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This edition of the *Education Notes* features two pieces focusing respectively on opportunities for encouragement of Aboriginal youth and of female undergraduates. The first is an article that draws attention to a set of books and videos that encourage discussion of mathematical ideas. The work has been created and translated into two First Nation languages with the goal of encouraging Aboriginal youth to succeed in mathematics at the primary and secondary level. While the success rate for girls completing high school and undergraduate-level mathematics is better than that of Aboriginal students, women do not go on to research careers at the same rate that men do. The second piece announces a summer school initiative for undergraduate women to be held in August 2012 at the University of Waterloo, in an effort to encourage the participants to pursue graduate studies.

Small Number: Breaking the Pattern

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In Spring 2011, NSERC awarded a PromoScience grant to the project *Math Catcher: Mathematics Through Aboriginal Storytelling*, which was proposed by the first author of this note. The project is also sponsored by the Pacific Institute for Mathematical Sciences, the Faculty of Science, the Department of Mathematics and the IRMACS Centre from Simon Fraser University, and the Department of Mathematics from the University of British Columbia.

The project is an outcome of the BIRS supported First Nations Math Education Workshop which was held in Banff, Alberta, in November 2009[1]. As it is stated in the Workshop's Final Report [R]:

> [t]he workshop was based on the assumption that First Nations/Aboriginal student participation and success in school math programs is limited. (...) Presently only 2% of BC's Aboriginal population completes Principles of Mathematics 12 compared to a completion rate of 25% for the whole BC population. This discrepancy in completion rate is one of the issues this group wanted to address given that successful completion of Principles of Mathematics 12 is a compulsory entrance prerequisite for many post secondary programs in British Columbia, and the statistics are similar in the other provinces.

The project was particularly inspired by the following two conclusions identified by Workshop participants as strategies for overcoming challenges in teaching mathematics to Aboriginal youth [R]:

- Teach math in the cultural context of the students,
- Teach basic skills and problem-solving early.

During the workshop, the authors of this note co-wrote a story, *Small Number Counts to 100*, which served as the cornerstone of the grant proposal.

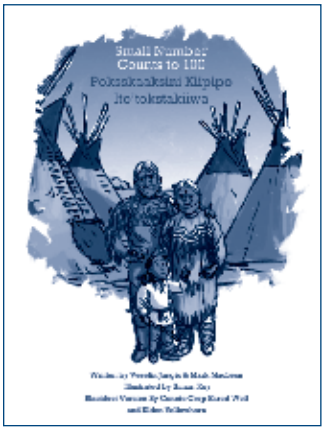

Figure 1 The cover page of the bilingual Blackfoot—English picture book

The *Math Catcher: Mathematics Through Aboriginal Storytelling* project includes the creation of a series of short animated films that accompany picture books, as well as the development of related activities that introduce math topics and techniques through stories that follow Aboriginal storytelling formats and contain elements of Aboriginal traditions and cultures. The animations and books have English, French, and Aboriginal languages versions. The primary objective of the program is to promote mathematics among elementary and high school students, as well as members of the Aboriginal communities, both in urban settings and on reserves. This is to be done in a way that Aboriginal children see themselves and their culture connected with mathematics. There are two further and, in our view, equally important objectives. First, short films in Aboriginal languages play a double role by promoting both mathematics and the languages. Second, through the movies, the picture books, and the activities that are built around these resources, we use mathematics as a vehicle to promote Aboriginal traditions and cultures among non-Aboriginal young people.

The main purpose of the short films, which are 3-4 minutes in length, is to relate stories about the adventures of animated characters. The scenarios take place in Aboriginal cultural and physical environments. The resolution of a particular plot always requires some mathematical knowledge. Plots in our stories are a mixture of adventures and math puzzles with the aim of catching

[1] The next First Nations Math Education Workshop is scheduled for November 18-23, 2012.
For details see www.birs.ca/events/2012/5-day-workshops/12w5076.

a viewer's attention and interest (thus the title of our project). Each story closes with an open-ended question that should spark discussions and lead to further activities. The question at the end of each story is purposefully not answered in the story.

As much as possible, hands-on activities are used to introduce fundamental mathematical ideas and techniques. Participants are asked to measure, construct, draw, colour, calculate, recognize, describe, tell or make up a story, and so on. Another level of interaction is between our volunteer presenters and participants. The authors of this note firmly believe that a positive role model, i.e., somebody who demonstrates their confidence, knowledge, love and passion for mathematics in a friendly environment, can play a crucial role influencing a young person's life-long attitude towards mathematics. For example, by bringing bright and enthusiastic math students and faculty to a school, onto a reserve, or into an Aboriginal urban community center, and by giving them a chance to talk to and work with young program participants in a friendly and familiar physical and cultural space, we help the participants recognize and understand that mathematics is something interesting and within their reach.

