn in kindergarten, first and second grades. Although they learn mathematics first in Inuktitut, from third grade onwards to the end of high school, they were then learning mathematics in either French or English only. As a result of our work, since 2005, they are now pursuing in their own language, during third grade, also their learning of mathematics. Could the passage from their mother tongue to a second language explain the difficulties that Inuit children encounter?

Spatial relations: the students that I have met are particularly good in spatial representation and in geometry. Pallascio (1995) made the same observations: Inuit children develop spatial representations that are different from those of the children who live in a city like Montréal. But, sadly enough, the current curriculum does not put much emphasis on these strengths.
Teaching methods: the teaching methods used by most teachers in the Great North (paper-pencil exercises) are not based on the « natural » ways of learning of these Inuit children. Traditional Inuit teaching is based on observing an elder or listening to enigmas. These enigmas could be clues for problem solving in mathematics. Furthermore, the Inuit teachers were telling me that traditionally they do not ask a student a question for which they think that student does not have the answer. We can easily see the necessity to adapt our southern ways.

To help the Inuit community explain their students’ mathematical difficulties and how to overcome them, a collaborative research project was elaborated. This project, involving members of the Inuik community, Inuit teachers, pedagogical councillors and curriculum developers, aims to understand both their mathematics and their language since it is in Inuktitut that mathematics are first learned. This is in order to teachers develop adaptive teaching activities.

2. COLLABORATIVE RESEARCH.

This project aims to unveil Inuit mathematics and to build teaching activities adapted to the Inuit context. The importance of having members of the Inuit community take part in this research cannot be overemphasized, for real progress cannot be made by the researcher alone if we want (and we do) the development to succeed.

When a researcher develops teaching activities, the question arises concerning the “validity” of these when adapted to the contextual situations (Artigue, 1990; Arsac, Balacheff, Mante, 1992; Bednarz, Poirier, Desgagné et Couture, 2001; Desgagné, Bednarz, Couture, Poirier et Lebuis, 2001, Van der Maren et Poirier, 2007). Teachers change these activities based on their teaching environment, their experiences and conceptions. This process may bring changes in the situations where the researcher does not recognize his or her work and the teachers themselves often have difficulties reproducing what the researchers have suggested because of the characteristics of their environment. This seems to us to be particularly true of the Inuit situation. A « triple entry » into the development of teaching situations therefore appears to be essential: didactical, the experiential knowledge of the teachers and the cultural knowledge of the Inuit.

The development of teaching activities must take into account the teachers’ understanding of their teaching and their teaching context. It was of the utmost importance to include members of the Inuit community in the research team. Our team is made up of 3 or 4 teachers of the Kativik school board, 3 or 4 teacher trainers and curriculum developers, all of them Inuit, and myself, with the support of a linguist and research assistants. By working with Inuit teachers and curriculum developers, we were able to develop teaching activities taking into account both their traditional ways of teaching and learning, and elements of their culture.

Collaborative research seemed to us one of the best approaches to use since it considers both the teacher’s actions and the rationality behind these actions as central research data. (Desgagné, 1997). It is not only a matter of developing useful teaching activities that will help students acquire a certain knowledge (something a more traditional didactical research would also do) but also developing teaching activities viable in the classroom context with the help of the teachers’ experiential knowledge and, in this project, their knowledge of the Inuit’s culture.

This collaboration between researcher, teachers, teacher trainers and curriculum developers, is done through reflexive activities which demand that teachers make explicit and analyse their experiences which, in turn, leads to the development and trial of new teaching activities in their classrooms. This approach is closely related to the reflexive analysis described by Schön (1987). It took the form of an alternation between the development of activities, their experimentation in the classroom and reflecting upon that experimentation. “The structure of alternation between action and reflexion makes possible the progressive re-structuring of teaching sequences through
a process where researchers and teachers play an important part…. This reflexive activity becomes the mediator between the teachers’ point of view (the practical framework from which they tackle the teaching activities) and the researchers’ point of view (the didactical framework through which they analyse these activities).” (Bednarz, Poirier, Desgagné et Couture, 2001). Such reflective activity takes the following form: meeting the team to develop activities – experimenting with these activities by the teachers in their classrooms – meeting the team to discuss and analyse these trials and develop new activities – experimenting in the classrooms…

The following diagram shows how our collaborative model emphasizes two aspects in particular: research and training, and the contributions expected from this research for both Inuit and research communities.

For the past 5 years, we have been meeting 5 or 6 times each year to discuss teaching activities, their experimentation in the classrooms and also to better understand the Inuit mathematics, culture and language. In the following section, some aspects of the Inuit mathematics are discussed.

