

Addressing Mathematical Inequity in Indigenous Education:

Efforts by Mathematicians and Educators in Western Canada

Melania Alvarez



Government practices of discrimination and assimilation towards the Indigenous population in Canada have had lasting effects. In particular, the implementation of residential schools created by the federal government and mainly operated by Christian churches with the goal of educating and assimilating Indigenous children into Canadian society shaped people's whole life experience, including their

Melania Alvarez is the BC education coordinator at the Pacific Institute for the Mathematical Sciences and outreach coordinator for the Department of Mathematics at the University of British Columbia in Vancouver. Her email address is melania@pims.math.ca.

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DOI: <https://dx.doi.org/10.1090/noti1851>

employment opportunities and their interactions with governmental agencies. At the residential schools students experienced isolation by being separated from their parents and siblings (boys were usually separated from girls), and they were forbidden to speak their language. Upon arrival, children were stripped of their traditional clothes, given uniforms and Christian names. Boys hair was cut. At some schools students were forced to work, and many suffered from starvation due to the lack of funds to feed them. There were many cases where students were psychologically, physically, and sexually abused, and more than 6,000 students (incomplete records) died; their parents were never given an explanation as to how or why, or told where their children were buried. The residential schools ran for over 100 years and the last one closed in 1996 [4, 5].

The impact of the residential schools extended beyond the individuals who attended these schools; it also affected their families, communities, and culture. In general, members of Indigenous communities may feel that their lives are a constant battle against a system that does not work for them. There exists a justifiable distrust towards government agencies and towards the kind of education their children currently receive at schools. They feel that they are receiving an unequal educational experience, given that teachers usually have low expectations for them, which is translated in their practice [11]. There is also a lack of cultural support in that most children do not see themselves and their culture reflected in the curriculum. For example, in the province of British Columbia, Indigenous content only appears briefly in the history curriculum at the end of grade 10. There exists

a well-documented educational achievement gap between Indigenous and non-Indigenous Canadians [9].

The self-identified Indigenous population grew from 1.17 million in 2006 to 1.67 million in 2016, which represents an increase of 42.5% and a rate of growth four times faster than the rest of the Canadian population (Stat Canada). Within a few years, provinces such as Saskatchewan and Manitoba are expected to have more than 20% of their population self-identify as Indigenous.² Given the rapid growth of the Indigenous population, it is increasingly apparent that Canada must urgently address the great disparity in educational achievement; otherwise, the repercussions will be disastrous as Indigenous youth will not have equitable access to jobs and economic prosperity.

In order to positively narrow the educational gap between the Indigenous communities and the rest of the population, there needs to be a continuous and long-term intervention for change. In the case of schooling, we should be working with the Indigenous communities to look at a long-term continuum of choices and to present opportunities and positive interventions that provide students with a more affirmative outlook for life. What is required is a long-term commitment on behalf of the educational system to provide marginalized students with very much needed comprehensive support [3, 7].

Mathematics seems to be an excellent way to start this change as research has shown that taking advanced and rigorous math courses positively affects several other educational outcomes, including standardized test scores, high school completion, college performance, and post-secondary degree completion, as well as having an impact on earnings in adulthood [1, 8].

The Pacific Institute for the Mathematical Sciences (PIMS) is a research institute closely associated with mathematical science departments at universities and colleges across Western Canada. PIMS has recognized the challenges many students face if they lack the necessary prerequisites in math and science to pursue post-secondary studies (especially in STEM fields), specifically when it comes to Indigenous students and other students at risk. By leaving behind the philosophy of reduced expectations, mathematical scientists and educators associated with PIMS have introduced a variety of interesting and challenging programs

² First Nations, Inuit, and Métis are the groups that constitute the Indigenous people in Canada. First Nations are diverse bands of Indigenous peoples in Canada who are neither Inuit nor Métis. The Métis are people who descended from marriages between Europeans (mainly French) and First Nations/Inuit people going all the way back to the 17th century. According to anthropologists, the Inuit are the descendants of Thule culture, which originated in Alaska around 1,000 CE and later on spread towards the east through the Arctic. The 2016 census counted a total of 1,673,785 Indigenous people in Canada, about 4.9% of the national population, consisting of 977,230 First Nations people, 587,545 Métis, and 65,025 Inuit. There are more than 600 recognized First Nations governments or bands with distinctive cultures, languages, art, and music.

and exciting ways to learn mathematics seeking to address these issues. Our goal is to be able to provide Indigenous students with the tools they need to make career decisions of their choice, including a career in science.

The hypothesis that guides these outreach programs is that if we are able to teach students and provide them with a stronger academic background, they will feel more confident in school, and this confidence will empower them to feel better about themselves. However, real empowerment comes from within, and this change from within does not happen in one day; it is a long process where the educator can only provide the learner with opportunities. Until the students take them as their own, change will not happen [6].

Our first step has been to build partnerships with schools run by Indigenous communities, as well as with urban public schools with a high concentration of at-risk students. With their input and support, the PIMS outreach team has implemented a variety of programs, some of which are described in detail below. These activities have been funded by private donors, universities in the PIMS consortium; the Actuarial Foundation of Canada, the Vancouver Foundation, the government of Canada, and the governments of Alberta, British Columbia, and Saskatchewan.



