

INTEGRATIVE SCIENCE

bringing together Indigenous and Western scientific knowledges and ways of knowing

University of Toronto Mississauga

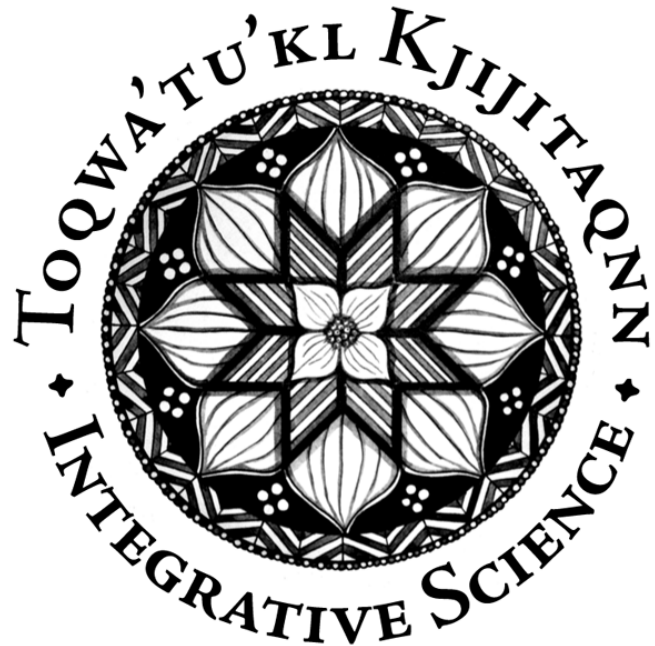
8 November 2007

Cheryl Bartlett, PhD

Canada Research Chair
in Integrative Science
(Dept of Biology)

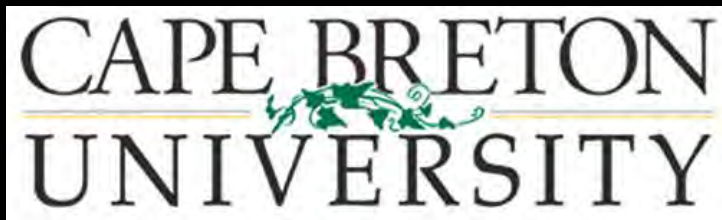
CAPE BRETON

UNIVERSITY



Canada Research Chairs / Chaires de recherche du Canada / Canada

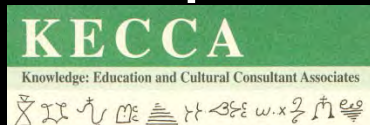
Social Sciences and Humanities Research Council of Canada / Conseil de recherches en sciences humaines du Canada



Wela'ioq / Thank you



Mi'kmaq Elders



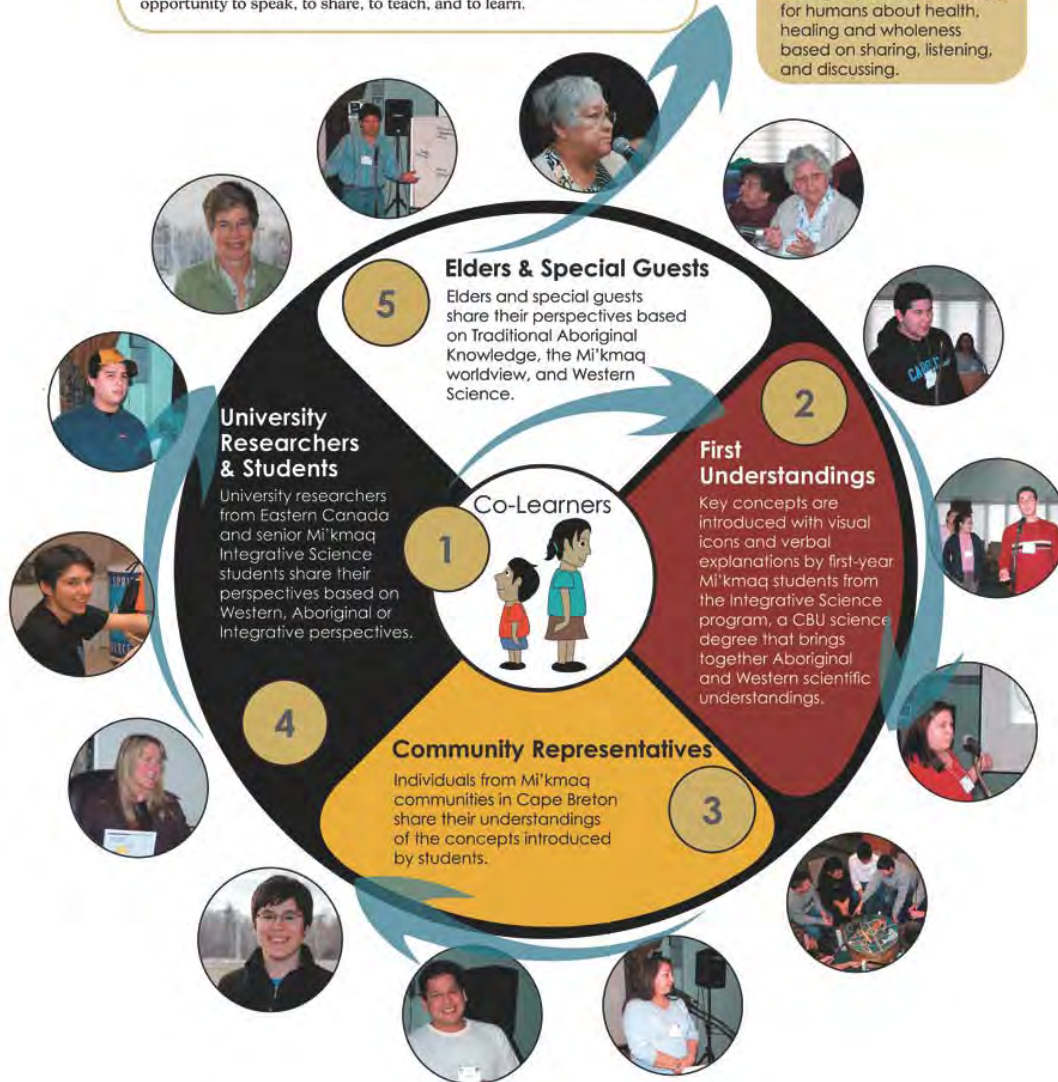
Co-Learning Journey

A shared understanding of how to talk together

This visual is based on the Medicine Wheel (or Circle of Learning) which is a commonly used Aboriginal teaching tool. The visual shows that within the discussion, all have a role to play. Each person has an opportunity to speak, to share, to teach, and to learn.



6
Each participant gains some new understandings of Mother Earth and her lessons for humans about health, healing and wholeness based on sharing, listening, and discussing.



10+ years: where our Co-Learning Journey has been and still is ...

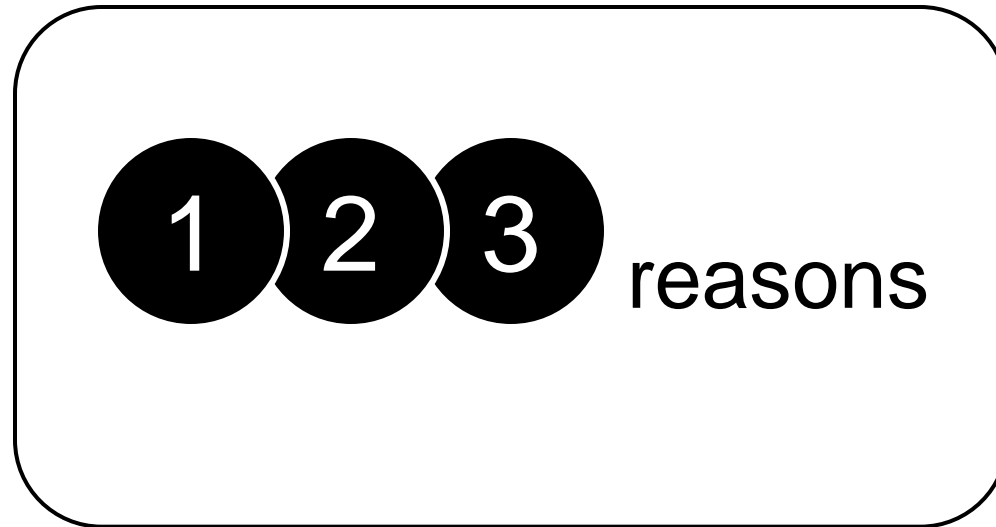
Integrative Science

bringing together Indigenous and Western scientific knowledges and ways of knowing

Indigenous

Western

Why our journey started ...

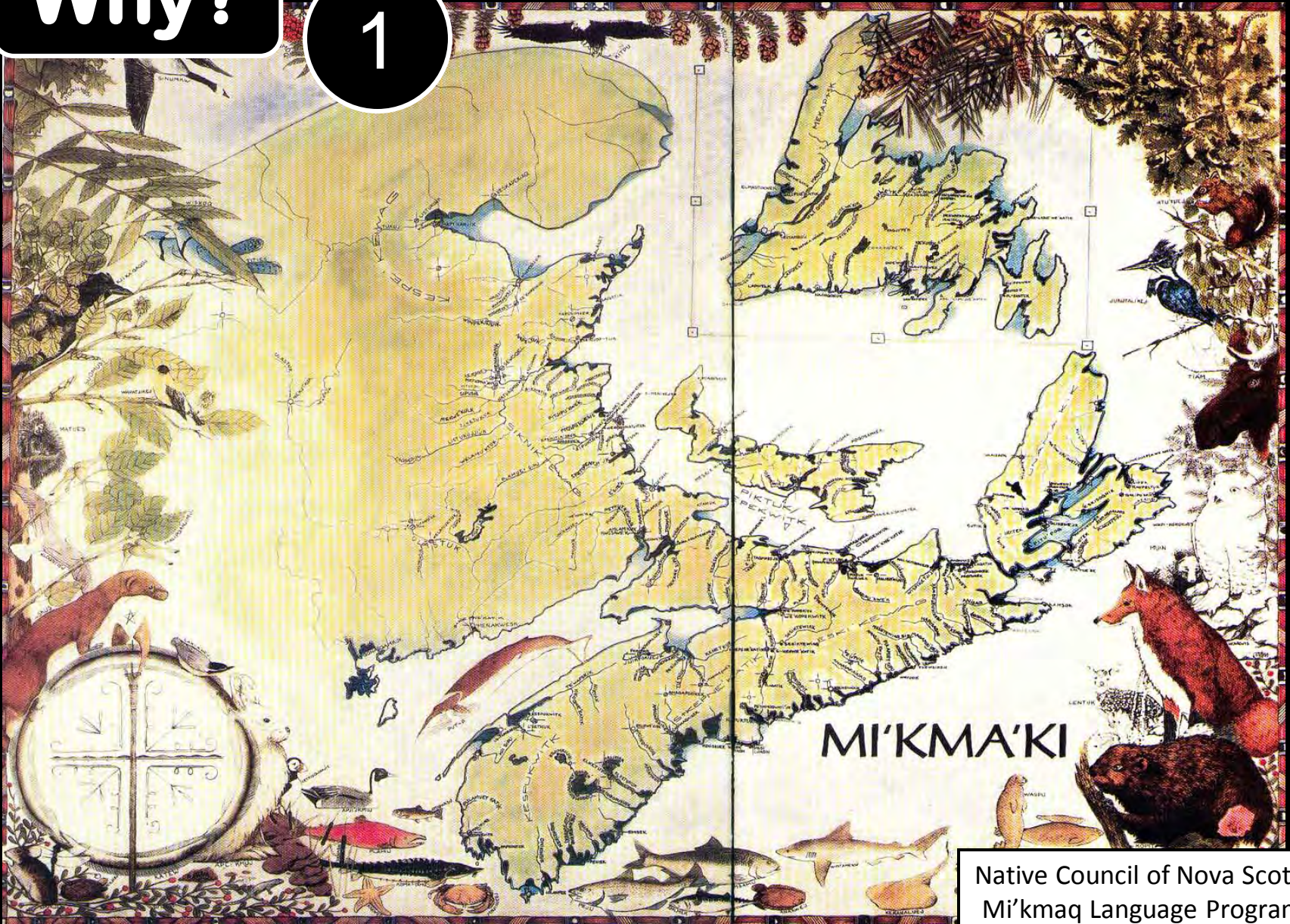


Indigenous

Western

Why?

1



Native Council of Nova Scotia
Mi'kmaq Language Program
Artist: Michael J. Martin

Why?

1



Why?

2



... and many, many youth



Why?

3

The central dilemma of science education today is the teaching of science from only one cultural perspective, and in an incomplete and non-connected manner.

Gregory Cajete, PhD, scientist & educator, Univ. of New Mexico

Indigenous

Western

Integrative Science



Artist Basma Kavanagh

Integrative Science

SCIENCE

education, research, applications,
youth and community outreach

Indigenous

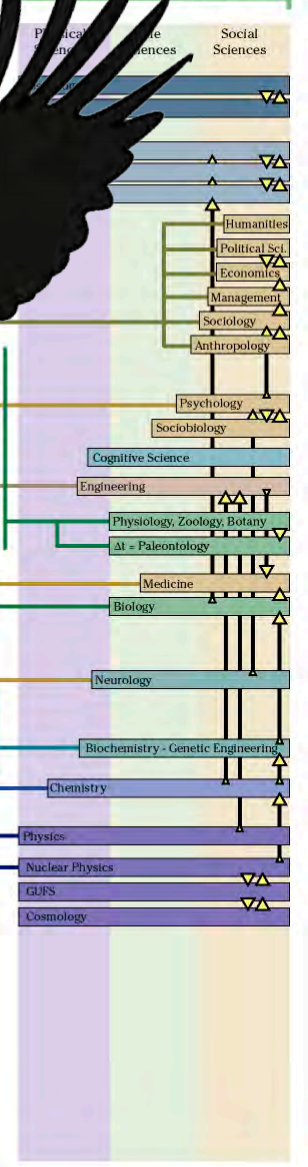
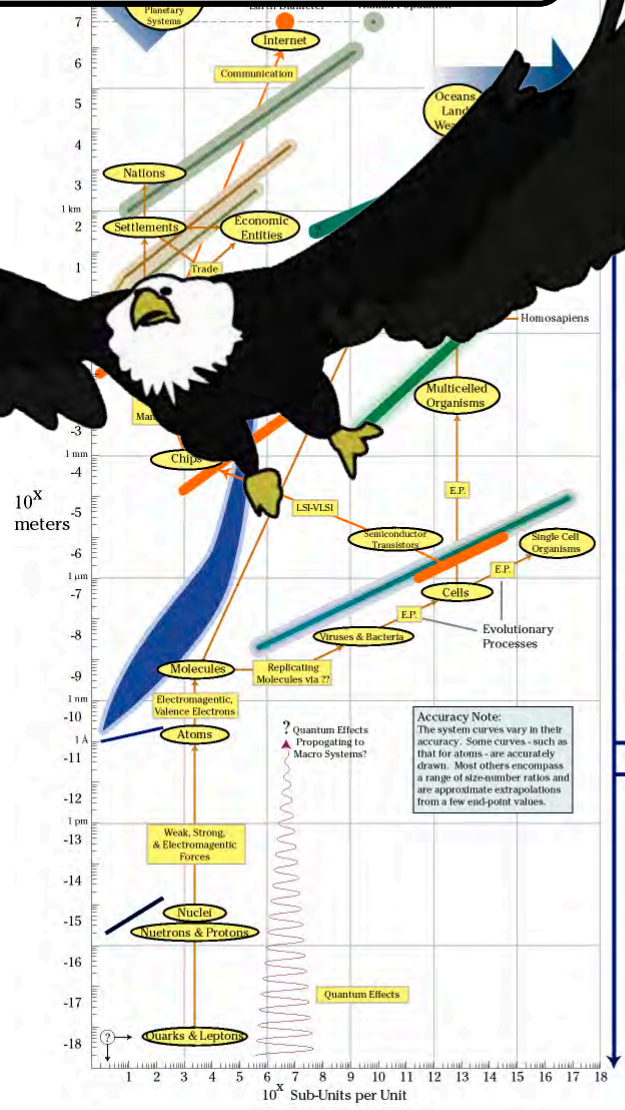
our sciences
our stories

Western

“bringing our knowledges together”

our worldviews

How? Become PATTERN-able.

