

Transforming School Science and Math Education for the 21st Century

Meadow Lake Tribal Council's
2019 FULL CIRCLE CONFERENCE
Saskatoon, March 14, 2019



Glen Aikenhead, Treaty 6
Aboriginal Education Research Centre
University of Saskatchewan

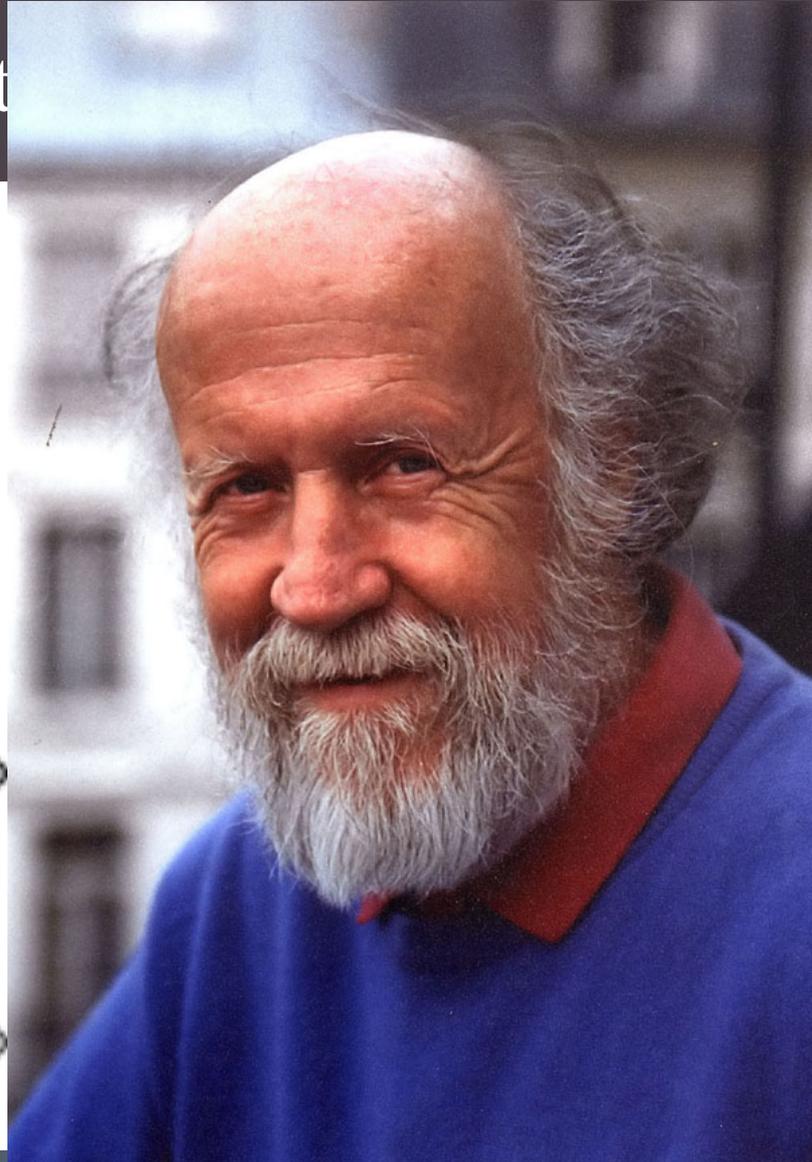


I acknowledge the land on which
we are now meeting as ancestral
land of the Nehiyaw, Dakota,
and Nakawē Indigenous peoples

Canadian astrophysicist Dr. Hubert Reeves

heart

entist



$$\frac{\partial \mathbf{E}}{\partial t}$$

Conventional School Science/Math

Most students' worldviews differ from the worldviews conveyed by school science/math

Thus, there is *a degree of* **culture clash** between:

- those students' cultural self-identities
(who they are, where they have been, where they are going, and who they want to become)

and

- students' views of school science/math, or their views of a person who thinks, talks, and believes like a scientist or mathematician