3. THE INUIT MATHEMATICS

The social dimension of mathematics has grown in importance in the last decades (Bauersfeld, 1998; Voigt, 1994;). Lakatos (1976) said that «mathematics is a dialogue between people who have maths problems to solve ». Taking from the work of Wittgenstein and of Lakatos, Ernest (1991) explains that, for socio-constructivism, mathematical knowledge is a social construction where the social processes of dialog and critique are necessary. If mathematical knowledge is a social construction then the learner’s culture and community will play an important role in their learning. According to Bishop (1988), we are more and more preoccupied by what he calls the “cultural interfaces” in the teaching of mathematics: “In other countries, like Papua New Guinea,
Mozambique and Iran, there is criticism of the “colonial” or “Western” educational experience, and a desire to create instead an education which is in tune with the ‘home’ culture of the society. The same concern emerges in other debates about Aborigines, of (sic) Amerindians, of (sic) the Lapps and of (sic) Eskimos. In all of these cases, a culture-conflict situation is recognized and curriculum are being re-examined” (Bishop, 1988 p. 179). The Inuit community of Nunavik is in a similar quandary but we know little about their mathematics: not surprisingly, this project also aims to discover more about Inuit mathematics!

2.1 Oral numeration  

Inuit children learn to count in their own language and, until last year, they would switch to either French or English in third grade. Since September 2005, the third grade has become a transition year for the learning of mathematics: 75% of the time allowed for mathematics is done in Inuktitut and the remaining 25% is either in French or English. But this raises the question of whether or not they are learning the same numbers, the same numeral system as the one they will use in French or English.

In the Inuit language, Inuktitut, they have the singular (for example, « Inuk » means one person), the dual (« Inuuk » means two persons) and plural (« Inuit » means many people). Traditionally, it was from « 3 » and up that they needed words to express quantities. Their tradition being essentially an oral one, Inuit have developed a system to orally express numbers. They did not have any other means of representing numbers; they borrowed from the Europeans their number symbols. Under the Europeans’ influence (there is even a community in Labrador that counts in German, missionaries from Moravia having introduced numbers in German), Inuit have introduced a word for « one » and another for « two ». The following chart presents some Inuit numbers in Inuktitut and their literal translation.

<table>
<thead>
<tr>
<th>Recent</th>
<th>Ancient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Atausiq (Indivisible)</td>
</tr>
<tr>
<td>2</td>
<td>Marruuk</td>
</tr>
<tr>
<td>3</td>
<td>Pingasut</td>
</tr>
<tr>
<td>4</td>
<td>Sitamat</td>
</tr>
<tr>
<td>5</td>
<td>Tallimat (Arm)</td>
</tr>
<tr>
<td>6</td>
<td>Pingasujurtut (They are many threes)</td>
</tr>
<tr>
<td>7</td>
<td>Sitamaujunngigartut (They are not exactly many fours)</td>
</tr>
</tbody>
</table>

2 A more complete description is given in Poirier L (2007)
3 I will not make here the distinction between traditional and modern Inuktitut, nor between the different dialects spoken in Nunavik. For example, the Ungava Bay Inuit and Hudson Bay Inuit speak different dialects.
<table>
<thead>
<tr>
<th></th>
<th>Inuktitut</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td><strong>Sitamaujurtut</strong> <em>(They are many fours)</em></td>
<td><strong>Arvinilik pingasunik</strong> <em>(Three from the right)</em></td>
</tr>
<tr>
<td>9</td>
<td><strong>Quliunngigartut</strong> <em>(They are not exactly ten)</em></td>
<td><strong>Arvinilik sitamanik</strong> <em>(Four from the right)</em></td>
</tr>
<tr>
<td>10</td>
<td><strong>Qulit</strong> <em>(The top)</em></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><strong>Tallima-ujurtut</strong> <em>(They are many fives)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Quillu atausirlu</strong> <em>(And ten and one)</em></td>
<td><strong>itikkanuuqtuut atausirmik</strong> <em>(They come to the feet and one)</em></td>
</tr>
<tr>
<td>12</td>
<td><strong>Quillu marruulu</strong> <em>(And ten and two)</em></td>
<td><strong>itikkanuuqtuut marrunungnik</strong> <em>(They come to the feet and two)</em></td>
</tr>
<tr>
<td></td>
<td><strong>Avatit</strong> <em>(The limbs)</em></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td><strong>Inuk naavuq</strong> <em>(The man is complete)</em></td>
</tr>
<tr>
<td>146</td>
<td><strong>Avatit tallimat avatit maqruuk</strong> Pingasuujuqtulu** <em>(twenty five times twenty two times and many threes)</em></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td><strong>Avatimmariit</strong> <em>(The reel twenty)</em></td>
<td></td>
</tr>
</tbody>
</table>

Several remarks can be made. First, the numbers 20 and 400 are pivotal numbers as other numbers are built from these two numbers. Inuit have developed a base 20 numeral system. Furthermore, the reader might have been struck by the length of certain number words in Inuktitut. One can imagine the challenge for a 5 or 6 year-old student learning to count in Inuktitut.