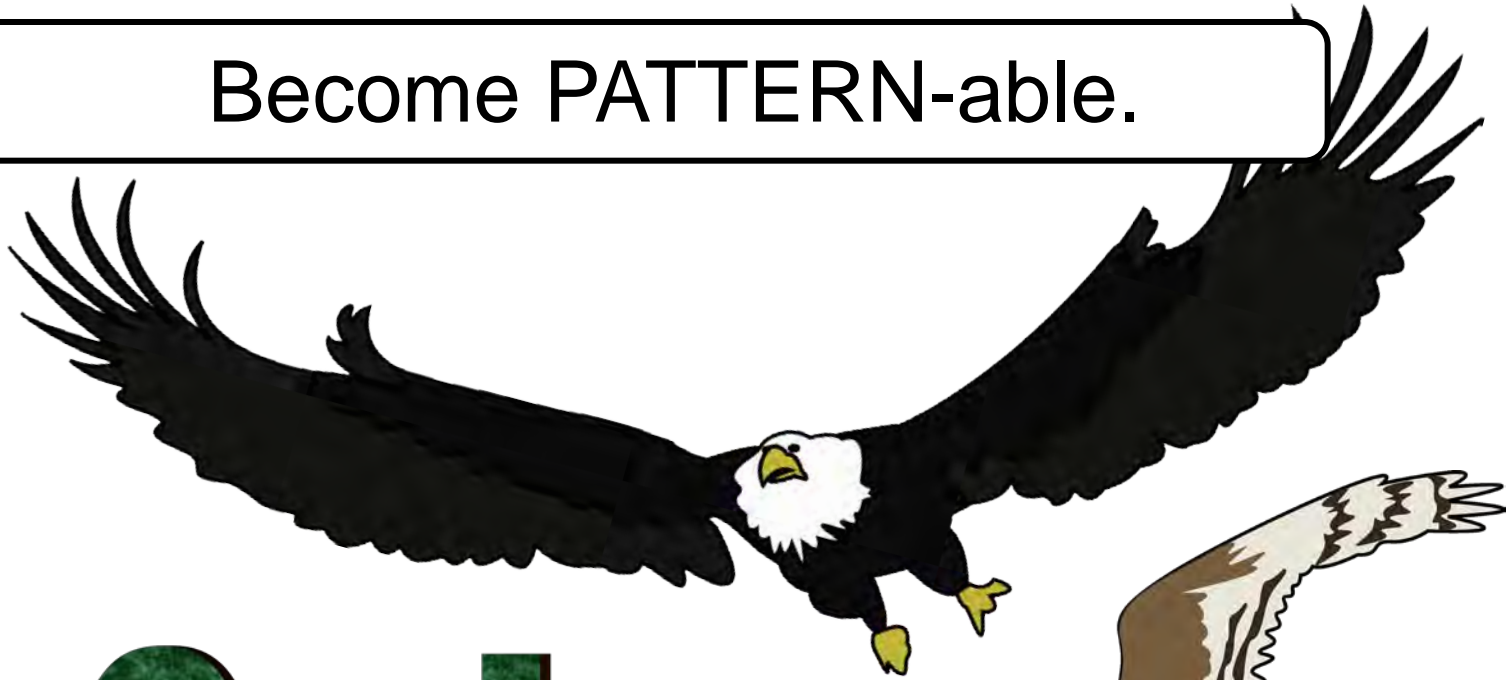


Become PATTERN-able.



Science

Become PATTERN-able.



Science



Paula Underwood Spencer: *Hawk and Eagle, Both are Singing*

http://www.ratical.org/many_worlds/NAworldview.html

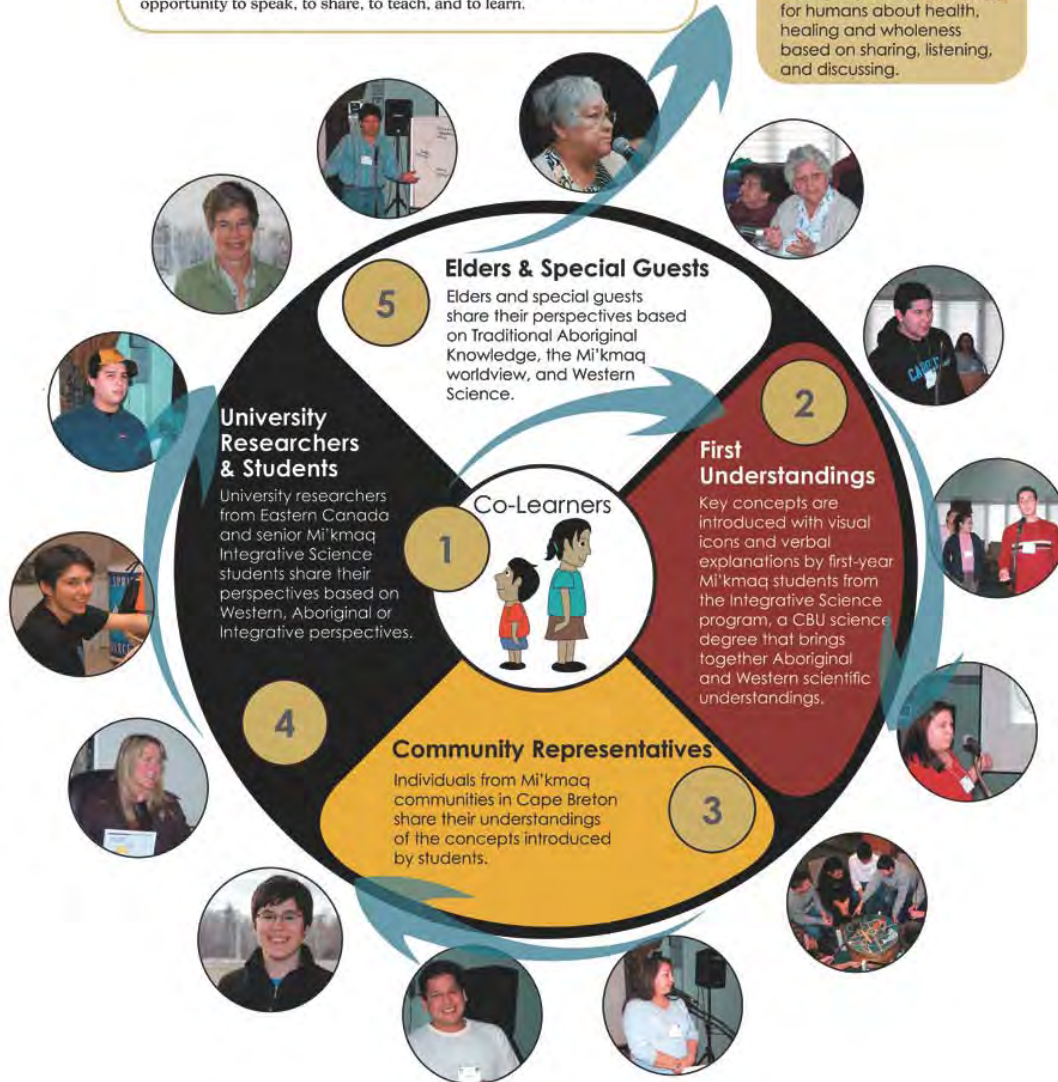
Co-Learning Journey

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Each participant gains some new understandings of Mother Earth and her lessons for humans about health, healing and wholeness based on sharing, listening, and discussing.

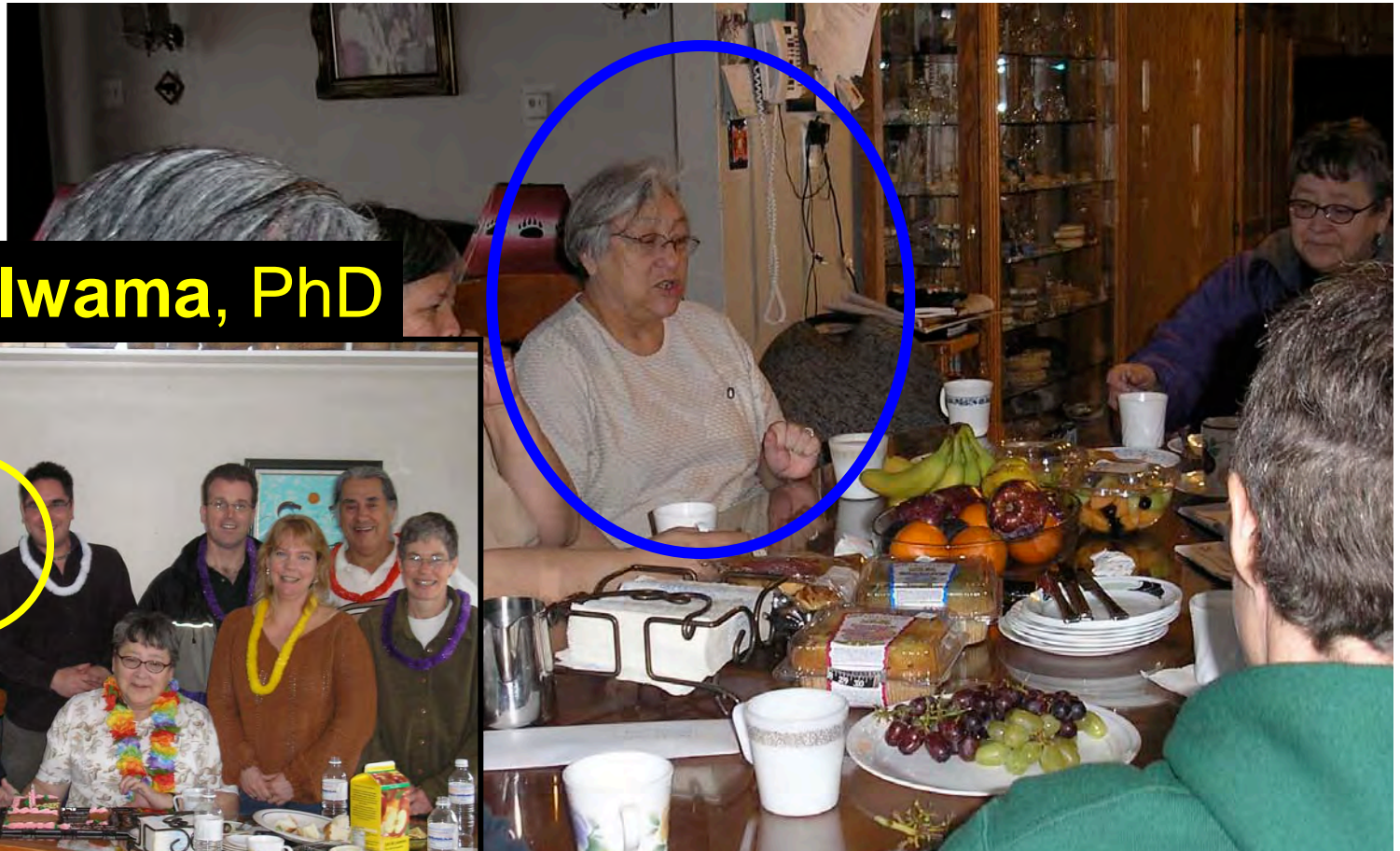




**... to Co-Learn, we
must “WALK” our
“know, do, value”**

**= an insight ...
coming via
extension
of understandings
from discussions
about healing
language**

Mrs. Murdena Marshall BA, MEd
Elder and Spiritual Leader, Mi'kmaq Nation
Eskasoni First Nation, Nova Scotia
Associate Professor (retired), Mi'kmaq Studies, CBU



Marilyn Iwama, PhD



Murdena Marshall:

There's something called the
healing tense.

THE HEALING TENSE ... an example

Mi'kmaq

English

Ketkiayop

I was drunk

Keskiayasa*nek*

I was drunk

The Healing Tense Heals

**... he has taken his misdeeds
[actions] and placed them in front of
him and walked around them, and
said "yes, I was there"**

Murdena Marshall

... in conversation with Dr. Ivar Mendez, Director,
Brain Repair Centre, Dalhousie University

We Heal Together

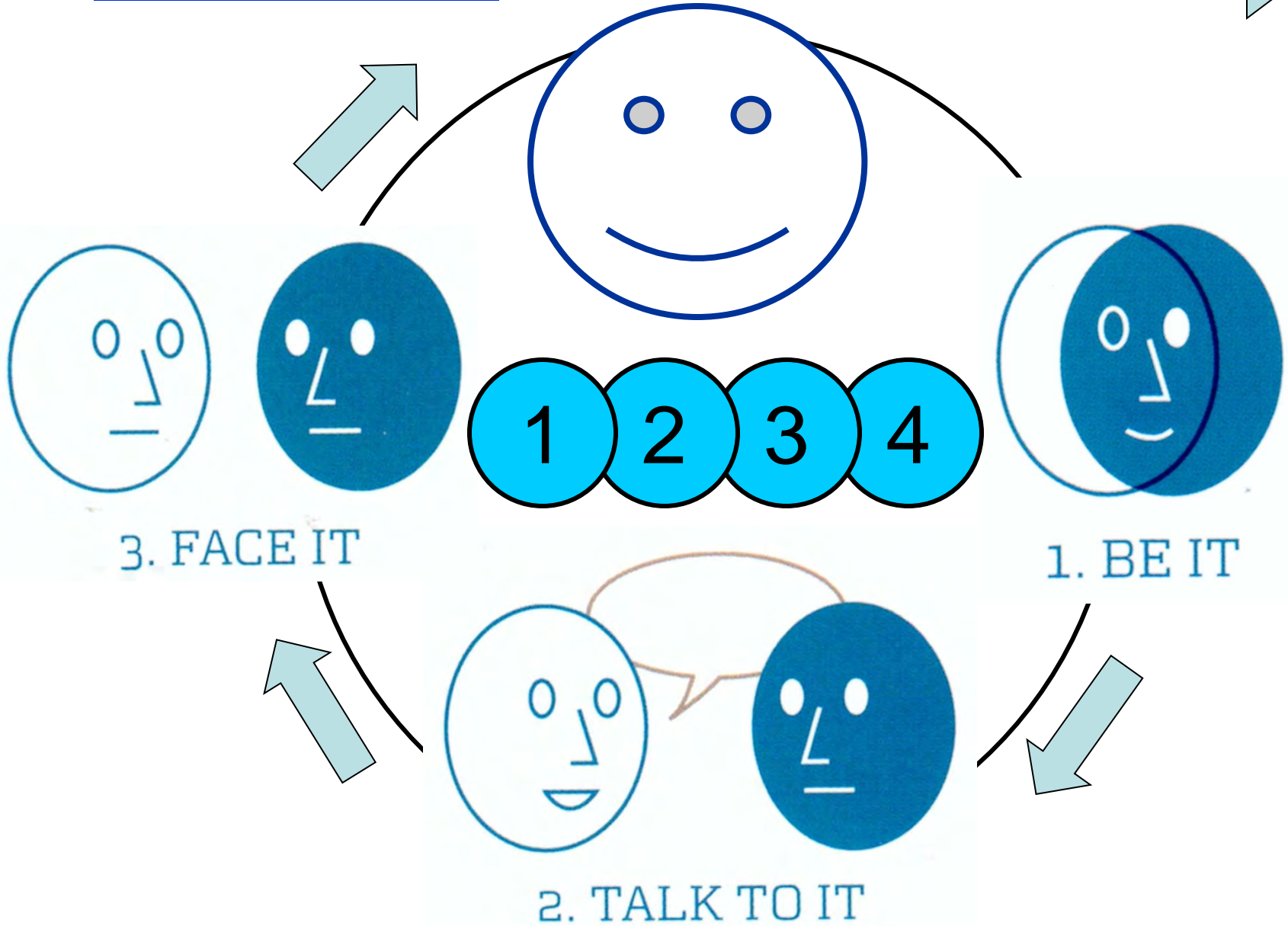
*"... when he goes into this healing tense,
then my attitude has to change ...
everybody in the household ...
everybody ... has to abide with him."*

Murdena Marshall

We must become able to put the **“know, do, value”** aspects of our worldviews in front of us ... like an object ... and then we must develop the abilities to walk around them ... to acknowledge them, take ownership of them, understand them, and put them beside those of another worldview ... to see our mutual strengths and to begin working together in a reciprocally respectful manner.