Conventional School Science/Math

As a result: Students become marginalized, and as adults, do not participate in the many STEM-related occupations that offer economic wellbeing



An alternative: Indigenous students should not have to set aside or devalue their cultural knowledge in order to achieve in school science/math

culture-based science/math



Today's Topics

1. What do we need to know about science?
and about math?
to transform these school subjects into a
21st century curriculum?
2. School science – what's crucial to know?
3. School math – what's crucial to know?
4. Developing a 21st century math curriculum
from a First Nations perspective

Reconciliation – central to 21st century education



The TRC defined it as
“an ongoing process of
establishing and
maintaining respectful
relationships”

It’s not a destination. It’s how we do whatever we
do, including our teaching
– always with respectful relationships between
Indigenous and non-Indigenous people

Topic 1/4

What do we need to know about
science and math?

In reality
they are both human endeavours

Science:

**a rational, empirically based way
of describing or explaining nature**

(an international definition of “science”)

Every major world culture has
established a science

- *Eurocentric (Western) sciences (ES)*
- *Indigenous ways of knowing nature (IK)*
- *Islamic science*
- *Japanese ways of knowing seigyo-shizen*



Ogawa, 1995

Eurocentric Sciences:

Eurocentric knowledge systems,
historically developed through
500 years of discovery,
invention, and appropriation



Scientific content is produced
by scientists within Euro-
American cultural paradigms

Eurocentric sciences (ES)

Definition? **What scientists do**

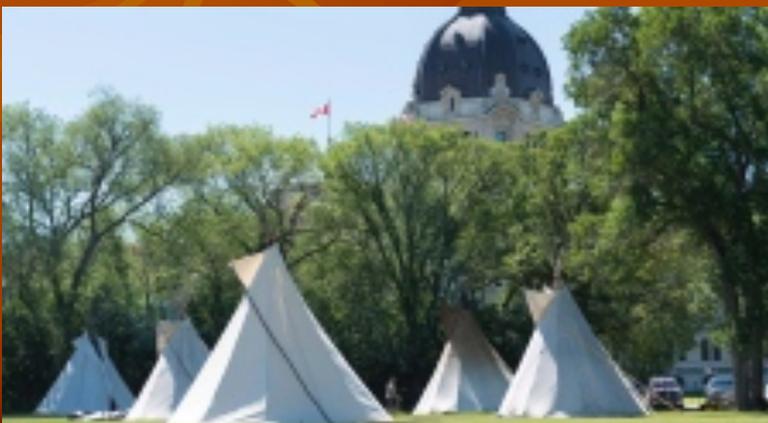
Indigenous Ways of Knowing Nature:

Knowledge systems about the world, held by descendants of the original inhabitants of a place who have suffered colonization

First Nations

Métis Nation

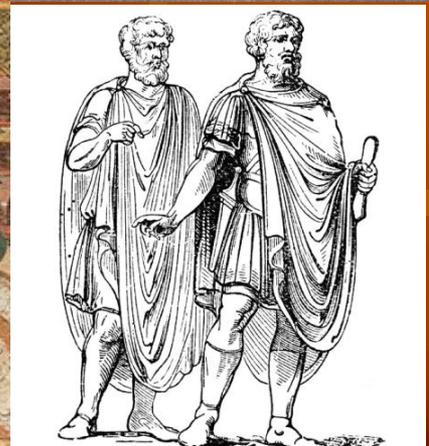
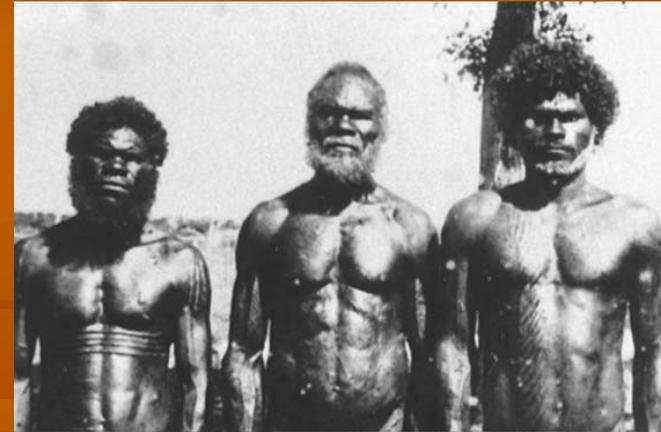
Inuit Nation