High School Summer Camps: Having fun.

High school summer camps for Indigenous students in Vancouver: These camps run for five weeks and are designed for students in grades 9 to 12. Each year thirty or so students are selected to participate in these summer programs. Students take ninety minutes of both math and English every day from a master teacher. They also participate in an internship program where they will work for a professor at the university for three afternoons a week. They participate in a variety of academic activities throughout the internship and are also given the option to complete an independent study elective. Students also engage in a special topics series that include cultural activities and college access and success discussions. The math

program addresses the particular mathematical needs of each student with the goal of enhancing their learning for the upcoming school year. The English program is designed to strengthen skills that they will use across all coursework. Students who choose to complete the independent study project earn elective credit that can be used to meet high school graduation requirements. The internship provides an opportunity for students to explore academic areas of interest and possible career options while learning transferrable employment skills. Students come to the university campus to attend this camp, with the primary rationale being to expose them to a post-secondary environment.

The main objectives are to provide students with strong academic support skills in mathematics and writing, to explore the STEM fields through the internship and academic activities, to remove access barriers to a post-secondary education, and to develop relationships between participants and university faculty and student mentors. We also aim to create a sense of pride in the Indigenous culture by offering a variety of activities and lectures led by members of Indigenous communities. The original camp started in 2007, and it has been a source of inspiration for camps not only in Canada but also in the United States. The camp ran first at University of British Columbia (UBC) under my supervision, then at Simon Fraser University (GSU) under the supervision of Veselin Jungic, and it will be running next year at Langara College in partnership with UBC under the supervision of Richard Ouellet and myself. Our goal is to create paths for outreach where we connect universities to local schools and colleges and also bring in local industry to expose Indigenous high school students to careers, professions, and technical trade opportunities and help them find out how mathematics can open up opportunities in traditional and nontraditional careers.

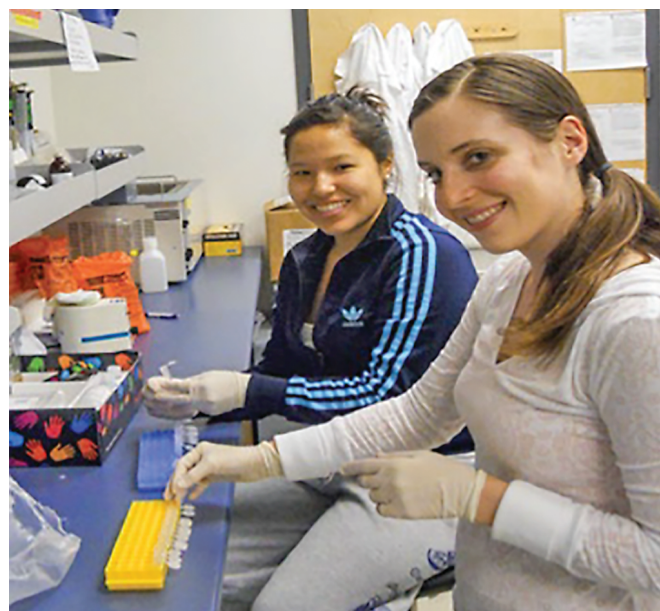
Alex³ attended this high school summer camp and, as an intern, he was able to do original research with professors in the chemistry department. This is what he thought of the camp:

I think it's the best summer school you can ever go to, and I highly recommend it for other students... My teacher is pretty cool, is kind of fun, a little challenging because I have to do a lot of things I haven't done before in the lab. I work with a couple of professors. The staff is kind, friendly, and helpful. They are hardworking people who I really respect and who are willing to take the time... Urban Aboriginal kids need an education for a really great future.

Alex is currently an undergraduate student at the UBC. He wants to become a teacher.

PIMS has also run **Transitional Summer Camps** (with a similar structure) for Indigenous children transitioning

³ Students' names have been changed to protect their privacy.



Internship Jobs: Chemistry lab.

from elementary school to high school.⁴ The transition from elementary to high school is a difficult one for many children, but for Indigenous students it seems to be particularly harsh. As a group, far too many Indigenous students are put into courses with low academic expectations, and as a result they often conclude that their coursework will not lead to a career path where academic knowledge is required. By grade 10 most students have stopped attending school on a regular basis. The goal of these camps is to provide a strong academic background as well as a sense of pride in the Indigenous cultures. Students who started high school with strong skills in mathematics and English showed a difference in their confidence, not only in their math classes, but also in other core science subjects. These summer camps take place at the high school most of the participants will be attending, allowing them to feel more comfortable as they start this new stage of their education.

Maria attended the first Transitional Summer Camp in 2008. She did well during the camp, though she was not at the top of the class. During her first year in high school, was unreliable with her attendance and she constantly tested the commitment of our support, but she always mentioned to us that what she had learned at the transitional camp helped her to feel that she had a chance. As time went by she realized the importance of consistent work and being able to ask for help when she needed it and how our program could help her maintain that consistency and provide the support she needed. She finished grade 10 with a good mark in math.