The main character in our animations thus far is a boy called *Small Number*. He is a bright, playful kid, with the ability to recognize patterns and calculate quickly. The name of our hero was inspired by two theorems and the experiences that the first author had as a math instructor in the Aboriginal University Prep Program and the Aboriginal Pre-Health Program at SFU, and as a volunteer math tutor at the Vancouver Aboriginal Friendship Centre. As a volunteer, he had a chance to work with a group of very young Aboriginal students all between the first and seventh grades of elementary school. Most of them were just that, very young urban kids more interested in playing computer games than in doing mathematics, but some of them[2] expressed real enjoyment in solving math puzzles, playing math games, finding various patterns and completing pages and pages in their math workbooks.

Working with adult students in the two SFU Aboriginal programs, the first author often found himself puzzled at the gap between students' talent for mathematics and their[3] level of formal math education.

The result of these experiences—an impression that early math potential is not matched with the right outcome—might be described by the Law of Small Numbers as it was stated in [GRS]: *Patterns discovered for small k disappear for k sufficiently large to make calculations difficult*.[4] The authors are aware (and afraid) that the present situation in Aboriginal math education combined with other factors, would probably be better described by the Strong Law of Small Numbers [G], *There aren't enough small numbers to meet the many demands made of them*.[5]

Other characters introduced so far[6] are Big Circle, Small Number's best friend, Perfect Number, Small Number's sister, and Small Number's mother and grandparents. An important part of our stories is love. His grandparents, his mother, his sister, and his friend all love Small Number, and he loves them back.

To underline the universality of mathematics, Small Number and the plots of our stories are not attached to a particular time and space. In the first story Small Number lives in a tipi settlement somewhere in the plains. In the second story he lives by a body of water, a river or a sea, and the third story is set in an urban environment.

Our intention is to create stories in such a way that they allow for interpretations at multiple levels of mathematical knowledge. For example, our first story, *Small Number Counts to 100* [SN1B], [SN1C], [SN1E], can be shown to elementary school students as a counting practice/puzzle or as a pattern recognition problem. For high school students it could be a way to introduce arithmetic progressions, modular addition, or an idea of number systems with a base different than 10.

In *Small Number and the Old Canoe* [SN2E] mathematics is present throughout the story with the hope that this experience will make at least some members of our young audience, with the moderator's help, recognize more mathematics around them in their everyday lives. We use terms like *smooth, shape, oval*, and *surface,*

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[2] A little girl who with children's kindness and a mature graciousness was letting her opponent, a man with a white beard, win the game they were playing; a pair of brothers finding patterns in the game of *Set* with lightening speed; or a tall quiet boy who was solving problems from math competitions above his grade level, are just a few examples.

[3] A recent high school graduate who demonstrated in class an absolute understanding and knowledge of Math 11 just shrugged her shoulders when asked why she didn't take Math 12; a women in her mid-thirties, back in a math class after working in construction for good part of her life showed such talent for mathematics that, even a few years later, her instructor cannot stop thinking where she would be if she started studying mathematics in her teenage years; or a man in his early forties with one of the finest analytical minds that his instructor, a working mathematician for the last 33 years, has ever witnessed, are some examples.

[4] We read "small" as "young".

[5] Richard Guy, who stated the Strong Law of Small Numbers, was one of the participants of First Nations Math Education Workshop in 2009.

[6] Three stories have been created at the time of writing this note.

the mathematical phraseology like, *It must be at least a hundred years old*, our artist[7] skillfully presents reflection (symmetry) of trees in water, and so on. The idea behind this approach is to give the moderator a few openings to introduce or emphasize various mathematical objects, concepts, and terminology. The short film is a little math suspense story and our question is related only to the last part of it. The aim of the question is to lead to an introduction at an intuitive level of the concept of a function and the essence of the principle of inclusion-exclusion as a counting technique. We would also like to give our audience an opportunity to appreciate that in order to understand a math question, one often needs to read (or in this case, watch) a problem more than once.

The mathematical context of the third story, *Small Number and the Basketball Tournament*, contains some basic principles of combinatorics. The plot of the story and the closing question are structured in a manner that allows the moderator to introduce the notion of permutations and combinations. Since the numbers used in the story are relatively small, this can be used to encourage the young audience to explore on their own. Mathematics is also present in the background. Small Number and his friends *do mathematics* after school in the *Aboriginal Friendship Centre*. He loves playing the game of *Set* and when he comes home his sister is *just finishing her math homework*. Small Number and his friend would like to participate in a *big half-court tournament*, and so on.

Even though our project is still at its beginning, it has already significantly contributed to our lives and to the lives of others[8]. We had the privilege to meet and discuss our project with a number of representatives from various Aboriginal communities in British Columbia and Alberta. Our visits to a number of communities went very well. In addition, the response to our search for volunteers has exceeded our expectations and we believe that in our group of volunteers we will have a few Aboriginals. Most importantly, we have learned so much about Aboriginal cultures and we are even more aware about the importance of encouraging young members of the Aboriginal population in Canada to study mathematics.

Next we list some of the challenges that we have been facing:

Mathematics

What are the appropriate mathematical topics that should be presented to student participants in the project? How can we use the full potential of the medium (story, images, sound) to transmit the intended math information? Should we make any assumptions about participants' previous math knowledge in our sessions? What additional material should accompany our stories so that they can be used as resources in classrooms?