4. “KNOW, VALUE, and DO” IT ... SHARE IT ... and GROW IT



“Two-Eyed Seeing”

learning to see with the strengths of each & together



Indigenous



Western



Mr. Albert Marshall, Mi'kmaq Elder
Eskasoni First Nation

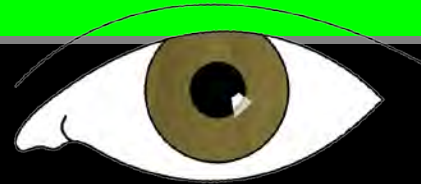
1

Two-Eyed Seeing

our key concepts & actions



- respect
- relationship
- reverence
- reciprocity
- ritual (ceremony)
- repetition
- responsibility



- hypothesis
(making & testing)
- data collection
- data analysis
- model & theory
construction

2

Two-Eyed Seeing our language & methodology



vigour

WEAVING



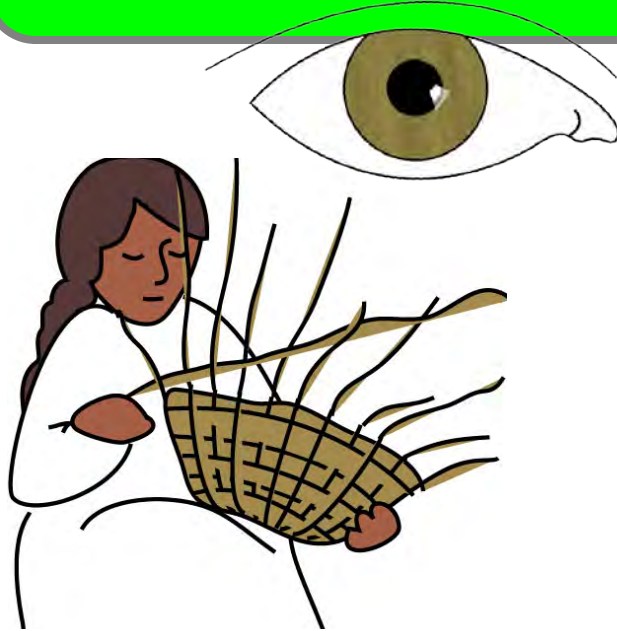
rigour

UN-WEAVING

3

Two-Eyed Seeing

our overall knowledge objective



towards resonance
of understanding
within environment

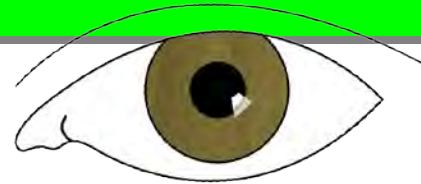
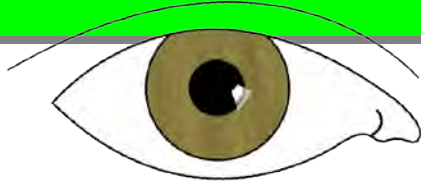


towards construction
of understanding
of environment

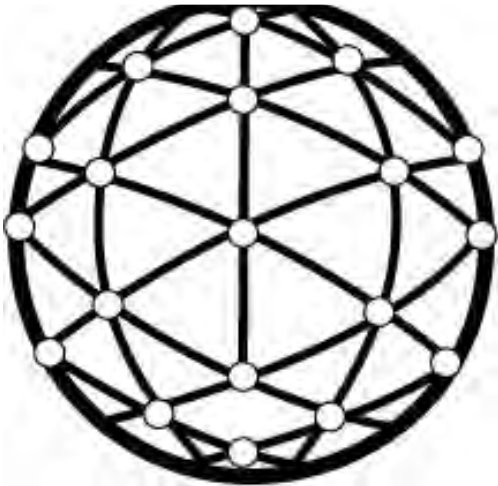
4

Two-Eyed Seeing

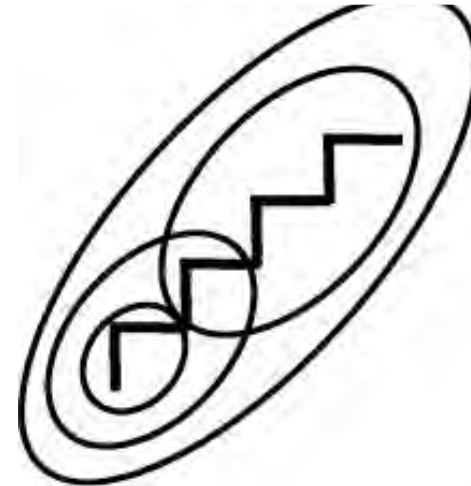
how our world is



interconnective



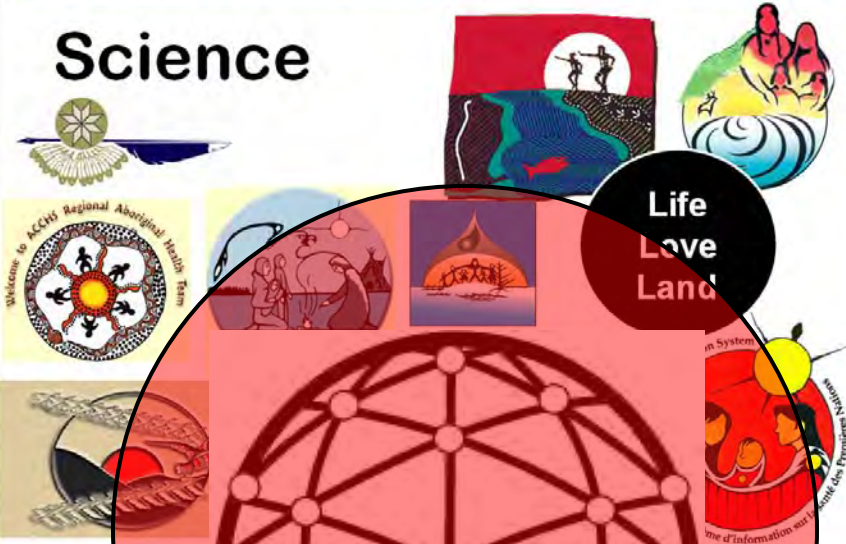
parts & wholes



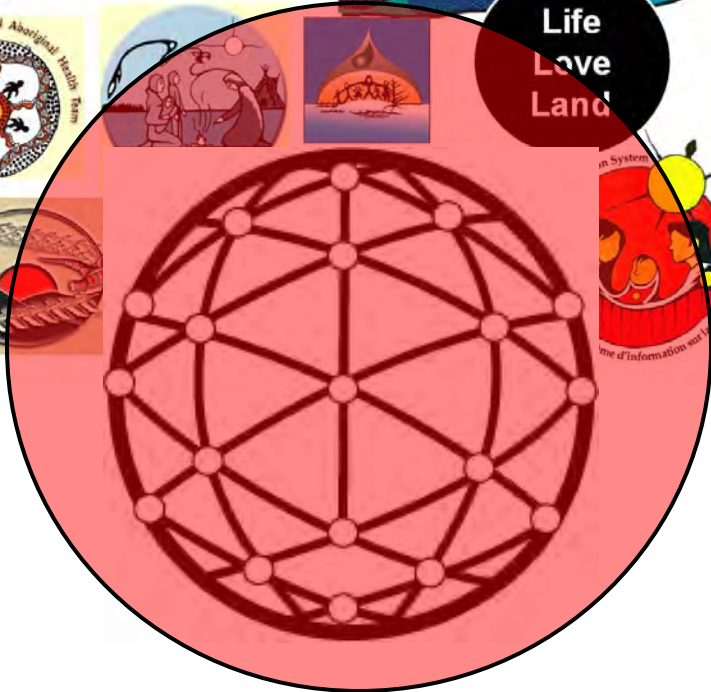


stories of our interactions with and within nature

Science

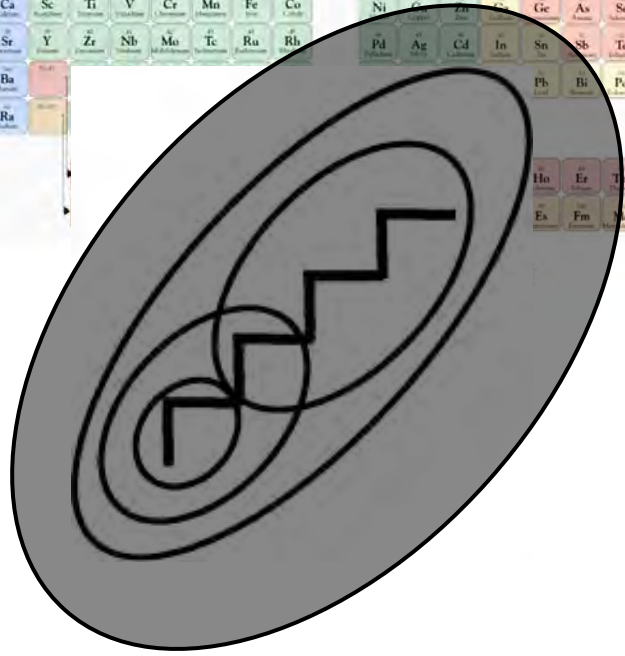
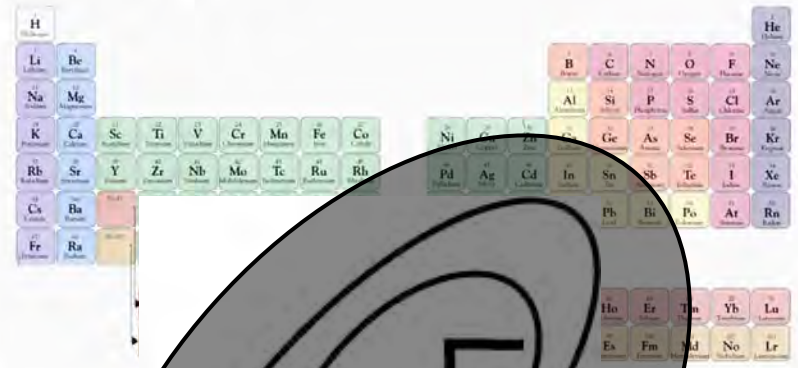


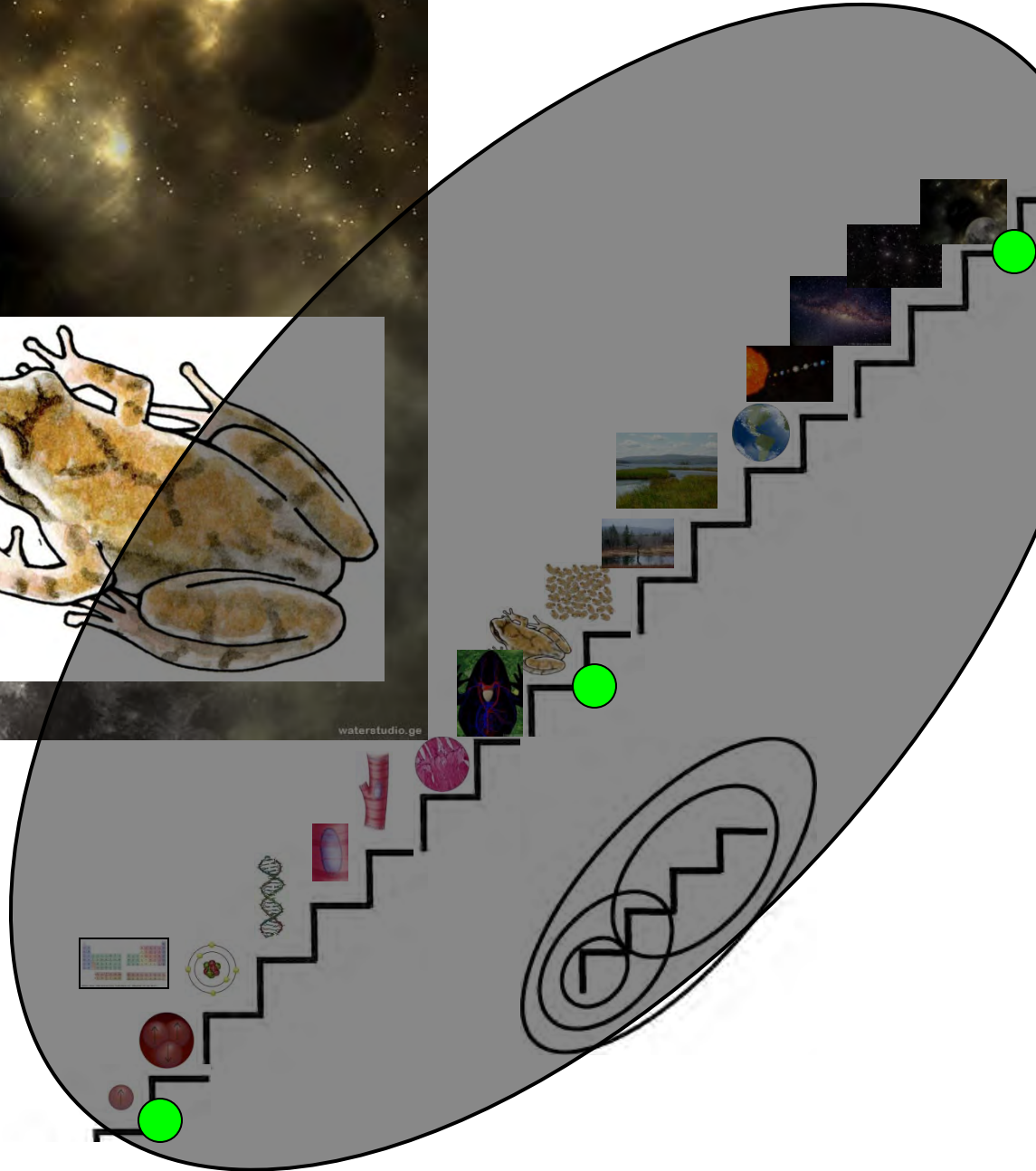
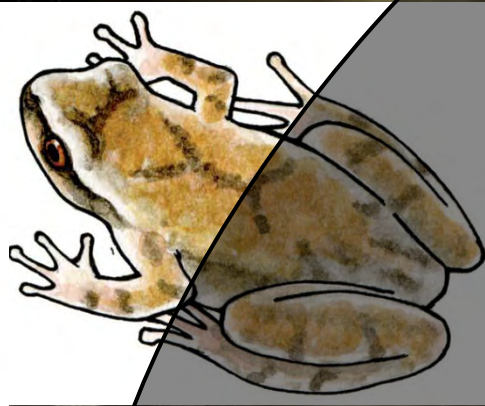
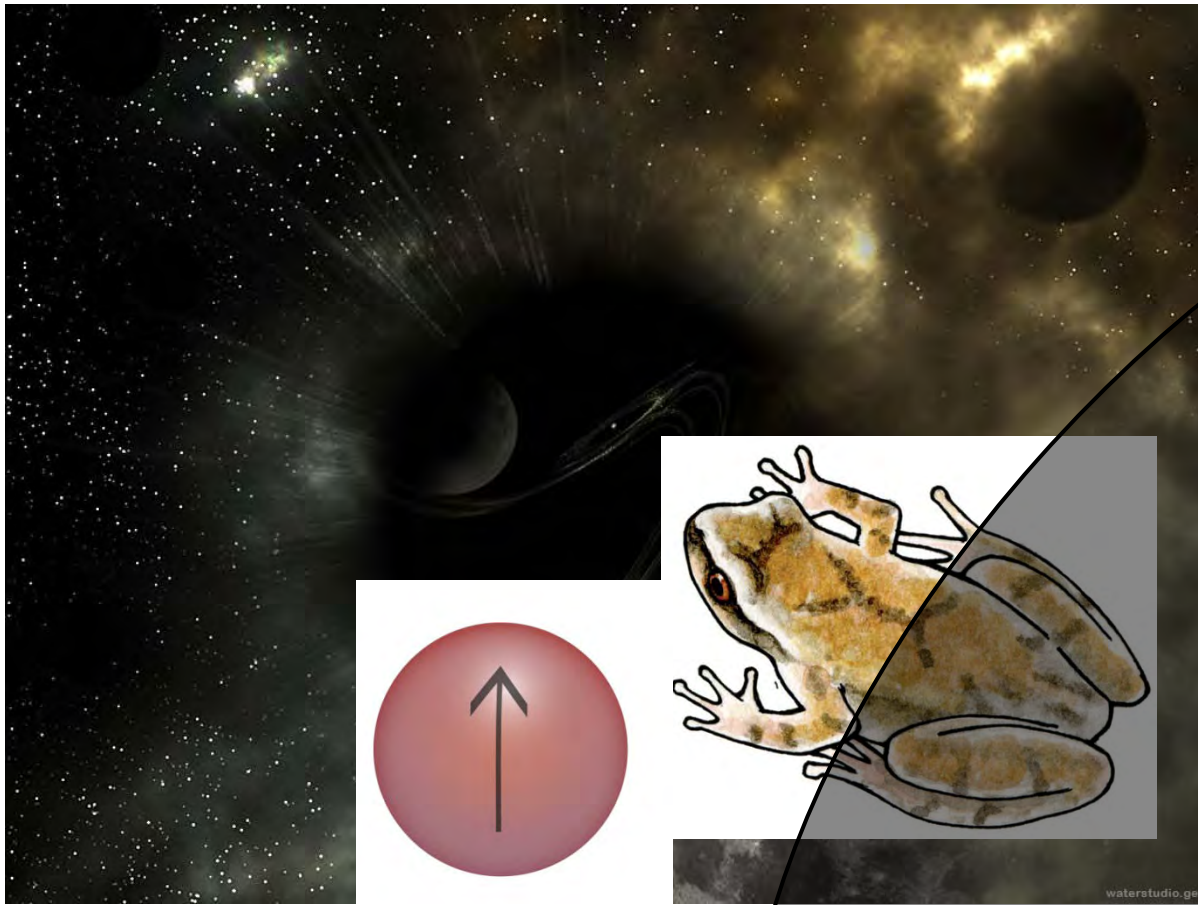
Life
Love
Land