Later on, she attended the high school summer camp where she told us,

⁴ In Canada, elementary school covers grades 1–7 and high school grades 8–12.



Transitional Summer Camp.

I get to experience studying the rat brain and fetal alcohol syndrome... I'm getting ahead for my next year math and English and I get to study stuff that I wouldn't even learn in high school. It will be good for my future, especially because I want to be a nurse. I think this will give me a head start on everything.

Our goal for her was to finish high school with precalculus 12, and she surprised us when in her last year she took not only precalculus but also calculus. She has blossomed into a wonderful, feisty woman, full of confidence. She told us that being able to do well in math, by working very hard and with our support and confidence in her skills, made her realize that she has talents. She was one of the two students in the cohort who attended the first Transitional Summer Camp who were accepted at a top Canadian university but she chose to enroll at a college with a more personalized program.

Peer-mentorship program: PIMS recruits high-performing Indigenous students at a high school to become peer-mentors to four or five of their classmates. We provide the mentors with a stipend and academic support. This program was implemented at several schools in British Columbia with great success. Here is the testimonial from one of the teachers,

Wow, the second year of the Peer-Mentorship Program has come and gone in a flash. The organizational piece came together flawlessly and you could see that the three Aboriginal high school students truly enjoyed the opportunity they were given. This year we had two grade 12 students (one female, one male) and one grade 11 student (female). This opportunity gave them a chance to push their personal boundaries (show assertiveness, kindness, and other leadership skills) but also gave them a chance to demonstrate their math skills to younger Aboriginal and non-Aboriginal youth. These students are proud of their Aboriginal ancestry,

and this was revealed to the youth they worked with. From this opportunity one of our Math Mentors was requested to be a guest speaker for the All Nations Room at the school he mentored at. He often spoke proudly of his Metis ancestry and talked about his ability to speak the Michif language. The classroom teacher was thrilled about his ability to connect with the students on a personal level while supporting them with their studies.



End of Camps Celebration.

First Nations Math Education Workshops held at the Banff International Research Station (BIRS) have brought together a group of Elders, mathematicians, and math educators and teachers, with the goal of improving mathematics education among Aboriginals while at the same time acknowledging the importance of traditional culture. Members of this group worked together in creating resources to honour the spirit of each student as an individual and as part of a community. This way of thinking is an integral part of many aboriginal cultures as well as a successful way of learning mathematics in any culture. The reality is that most of the "Aboriginal resources in mathematics" are very simplistic and do not honour the similarities, differences, depth, and richness of First Nations cultures. One of the ideas developed by members from this group (Veselin Jungic from SFU, and Mark Maclean from UBC, together with the elder Rena Sinclair of the Siksika Nation), was the story and the movie of "Small Number counts to 100," with more stories that followed (www.math.sfu.ca/~vjungic/smaller.mov). This project has grown quite considerably thanks to the tireless and talented efforts of Jungic and MacLean, who have developed a slew of mathematics materials in Indigenous contexts.

So far, we have held five of these meetings, and, in doing so, BIRS and PIMS have shown their leadership in bringing various people, resources, and institutions together in working towards the improvement of Indigenous mathematics education.



First Nations Math Education, November 2009, at the Banff International Research Station (BIRS)

Other activities organized by PIMS that have an impact on the Indigenous population include the following:

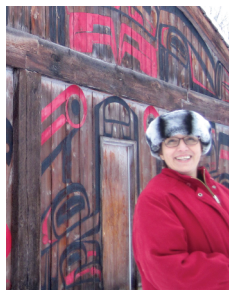
- A comprehensive teacher professional development upgrade program. This targeted initiative helps upgrade our teachers' mathematical knowledge and pedagogical skills as well as support their ability to help students see the relevance and connections of mathematics and science with a variety of career opportunities.
- Mentoring programs where we team undergraduate students from local universities/colleges with local teachers to support their students.
- PIMS has been providing assistance in choosing and implementing mathematics curricula at First Nations Schools.
- Math Mania and Parents Night. We bring a variety of hands-on math outreach activities such as puzzles and games at local schools and community centres with the participation of students, teachers, and parents.
- Working with Elders in order to emphasize the importance of storytelling as a traditional way of teaching, and to use it to teach mathematics and other subjects.
- Funding and facilitating the organization of a variety of month-long summer camps at First Nations schools. These camps can be full-day camps or half-day camps where math instruction is provided every day as well as instruction in other subjects. There is some flexibility in how these camps run given that we take into account specific community needs and resources.

Conclusions

The problem of providing equitable opportunities for Indigenous students is a daunting one and will require the ongoing, active involvement of mathematical scientists and educators. In this article we have summarized a variety of activities and programs organized by the PIMS community that have had an impact on the mathematical opportunities for students and teachers. These should be considered pilot programs that have the potential for broad implementation given the required funding and support. We are happy to share the outcomes of our efforts and experiences, and we invite you to contact us.

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Melania Alvarez

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