Mathematics:

Many major world cultures have established math systems:

- Indigenous Australians
- Mesopotamians
- Ancient Greeks
- Islamic Empire
- Europeans



Mathematizing (according to culture anthropologists)

All these math systems are ways of:

- counting
- measuring
- locating
- designing
- playing
- explaining

0	1	2	3	4
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$$m_2 \frac{d^2 x_2}{dt^2} - \lambda_2 \frac{dx_1}{dt} + (\lambda_2 + \lambda_3) \frac{dx_2}{dt} - k_2 x_1 + (k_2 + k_3) x_2 = 0$$

Mathematizing:

Turtle Island Indigenous people certainly counted, measured, located, designed, played, and explained

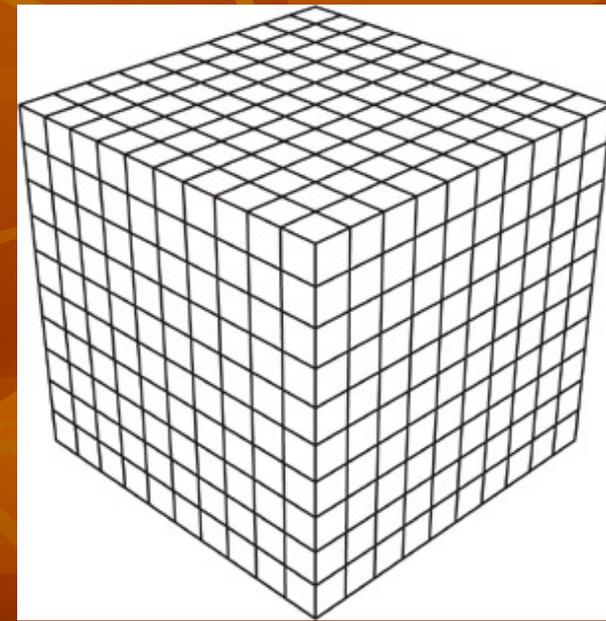
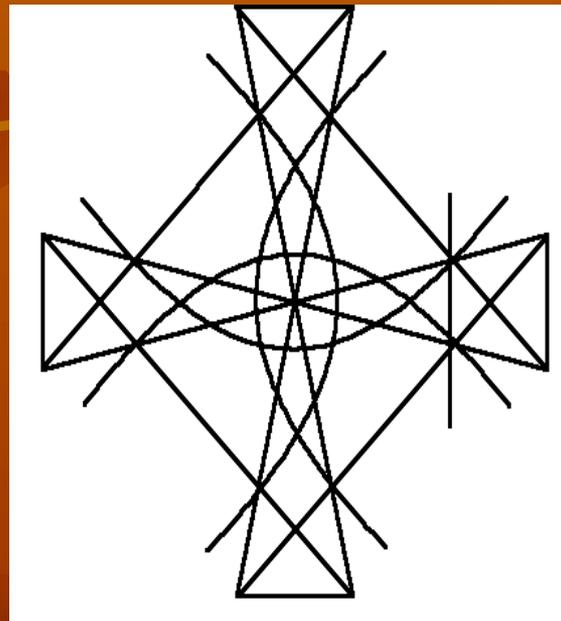
Therefore they mathematized

with their Indigenous math systems



Mathematizing: How do you invent a math system?