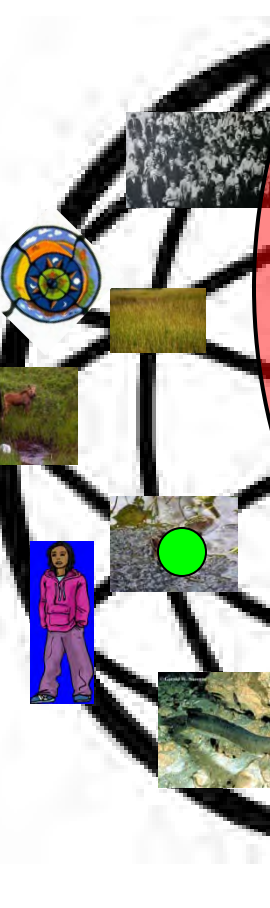
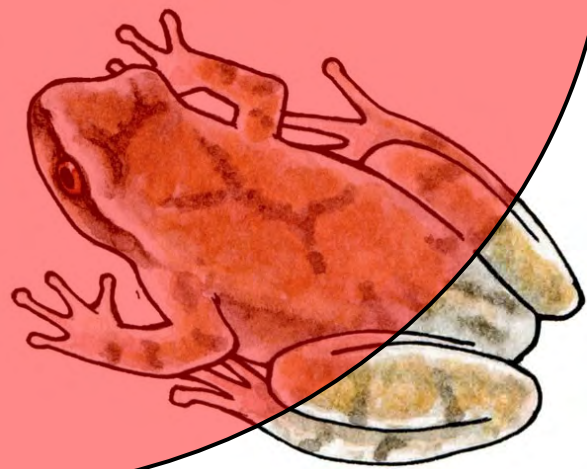
stories of our interactions with and within nature

Science





waterstudio.ge



Integrative Science



SCIENCE

education, research, applications,
youth and community outreach

Indigenous

Western

“bringing our sciences together”

4 yr Science Degree Program

Bachelor of Science Community Studies

Degree Profile for:
**Toqwa'tu'kl Kijjitaqnn /
Integrative Science**



1) core

18

CREDITS: 48
Science: PCS (3 core)
**Topics: perspectives*
& skills***

2) concentration

42

CREDITS: 42
**Science: university &
applied (tech)**

3) electives

30

CREDITS: 30
Science: all, some, none

4) work placements

max. 105

min. 60
(18+42)

CREDITS: 0
Science: experience

Degree Core (48 credits)

- 1) _____ PCS 100: Analysis and Decision Making (6 credits)
- 2) _____ PCS 200: Applied Research (6 credits)
- 3) _____ PCS 300: Community Intervention (6 credits)
- 4) _____ science and technology perspectives (6 credits): Phil 222, or equivalent
- 5) _____ world views and values (3 credits): Phil 251, Phil 253, or equivalent
- 6) _____ Aboriginal perspectives (3 credits): Mikm at 100 or 200 level, or 361, or equivalent

Science Area of Concentration (42 credits)

- a) University (8 courses)
 - 1) 3 credits: MSIT 101
 - 2) 3 credits: MSIT 103
 - 3) 3 credits: MSIT 201
- b) Technology (6 courses)
 - 1 + 2) 6 credits: Chem 121 + 122
 - 3 + 4) 6 credits: Math 131 + 132, or Phys 100, or Phys 111 + 112
 - 5) 6 credits (at least 3 credits must be at 300 level):
 - Geol 111
 - Biol at 200 level or higher
 - any ENR

Student's Electives (30 credits)

- 1) 3 credits: _____
- 6) 3 credits: _____

Work Placements (paid or voluntary, each at least 120 hours)

- 1) _____
- 2) _____

An overall average of 60% (in courses over your four years) is required for graduation.



4 yr Science Degree Program

Bachelor of Science Community Studies

Degree Profile for:
**Toqwa'tu'kl Kjjitaqnn /
Integrative Science**

Bringing Knowledges Together
... from Western scientific and Aboriginal world views



Degree Core (48 credits)

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- 2) _____ PCS 200: Applied Research (6 credits)
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2) concentration

Science Area of Concentration (42 credits)

- | | |
|----------------------------------|---|
| a) University (8 courses) | b) Technology (6 courses) |
| 1) 3 credits: MSIT 101 | 1 + 2) 6 credits: Chem 121 + 122 |
| 2) 3 credits: MSIT 103 | 3 + 4) 6 credits: Math 101 + 102, or |
| 3) 3 credits: MSIT 201 | Phys 100, or Phys 111 + 112 |
| 4) 3 credits: MSIT 203 | 5 + 6) 6 credits (at least 3 credits must be at 300 level): |
| 5) 3 credits: MSIT 301 | - Geol 111 |
| 6) 3 credits: MSIT 303 | - any PubH at 200 level or higher |
| 7) 3 credits: MSIT 401 | - any Envi at 200 level or higher |
| 8) 3 credits: MSIT 401 | |

Student's Electives (10 credits)

- | | |
|---------------------|----------------------|
| 1) 3 credits: _____ | 6) 3 credits: _____ |
| 2) 3 credits: _____ | 7) 3 credits: _____ |
| 3) 3 credits: _____ | 8) 3 credits: _____ |
| 4) 3 credits: _____ | 9) 3 credits: _____ |
| 5) 3 credits: _____ | 10) 3 credits: _____ |

Work Placements (paid or voluntary, each at least 120 hours)

- 1) _____
- 2) _____

An overall average of 60% (in courses over your four years) is required for graduation.



**CREDITS: 24
Science**

**MSIT
courses
(core)
24 credits**

Bachelor of Science Community Studies

Degree Profile for: Toqwa'tu'kl Kijjitaqnn / Integrative Science

Bringing Knowledges Together
... from Western scientific and Aboriginal world views



Degree Core (48 credits)

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- 2) _____ PCS 200: Applied Research (6 credits)
- 3) _____ PCS 300: Community Intervention (6 credits)
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- 6) _____ Aboriginal perspectives (3 credits): Mikm at 100 or 200 level, or 361, or equivalent
- 7) _____ business perspectives (3 credits): Buss 111, Buss 231, or equivalent
- 8) _____ public communication (3 credits): Comm 103, Comm 105, or equivalent
- 9) _____ effective writing (6 credits): Engl 100, Engl 205 + Engl 207, or equivalent
- 10) _____ computer literacy (3 credits): Phil 115, Comp 102 or 111, Buss 181, or equivalent
- 11) _____ statistics (3 credits): Math 135, Math 335, Buss 182, Psych 201, or equivalent

Science Area of Concentration (42 credits)

- | | |
|---|---|
| <p>a) <u>University</u> (8 courses)</p> <ol style="list-style-type: none">1) 3 credits: MSIT 1012) 3 credits: MSIT 1033) 3 credits: MSIT 2014) 3 credits: MSIT 2035) 3 credits: MSIT 3016) 3 credits: MSIT 3037) 3 credits: MSIT 4018) 3 credits: MSIT 401 | <p>b) <u>Technology</u> (6 courses)</p> <p>1 + 2) 6 credits: Chem 121 + 122</p> <p>3 + 4) 6 credits: Math 131 + 132, or
Phys 100, or Phys 111 + 112</p> <p>5 + 6) 6 credits (at least 3 credits must be at 300 level):
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- any PubH at 200 level or higher
- any Envi at 200 level or higher</p> |
|---|---|

Student's Electives (30 credits)

- | | |
|---------------------|----------------------|
| 1) 3 credits: _____ | 6) 3 credits: _____ |
| 2) 3 credits: _____ | 7) 3 credits: _____ |
| 3) 3 credits: _____ | 8) 3 credits: _____ |
| 4) 3 credits: _____ | 9) 3 credits: _____ |
| 5) 3 credits: _____ | 10) 3 credits: _____ |

Work Placements (paid or voluntary, each at least 120 hours)