2.2 Sense of space

Imagine that you are an Inuk hunter, in the snow and ice covered tundra, at minus 60 degrees. How will you orient yourself? Days afford a few hours of light only, and getting lost far away from your camp or village is a death defying experience. The Inuit have developed an outstanding sense of space to help orient themselves. They have learned to « read » snow banks and assess, with that, the direction of winds. I was told that they can say how far they are from the bay by smelling how salty the air is (each village is built on the banks of a bay). But mostly, for thousands of years, Inuit have built inukshuk to help them. An inukshuk is a huge human shaped pile of rocks (inukshuk: that looks like a person). An inukshuk will help travelers of the Great North: because of its great height, it is seen from very far and it transmits messages: « Someone was here; it is a good fishing spot ». An inukshuk can also shield the hunter from the wind and be a hiding place to surprise the caribous.
The Inuit speakers are very much concerned to be understood by others. Such a precision of language can be seen when an Inuk describes the path one must take to reach a spot. Space in the Great North is an ever changing space, changing with the season, the time of day, the temperature, … Béatrice Collignon, a geographer, wrote in 1996 « It is impossible for an Inuk to describe a place in an objective manner. He will always be sure to specify the point of view, the place where he is positioning the observer : is he higher or lower, is he coming from the land, or a frozen lake, crossing by foot, on a skidoo or a dogsled. Is he alone or with a group? Why is he there? All this contextual data is essential if one wants the description to be understood ».

2.2 Measuring length

As soon as humans needed clothing and shelter, they needed to measure. The first measuring tools were parts of the body (the finger, the foot…). Inuit women, still today, use certain parts of their body to measure length (the palm when making “atigi” (parkas)). Measuring the base of your neck will help make a perfectly fitting parka. If they need to be more precise, for example when making “kamiik” (boots), they will use one phalanx as a smaller measuring unit.

A few elements of Inuit traditional mathematics have been presented here but we still have a lot to explore and understand. Parallel to discovering their mathematics, we have tried to understand the structure of their language : Inuktitut. Being of an oral tradition, the Inuit rely on their language – in fact, not only do they rely on it, they identify themselves with their language. During the presentation, some remarks about Inuktitut, its structure and also some words that are used to talk about certain mathematical concepts will be presented.

In closing, I would like to show some of the teaching activities that were developed in this collaborative project. These activities are quite unique since they take into account the Inuk culture and the mathematical concepts. For example, in grade 3 for introducing odd and even numbers, we used and adapted an Inuk legend, the legend of Kajutaijuq, The Evil Spirit :

Activity

- Read the following Inuit legend to the students. The legend has a riddle that you can use to develop the concept of even and odd numbers. As you read the story to the students, ask them the questions that you will find in the tables.

The Legend

Kajutaijuq, The Evil Spirit

Many, many years ago, a group of nomad campers (migration camp) had to leave some people behind with the promise that they would come to get them later on with dog teams. The people left behind got tired of waiting to be picked up. They were hungry and as there was no food around, they decided to walk to the new camp. When they saw the camping area, a young boy and girl quickly ran ahead to one of the empty snow houses in the hope of finding left over food. Instead of food, they came upon something quite stunning.

In the snow house was this amazing creature called Kajutaijuq. Kajutaijuq was a female spirit without a body. She had a humongous head resting on two short legs with three toes. She had the
reputation of causing thunder when she walked and of devouring Inuit who were not aware of her presence. When she saw the children, here is what she said:

“I should eat you both because you were not aware that I was here. But you seem way too young to die, so I will give you a chance. Find the answer to my riddle and you will not die. Now, listen carefully…: One part of my body is unhappy because it has an uneven number of elements. However, when I pair it up with another identical part of my body, together, these parts of my body have even elements. What part of my body am I thinking of?

Questions for the students:
What is an even number? An odd number?
Write down their answers on the board. If they seem puzzled, continue reading the legend.

The legend continues…

The children were very puzzled by this riddle. Besides, they did not know about even and odd numbers. Hopelessly, they looked at Kajutaijuq. She decided to give them a hint: “Many things about my body are even; that is, they come in twos. Can you name the elements of my body that come in twos?”

Questions for the students:
What elements in nature or in our everyday life always come in twos?
Write their answers on the board and then tell them the ones that the two children came up with to complete the list.
Here are likely answers that you might get from the students:
- two eyes
- two legs
- husband and wife
- a pair of mitts or gloves
- two bird wings
- two sets of legs on animals
- two feet
- two hands
- etc.

And the legend continues…

Kajutaijuq then gave the children two packages with bones telling them that one of the packages had an even number of bones. The children took the packages and tried to make pairs with the bones. One package had 7 bones and the other had 10. That is how the children found out the meaning of **odd** and **even** numbers. Then they were able to find the answer to the riddle and come out of their adventure alive.
Other examples will be shown during the presentation.

**BIBLIOGRAPHY**