- Humans superimpose an image, which originates in their mind, onto their environment
- Thus, school math teaches a *Eurocentric* (Western) math system



Topic 2/4

School science?

What's crucial to know?

Two Saskatchewan stories

Implementing a Culture-Based Science Curriculum

Rekindling Traditions: Cross-Cultural Science & Technology Units 2000

community



based

<https://education.usask.ca/documents/profiles/aikenhead/index.htm>

Community-Based School Science

Students constantly treat IK & ES as co-existing knowledge systems, each with strengths and limitations – reconciliation enters into *how* students learn:



Implementing a Culture-Based School Science Curriculum

Province of Saskatchewan
Ministry of Education

- In 2008, Indigenous knowledge became foundational to our curriculum. Grades 1-10 have now been implemented
- Indigenous Elders were heavily involved in various ways

Ministry of Education

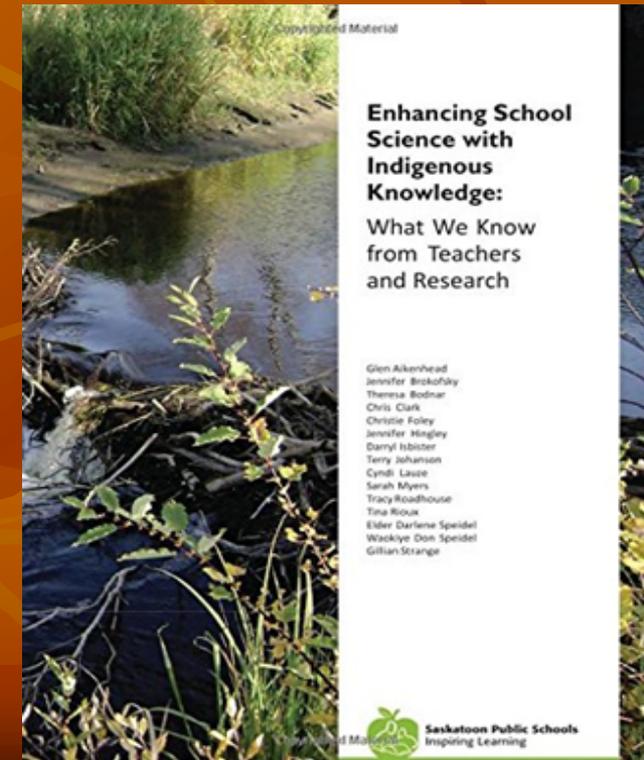
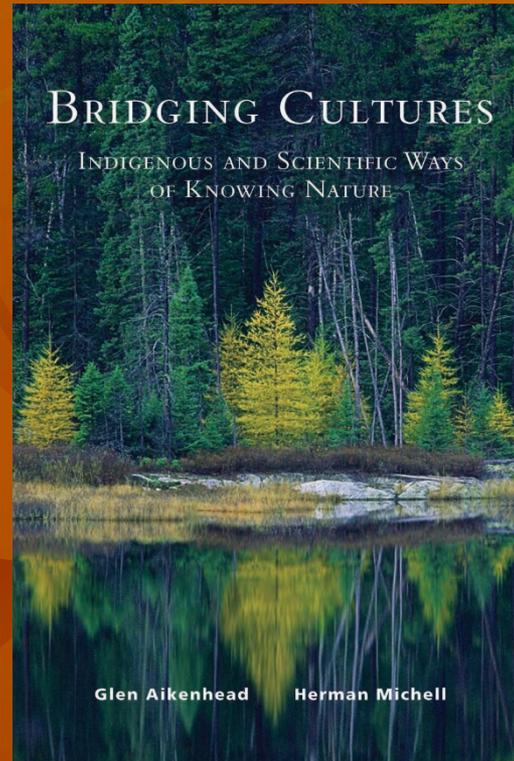
- Textbooks were developed. Elders decided what Indigenous knowledge would be integrated into each science unit, and how it would be worded