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- 2) _____

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Science

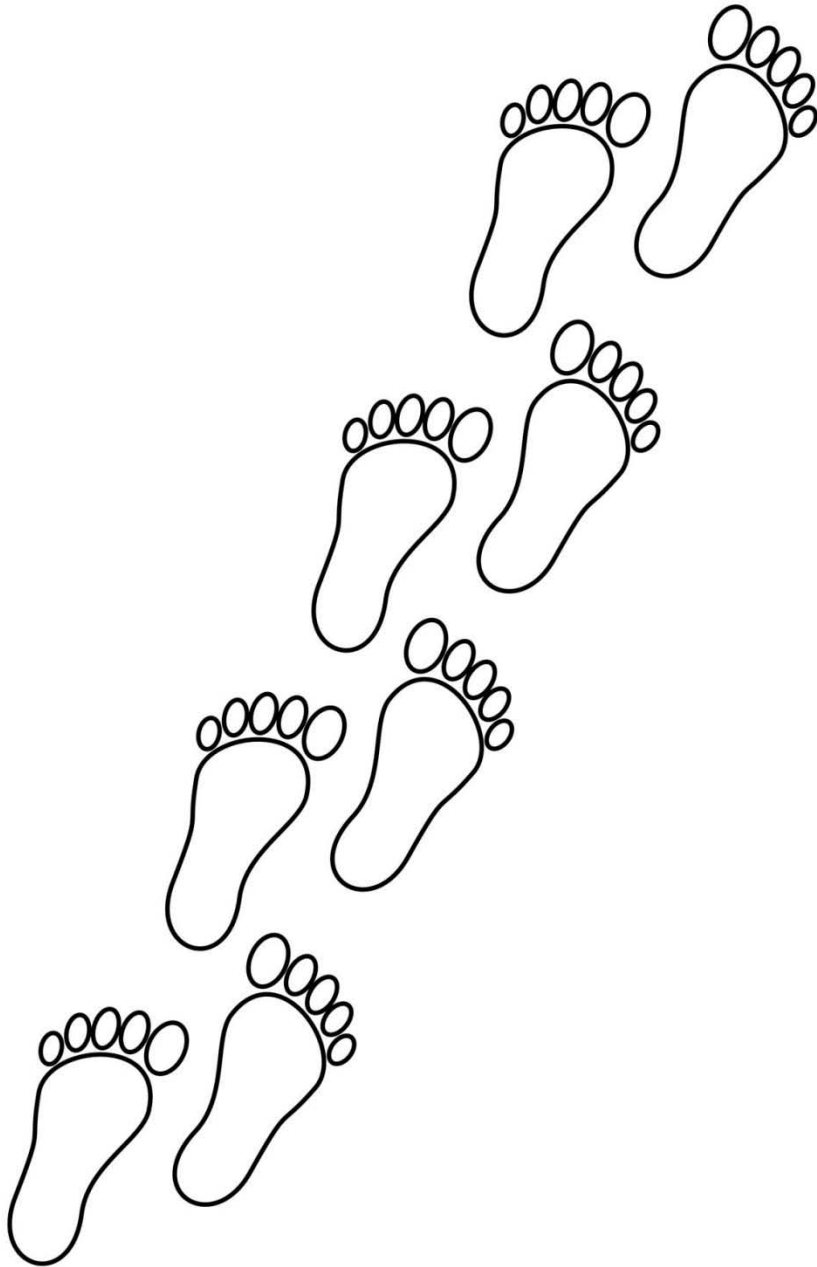
PATTERN

conceptual space shifting

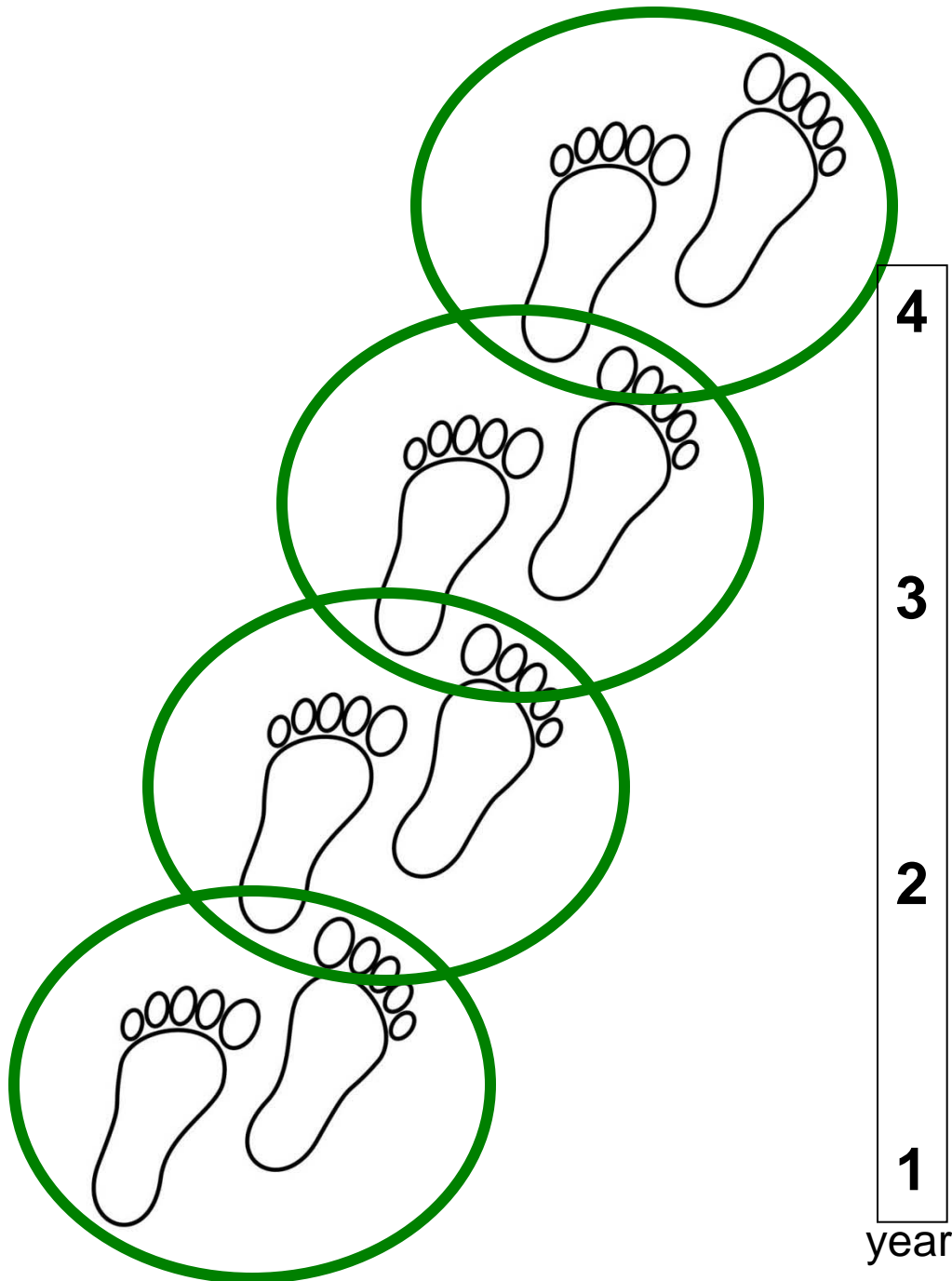
Science

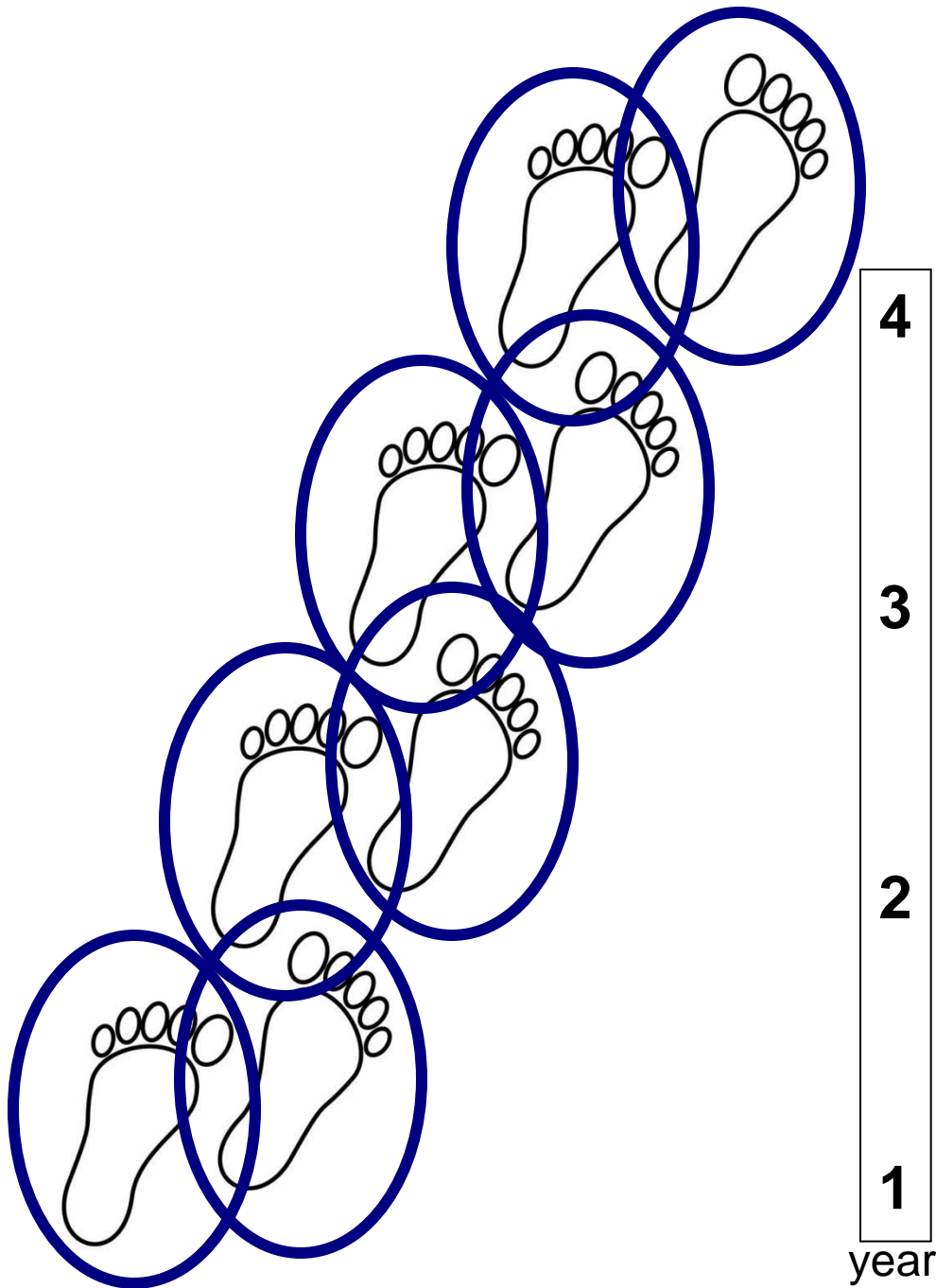
PATTERN

**conceptual
space
shifting**



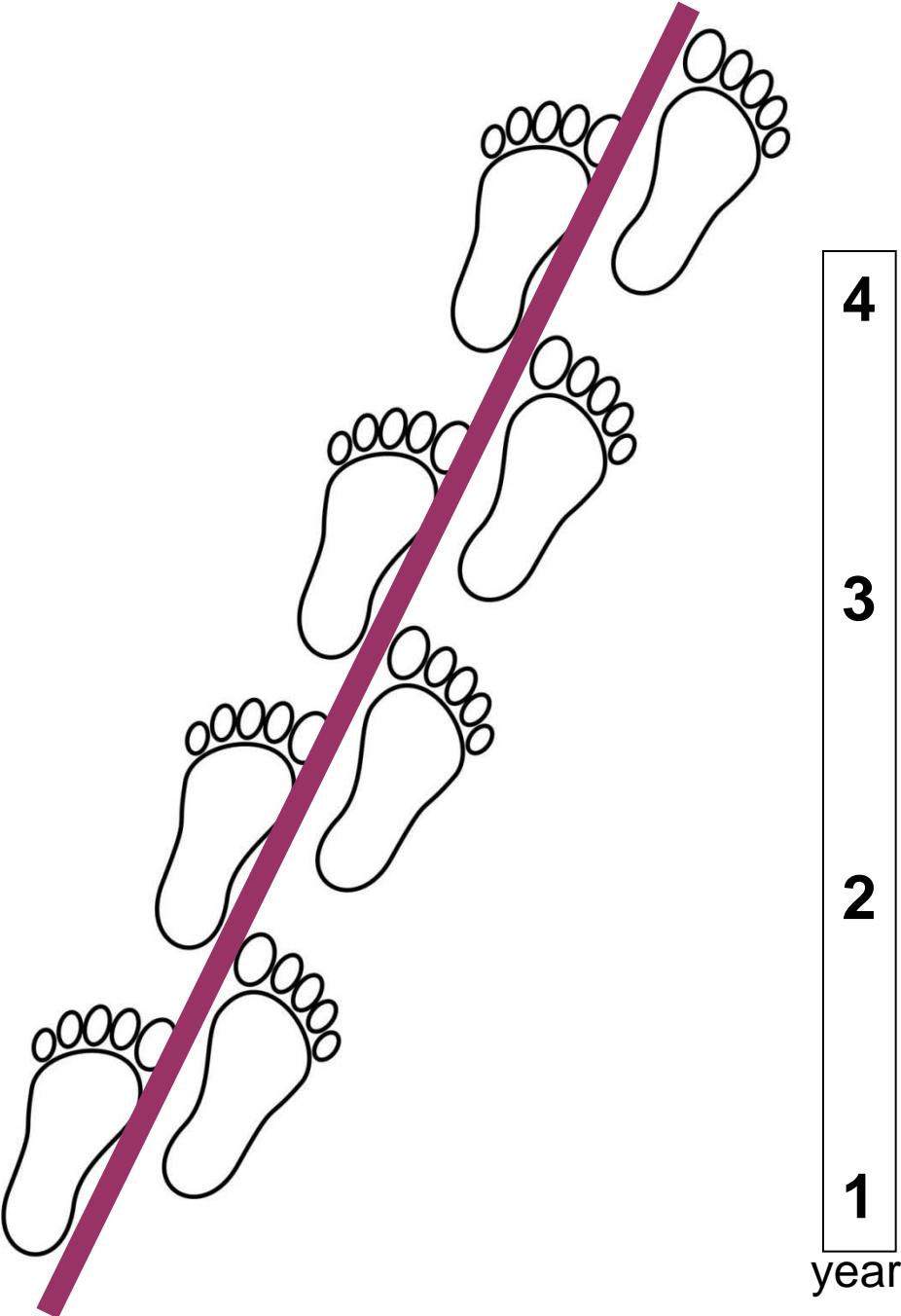
4 Years



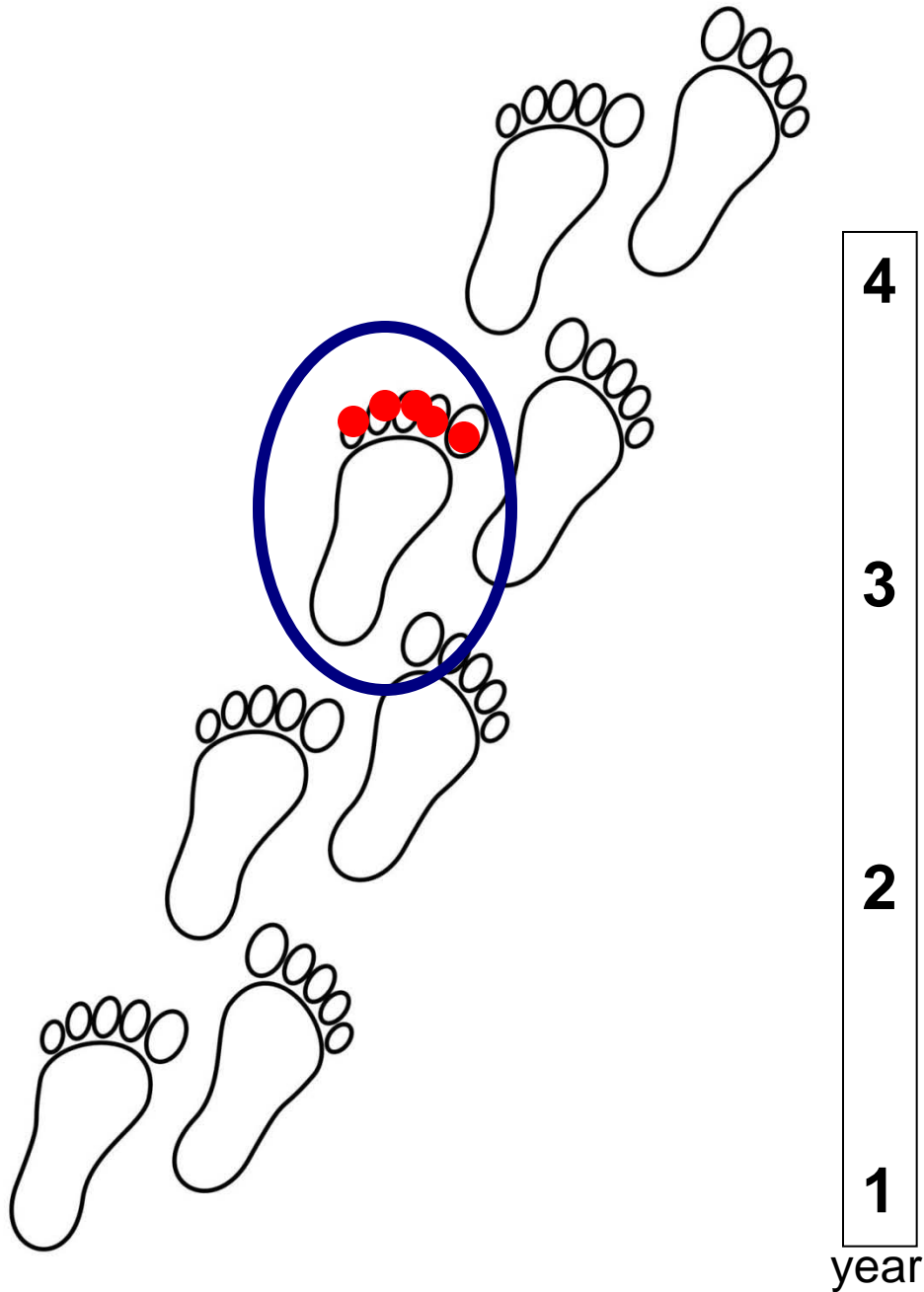


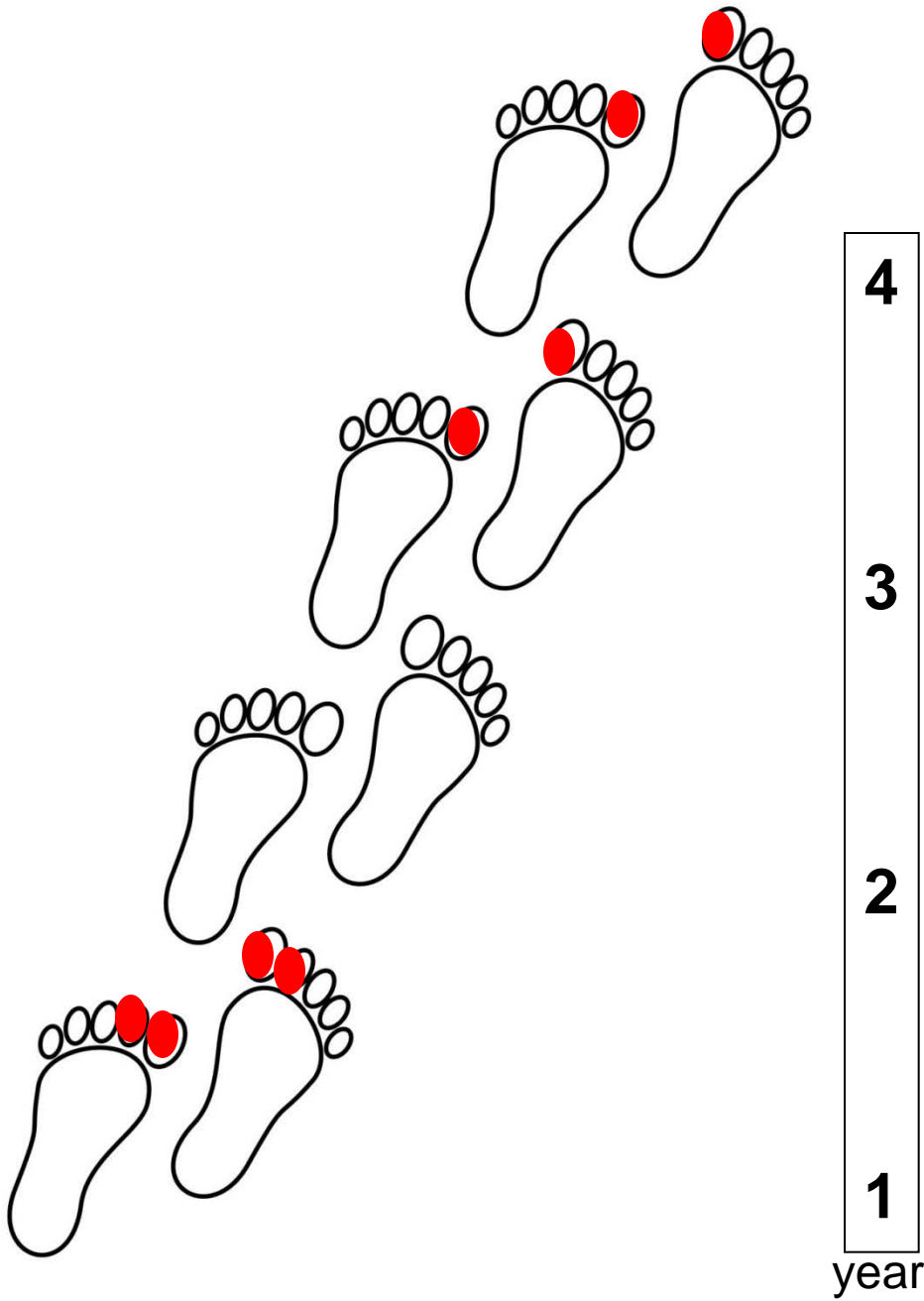
Fall terms
Winter terms

Christmas break

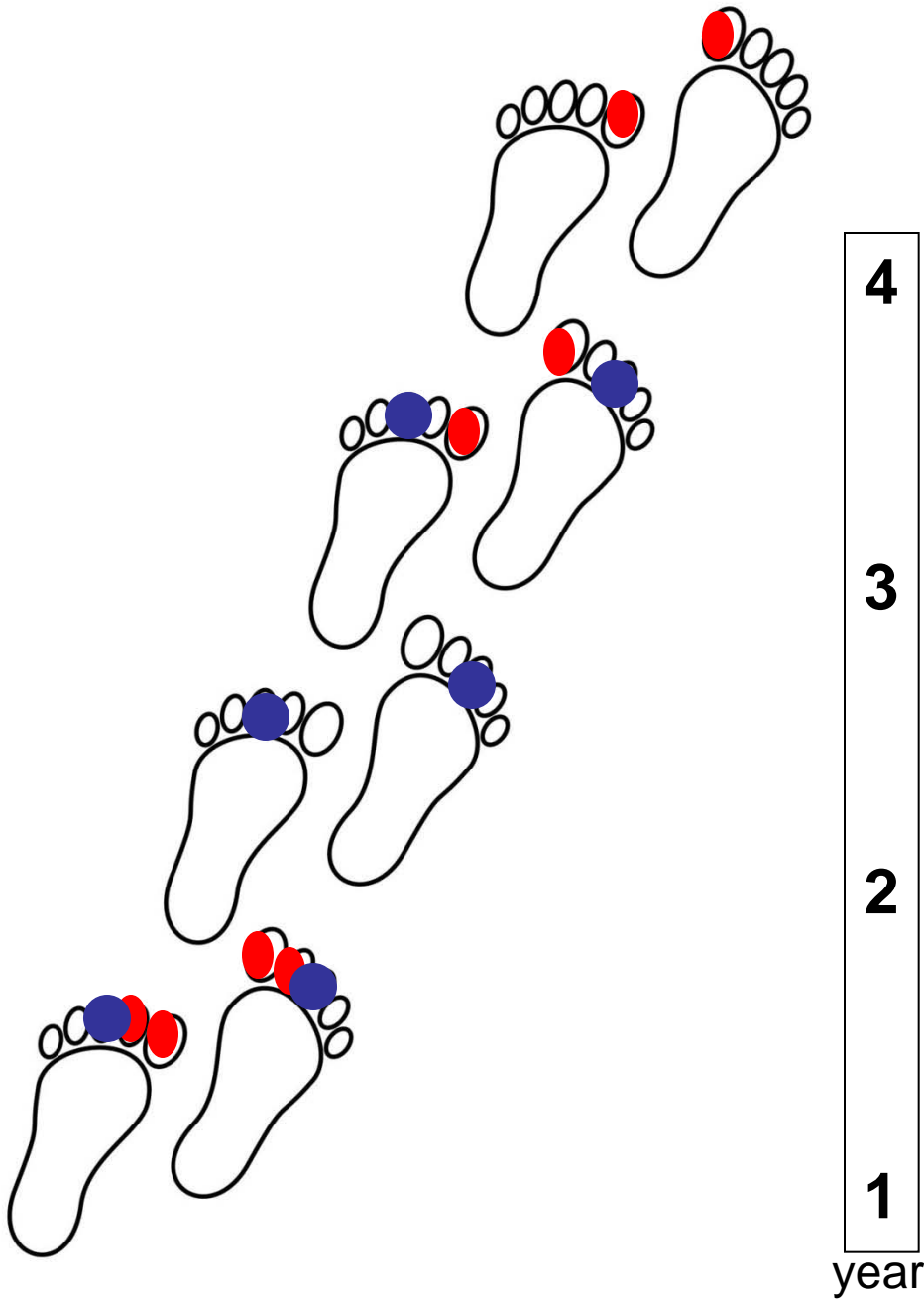


**Each term
= 5 courses**





MST **science** **courses**



**MSTT
science
courses**

**PCS
courses**



Science

common ground

Both Indigenous and Western scientific knowledges are based on observations of the natural world.



Artist Basma Kavanagh

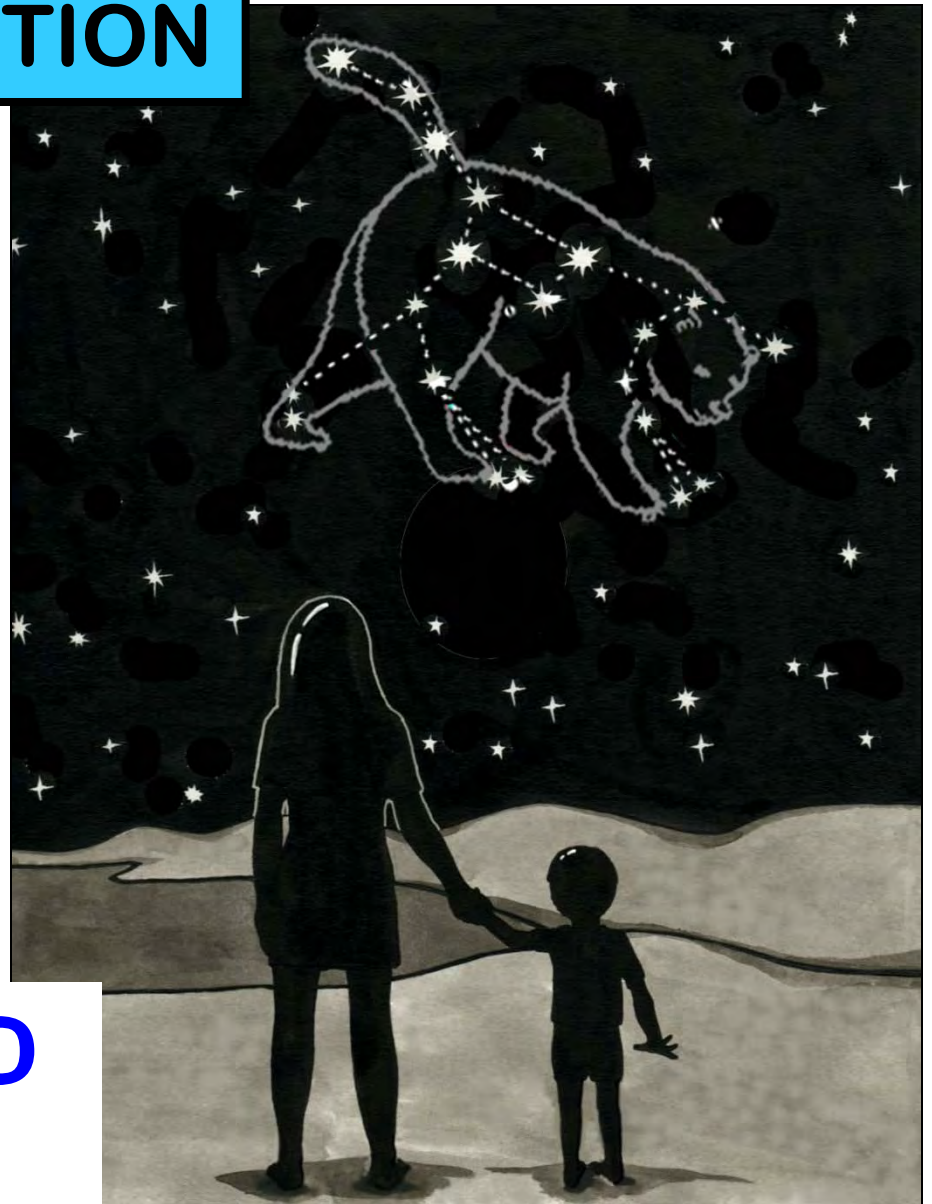
PATTERN RECOGNITION