Language

Finding people willing to read stories in their native languages has proved difficult. In addition, we have been gently warned that different communities inside the same nation could be very sensitive regarding the specifics of their own dialects. We were asked to make choices that we were not qualified to make, like choosing between writing the Cree translation of the first story in orthography or syllabics [SN1C]. We have learned how precious native languages are for Aboriginal people and what a crucial role elders play in preserving languages and passing them on to new generations.

Culture

The co-authors[9] of the *Small Number* stories are two mathematicians who are interested in promoting mathematics and who have enormous respect for Aboriginal culture traditions. As mathematicians, we have tried to be extremely careful with everything related to Aboriginal cultures. In their essence, our stories are inspired by what we have read in relevant literature, by what we heard from our Aboriginal friends, and by what we experienced working with the Aboriginal students. We share our stories and images during their inception with our Aboriginal colleagues to receive their opinions and suggestions. Perhaps the biggest compliment that we have received so far was the comment that our stories are *culturally sensitive*[10]. Still, the cultural component is the most delicate part of our project. Our approach has been to avoid specifics as much as possible, but still we have not been able to avoid controversy. We have learned that the Aboriginal community is not unanimous on some issues. For example, we witnessed[11] an exchange of completely opposite views between two members of the same First Nation about images in the animated short *Small*

[7] Mr. Simon Roy from Victoria, British Columbia.

[8] For example, the first author invited one of his former Aboriginal students to work on a segment of the project. The young lady, a second generation urban Aboriginal, while searching for a translator for our second story, discovered and got in touch with relatives that she did not know about.

[9] That is, the authors of this note.

[10] In a letter from the First Nation Adult and Higher Education Consortium, Calgary, AB.

[11] On June 7, 2011, in one of many Starbucks outlets in the Greater Vancouver Area.

Number Counts to 100. For one of our friends, the images were inappropriate because they *supported a colonial view of Aboriginal history*. The other friend said that he *liked them* because they represented exactly what, he said, *we are*. Sometimes our ignorance causes the controversy. For example, we have been reminded that totem poles that appear in our second animation are not universal on the coast of BC. In many cases, like the Musqueam, lodge poles were carved only for longhouses.

Reaching to Schools and Communities
We have established contacts with several school districts in the Lower Mainland as well as with a number of schools on reserves. There is no doubt that there is good will to support the program on all sides. It seems that expectations vary from institutions to institution. For example, one school district is expecting us to meet with a group of teachers and to help them to develop lesson plans around our stories. Another sees our visits as an opportunity to have a joint event for Aboriginal and non-Aboriginal students. We will need time to adjust the program so that we can meet this spectrum of expectations.

Evaluation of the Project
We divide our goals in two parts. One aim is to generally popularize mathematics and to increase students' awareness about the presence and importance of mathematics in their lives. The other is to encourage one bright student in our audience to decide to follow her or his talent and go with mathematics all the way... Is this too much to ask for? Or too little? And how will we know if we meet our hopes and make any changes? Maybe a hint of the answer to our dilemmas is in this philosophical and infinitesimal calculus spirited saying by Crowfoot[12], a chief of the Siksika First Nation,

> What is life? It is a flash of a firefly in the night. It is a breath of a buffalo in the winter time. It is as the little shadow that runs across the grass and loses itself in the sunset.

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Bibliography:
[G] Richard Guy, "The Strong Law of Small Numbers". American Mathematical Monthly 95 (8), 697–712, 1988.

[GRS] Graham R., Rothschild B., Spencer J., "Ramsey Theory", John Wiley and Sons, New York, 1990

[R] www.birs.ca/workshops/2009/09w5078/report09w5078.pdf

[SN1B] www.youtube.com/watch?v=lEmNuqAH5wU&feature=relmfu

[SN1C] http://vimeo.com/27301049

[SN1E] www.youtube.com/watch?v=gi0-2-vfh58

[SN2E] http://vimeo.com/28020225

Two weeks at WATERLOO - A Summer School for Women in Math

August 12-25, 2012

Kathryn Hare, University of Waterloo

This summer school is an opportunity for up to sixteen outstanding female undergraduate students, from across Canada, to gather together to study topics in mathematics in an intense two-week immersion. The aim is to encourage and inspire these gifted women to continue on to graduate work in mathematics. The program will provide both enrichment of the undergraduate curriculum and a research component, in a collaborative environment.

The students will participate in two mini courses, taught by Prof. Matilde Lalin (University of Montreal) and Prof. Gail Wolkowicz (McMaster University). Four female guest speakers will talk about their work in mathematically-related fields and visits will be made to businesses and institutions which employ mathematicians.

The women will be housed at the University of Waterloo. The students' accommodation, meals and travel costs within Canada will be covered, subject to availability of funds.

The summer school is open to female undergraduate students studying mathematics or a related discipline at a Canadian university, with at least one year of studies remaining in their program. Canadians and permanent residents of Canada studying outside Canada are also eligible to apply.

Applications for this very selective program are due January 31, 2012. For more information and an on-line application form, please go to the website http://women.math.uwaterloo.ca/Summer_School.shtml .

For further information please contact the organizers at wimsummer@math.uwaterloo.ca .

[12] c. 1821-1830 – April 25, 1890.