- A process of *collaborating*, not consulting, led to culture-based school science

Culture-Based School Science

- Teacher background academic reader
- Teacher professional development guide



Culture-Based School Science/Math

Indigenous students have equitable *access* to master and critique STEM ways of knowing, *if they want to*, without sacrificing their cultural way of knowing

Students learn to “*walk in both worlds*”

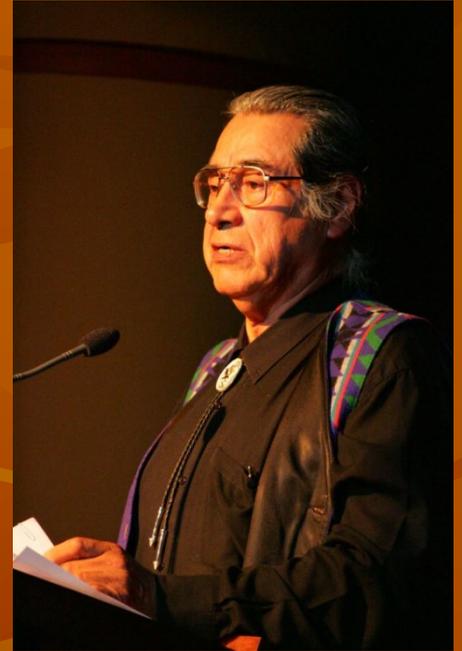


Culture-Based School Science/Math

All students learn the best from
ES and IK— resulting in

“two-eyed seeing”

Elder Albert Marshall
Mi'kmaw First Nation



Research shows it is beneficial for both
Indigenous and non-Indigenous students

Topic 3/4

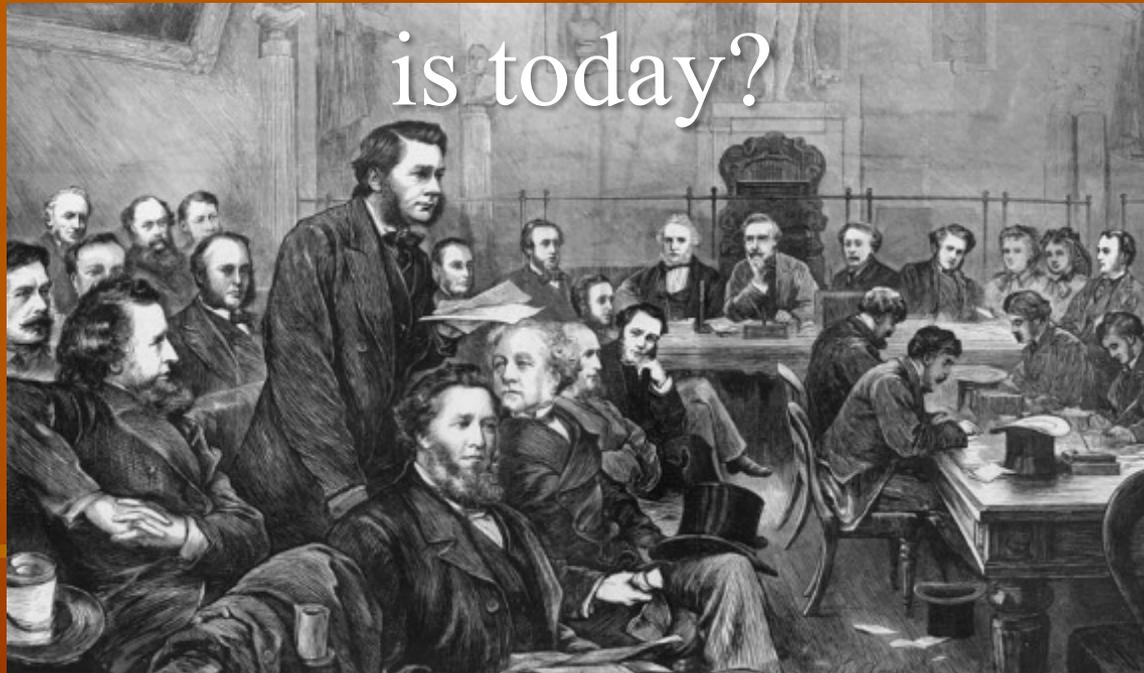
School math

What's crucial to know?