common ground

Both Indigenous and Western scientific knowledges result from the same intellectual process of creating order out of disorder.

order

= **PATTERN-BASED STORIES**



Artist Basma Kavanagh

stories of our interactions with and within nature

Science

**Science is
dynamic,
pattern-based
knowledge.**

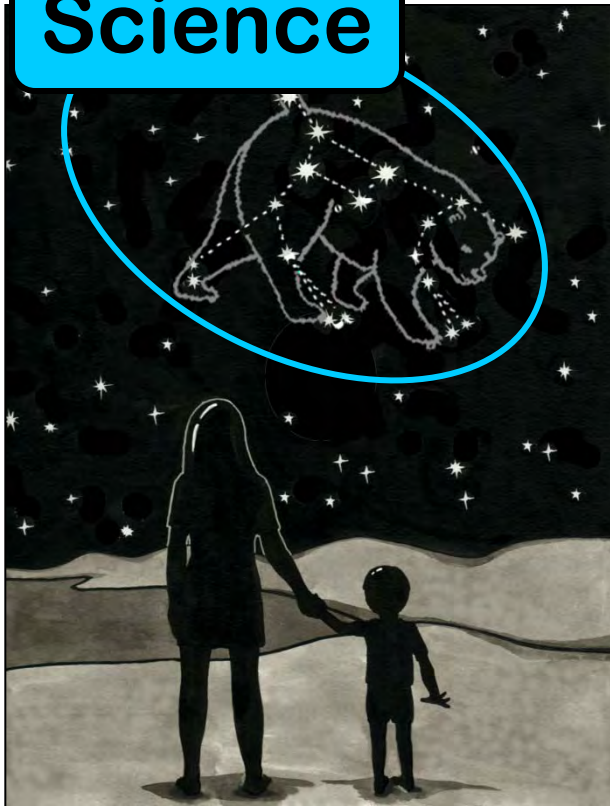
**= PATTERN-BASED
STORIES**



Artist Basma Kavanagh

stories of our interactions with and within nature

Science



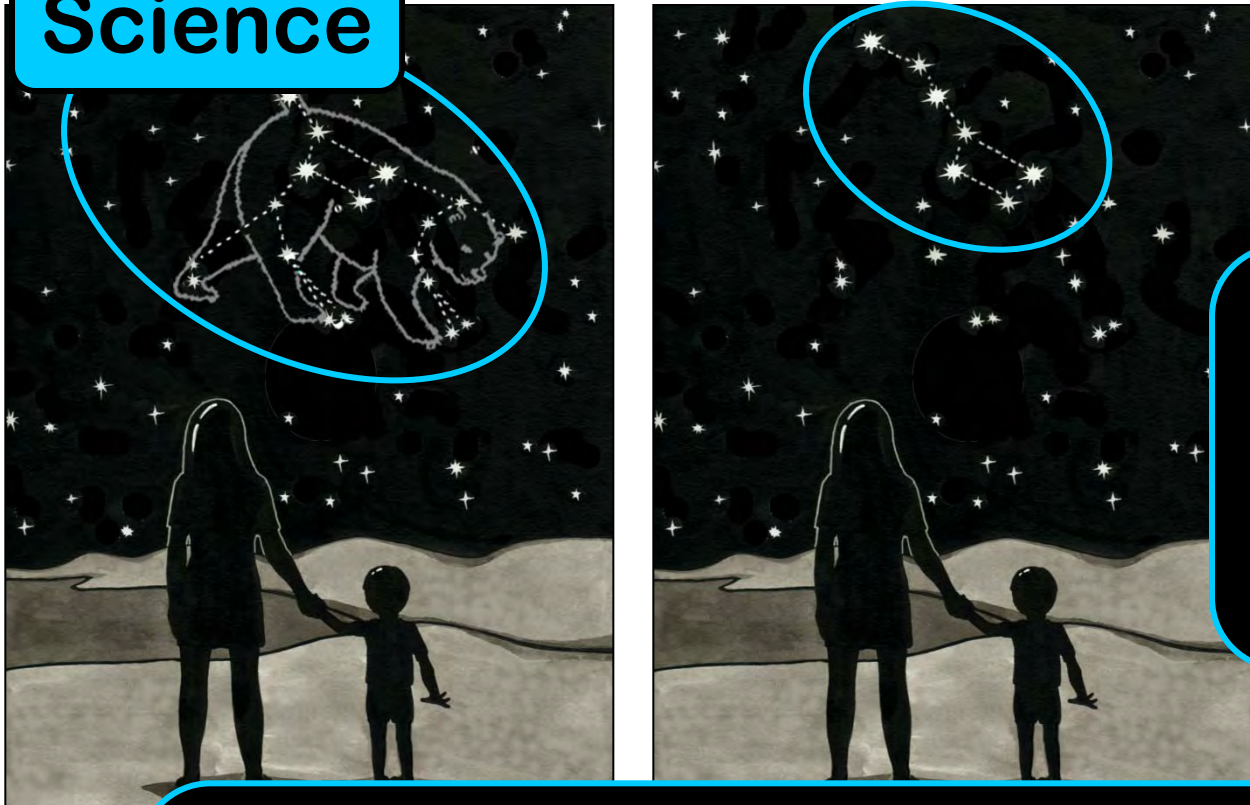
PATTERN

- recognition
- transformation
- expression

- various **pattern smarts**
- various ways to connect the dots
 - variety in our stories

stories of our interactions with and within nature

Science

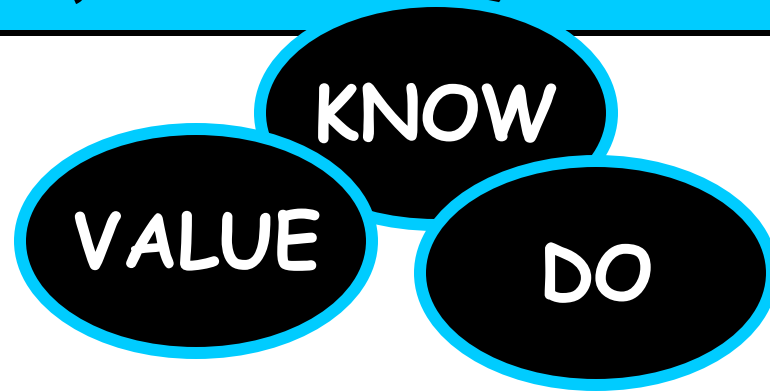
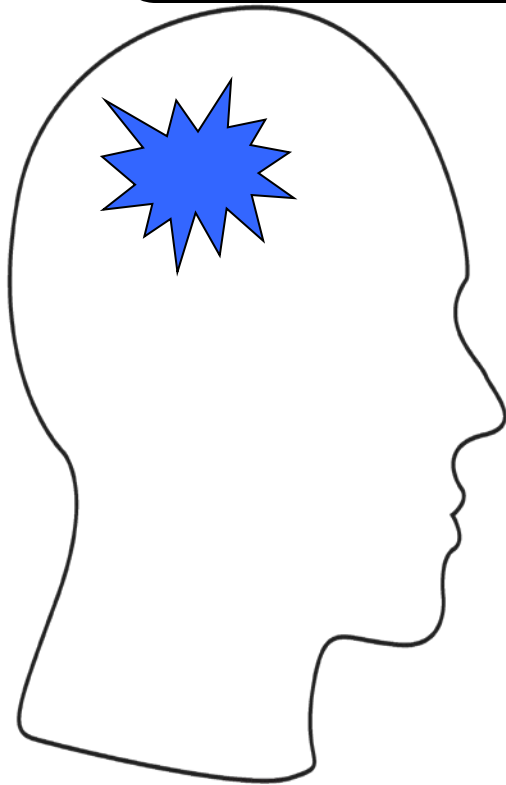


the patterns
that we see
within nature
reflect our ...