The story of suppression

Conventional School Math

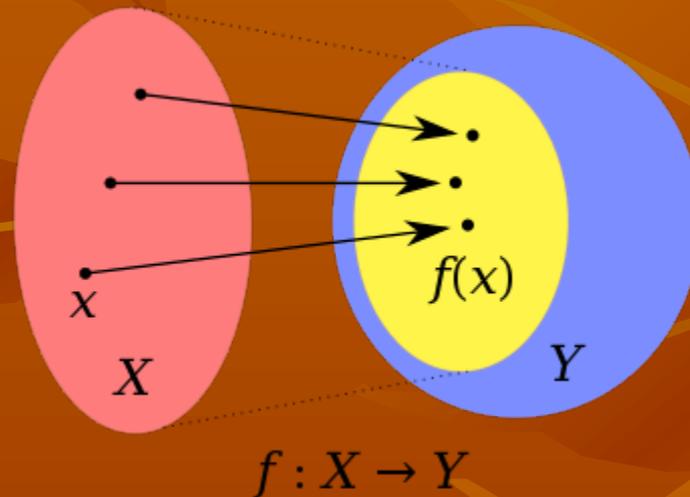
What decision made school math what it is today?



In the 1800s, elitist math educators wanted the ancient Greek worldview of Plato to define the school subject of math. They won the debate

Conventional School Math

School math became extremely abstract,
rather than concrete for a contextualized
everyday world



Its human dimensions were suppressed!

Conventional School Math

What can we do to transform the old school math into a 21st century school math (Gr. 6 to 12)?

Revisit the 1800's debate and investigate what's needed and what's obsolete, for a *diversity* of students

This is beginning to happen:
placed-based, land-based school math



“Develop culturally appropriate curricula”

What might a 21st century culture-based math curriculum could look like in Saskatchewan?

Topic 4/4

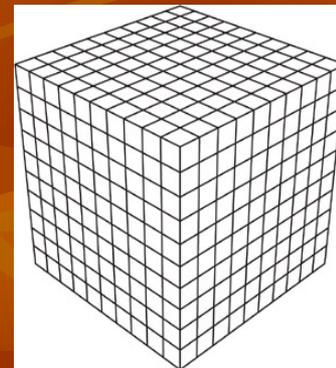
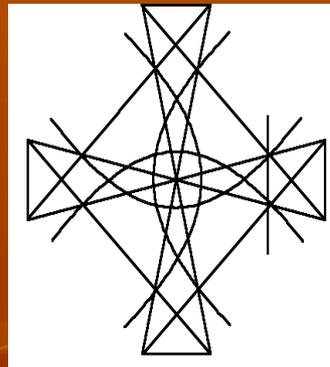
Developing a 21st century math curriculum

Provincial Schools: **Culture-based school math**
(Euro-Canadian & Indigenous)

Reserve Schools: **What would a decolonized
school math look like from a
First Nations perspective?**

School Mathematics for Reconciliation: From a 19th to a 21st Century Curriculum

2017



Culture-Based School Math

Traditional and contemporary
Indigenous mathematizing
learned by teachers is *taught
to students*

(analogous to Western math)

Translated into Western math
content, in non-appropriating
and non-tokenistic ways, to be
learned by students



Culture-Based School Math

To emphasize:

Students learn Indigenous mathematizing in the context of place-based learning, and then they learn analogous Western math

Culture-Based School Math



Non-Indigenous students & teachers begin
to *understand both worlds*

A path of reconciliation



Thank you