**SANCTIONED
PERSPECTIVES & INTELLIGENCES:**
who we are; where we are; where we were;
what we know, do and value

“pattern smarts”

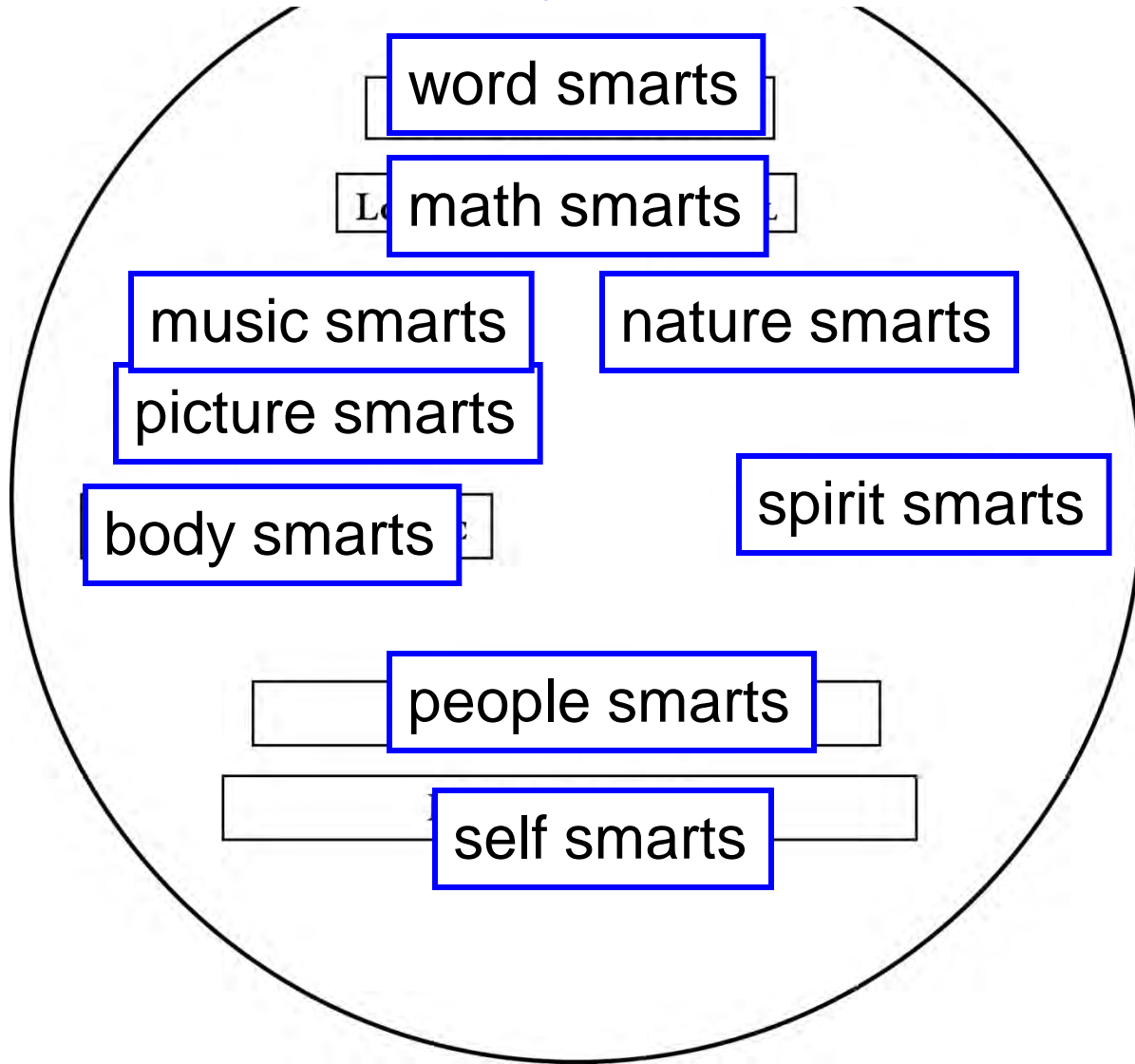
**sanctioned world view, methodologies,
perspectives, and intelligences**



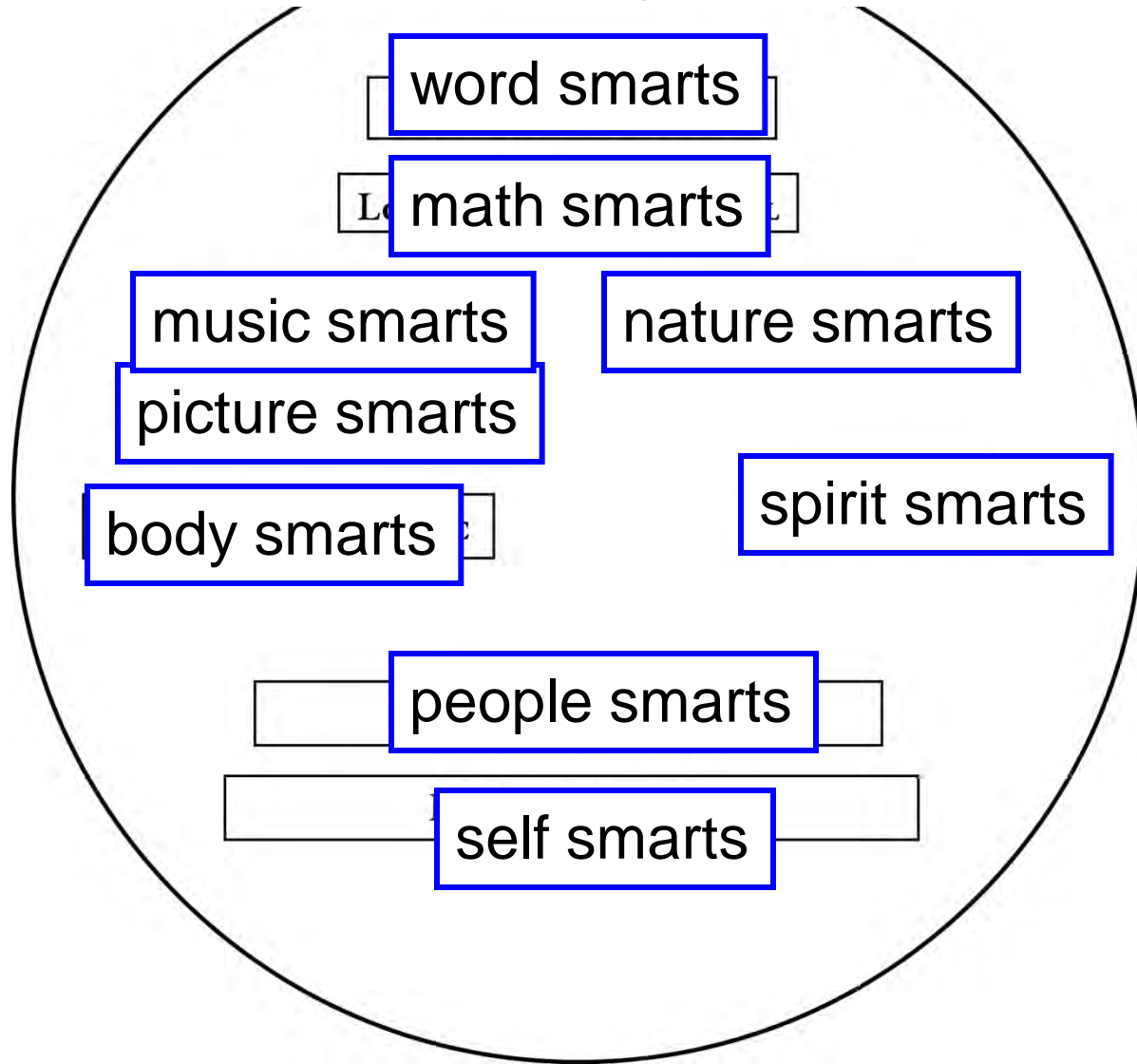
multiple intelligences theory

(H. Gardner, Harvard Univ.)

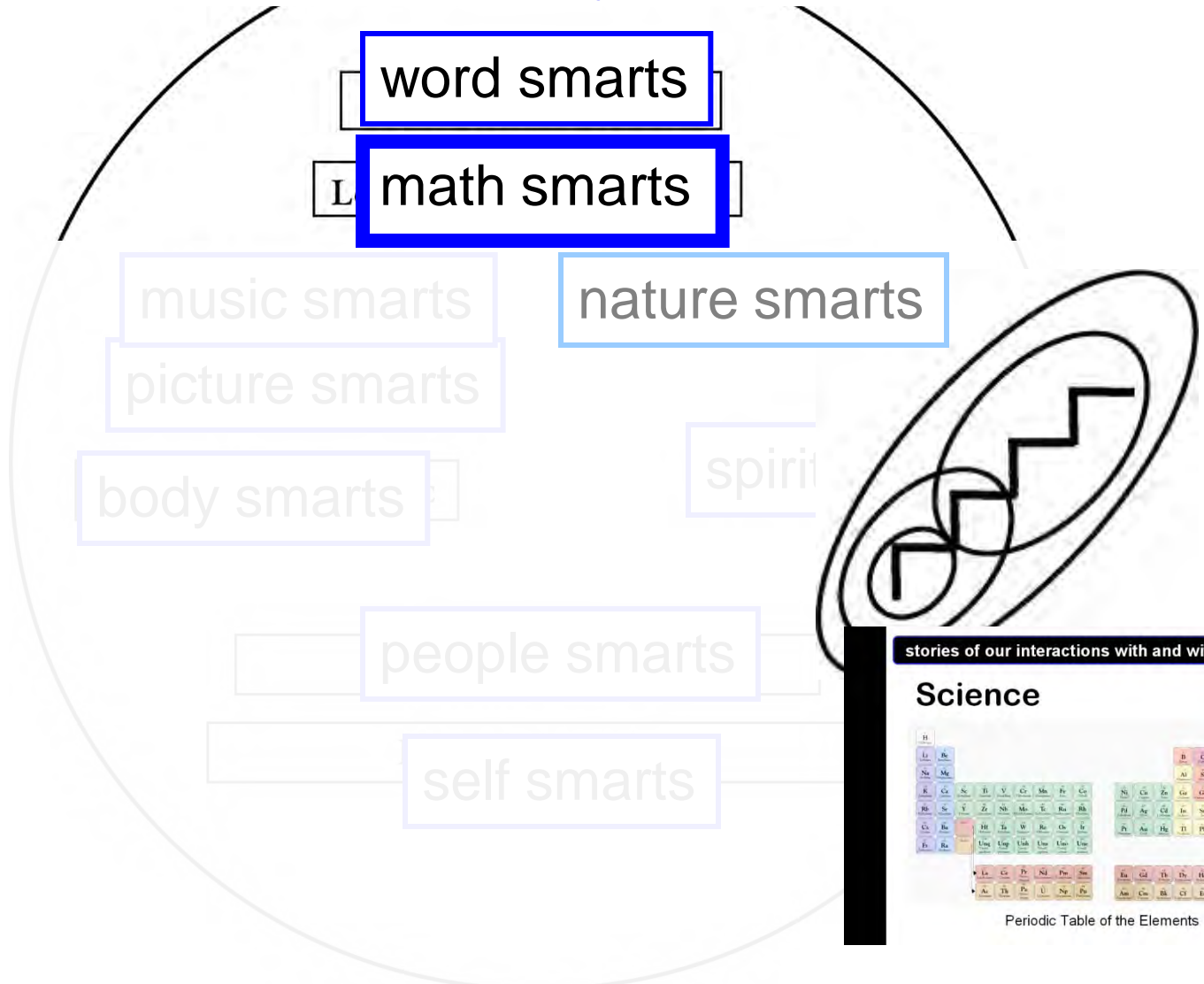
our science stories ...
draw upon our “**pattern smarts**”



our different science stories ... privilege different "pattern smarts"



our different science stories ... privilege different "pattern smarts"



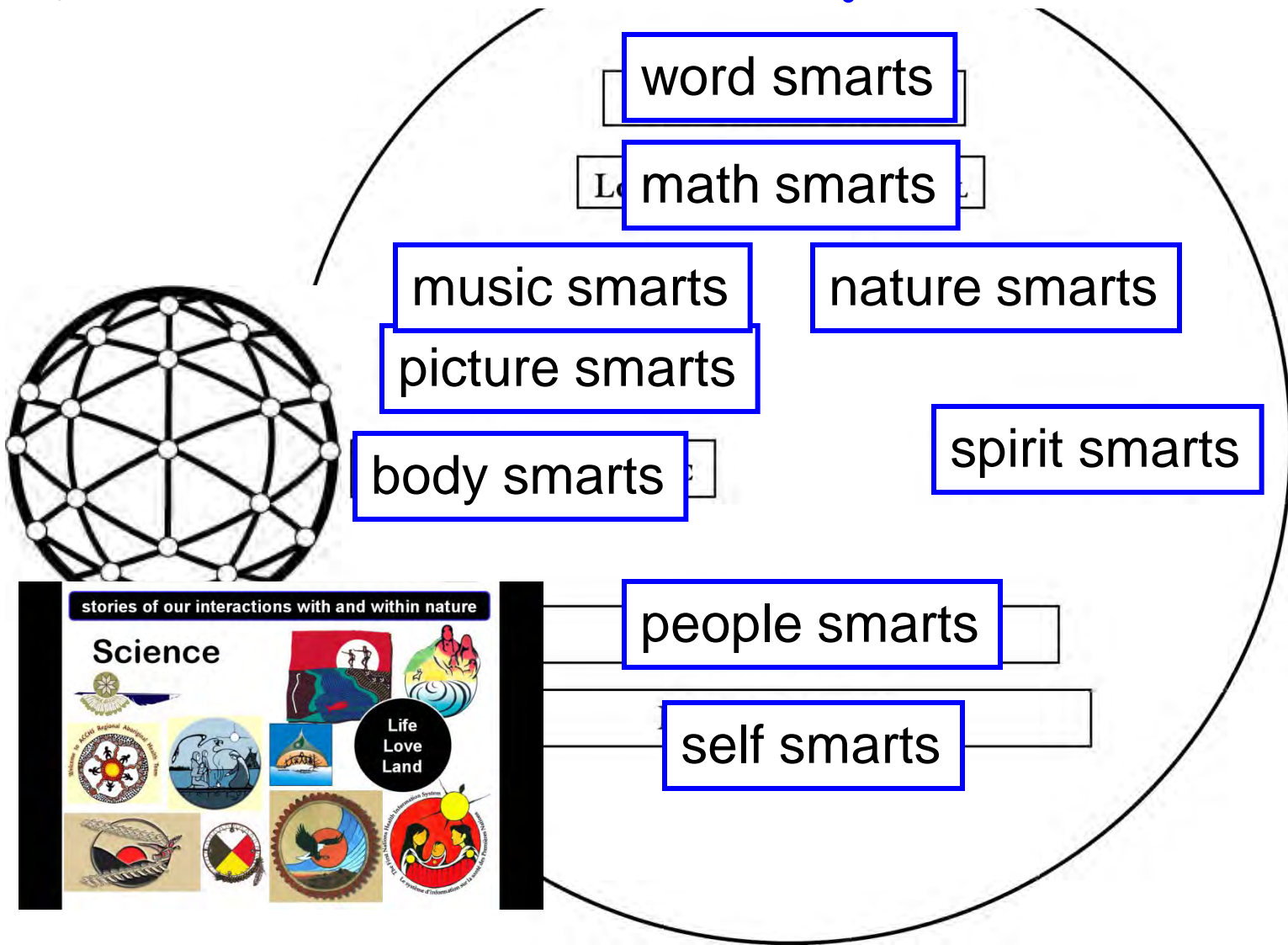
stories of our interactions with and within nature

Science

H																	He									
Li	Be											B	C	N	O	F	Ne									
Na	Mg											Al	Si	P	S	Cl	Ar									
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Cu							Zn	Ga	Ge	As	Se	Br	Kr					
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh							Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe			
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir							Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn			
Fr	Ra																									
		Lu	Ce	Pr	Nd	Pm	Sm											Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		Ac	Th	Pa	U	Np	Pu											Am	Cm	Bk	Cf	Es	Fm	Md	Nr	Lr

Periodic Table of the Elements

our different science stories ... privilege different "pattern smarts"



FEAR

domain of the
unknown

Land of Eagle



ONE WHO SEES BIG PATTERNS

domain of the
known

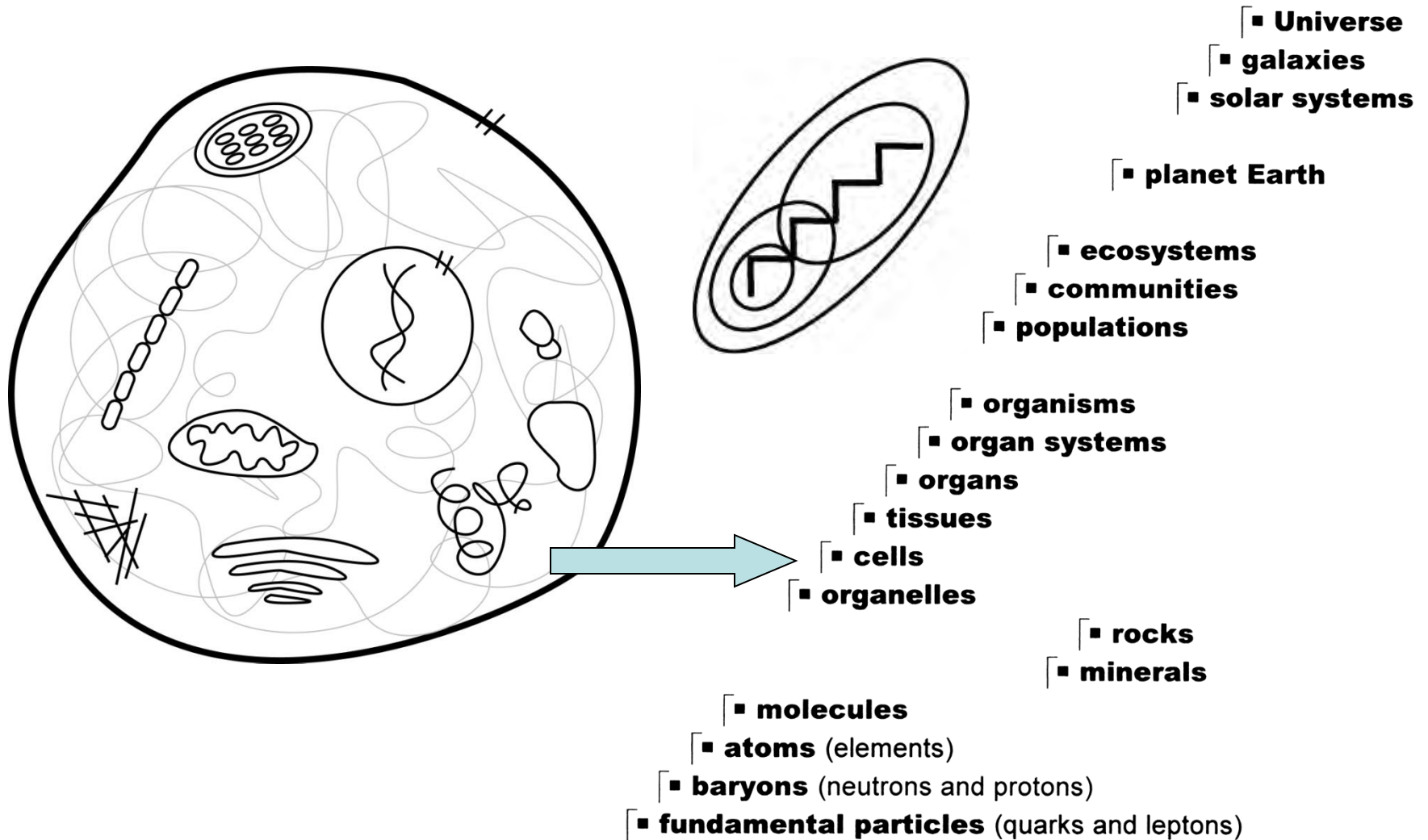


“must become
PATTERN-able”

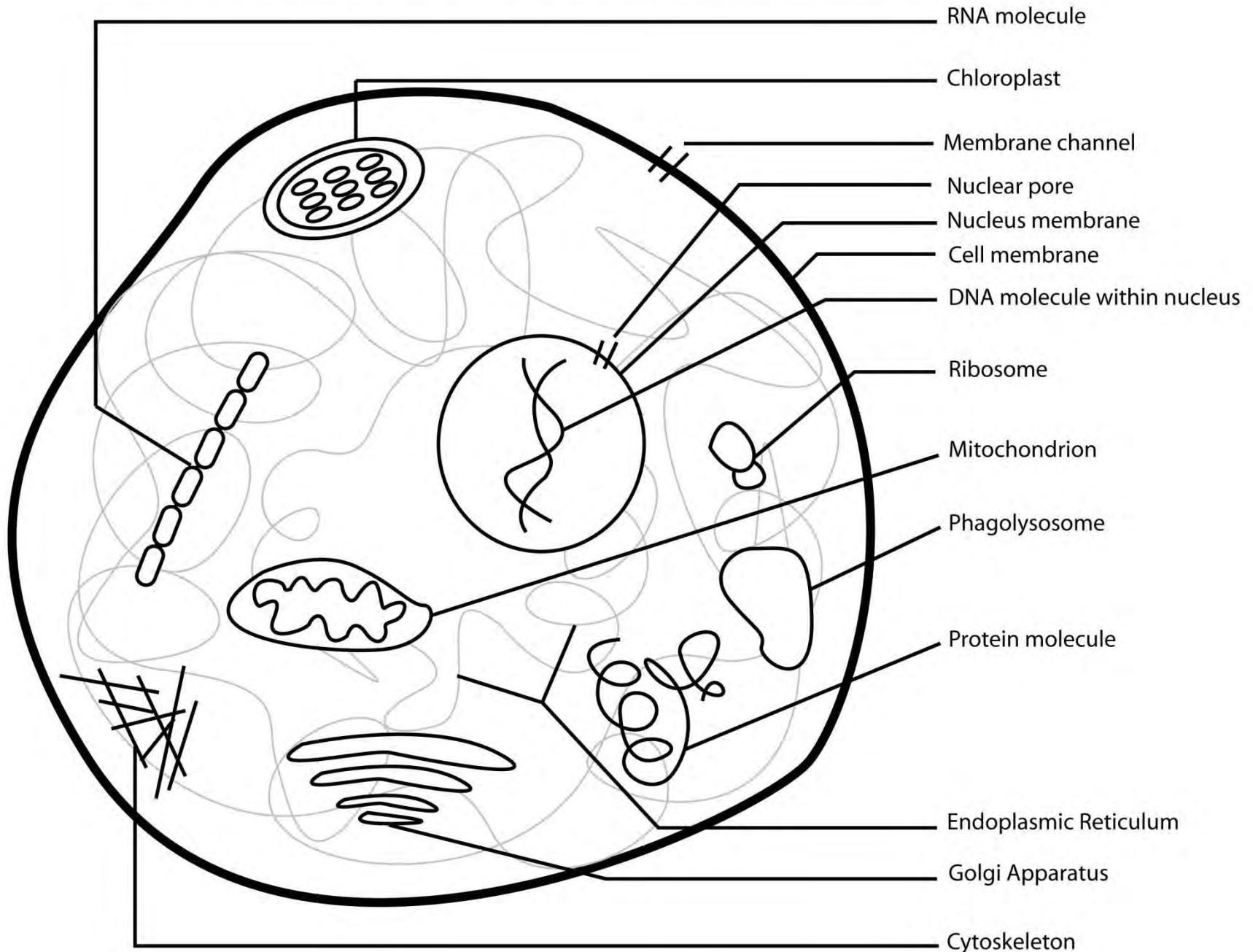
(Douglas J. Cardinal)
architect

HOLARCHY

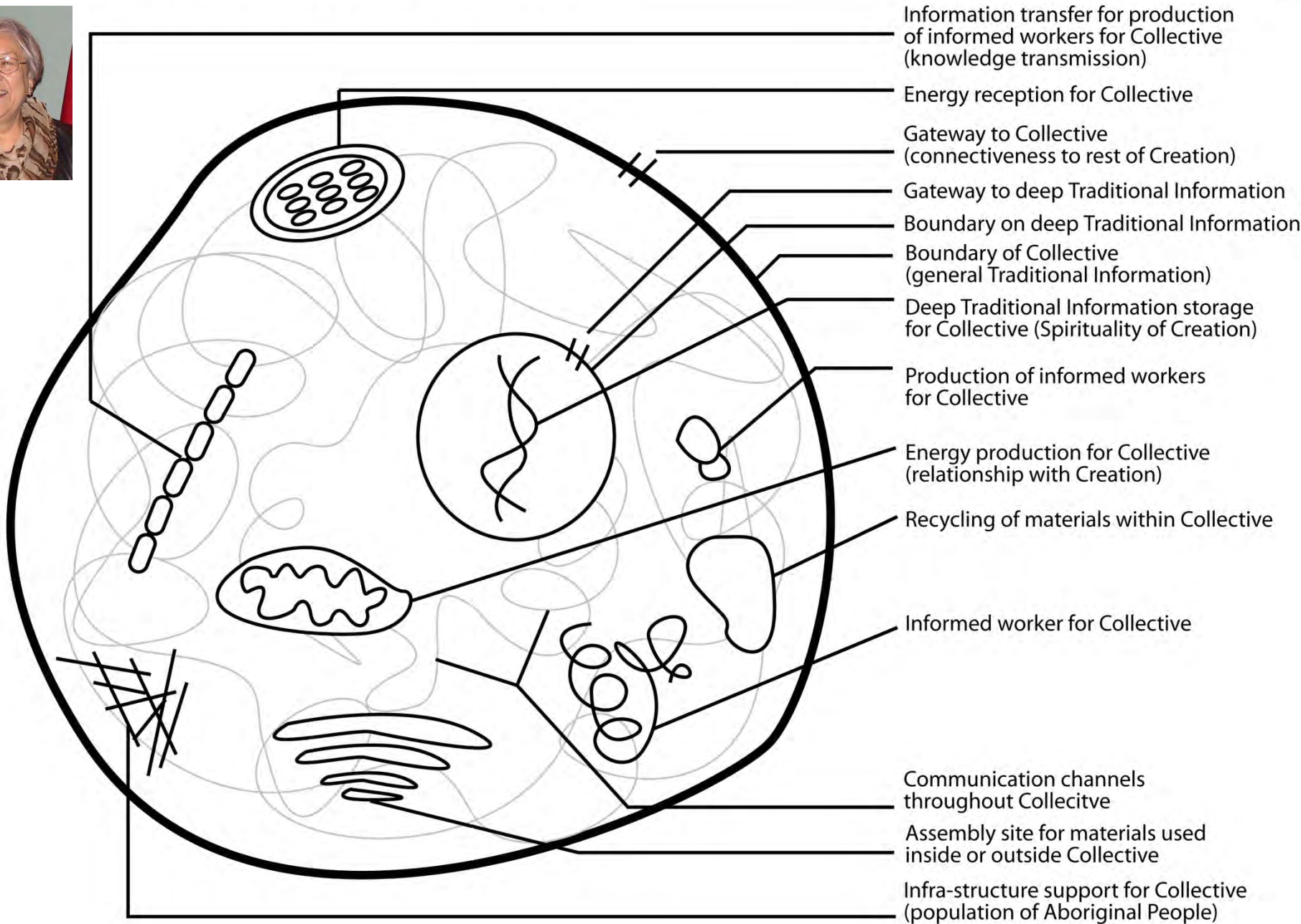
- VISIBLE MATTER IN THE UNIVERSE -

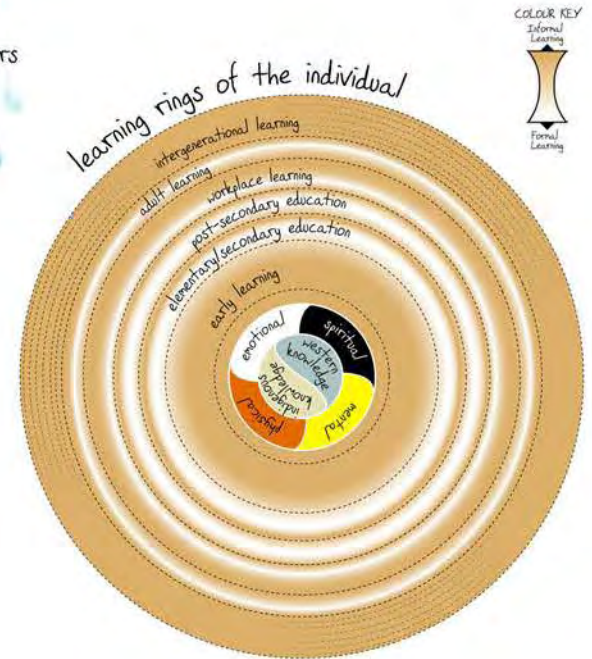
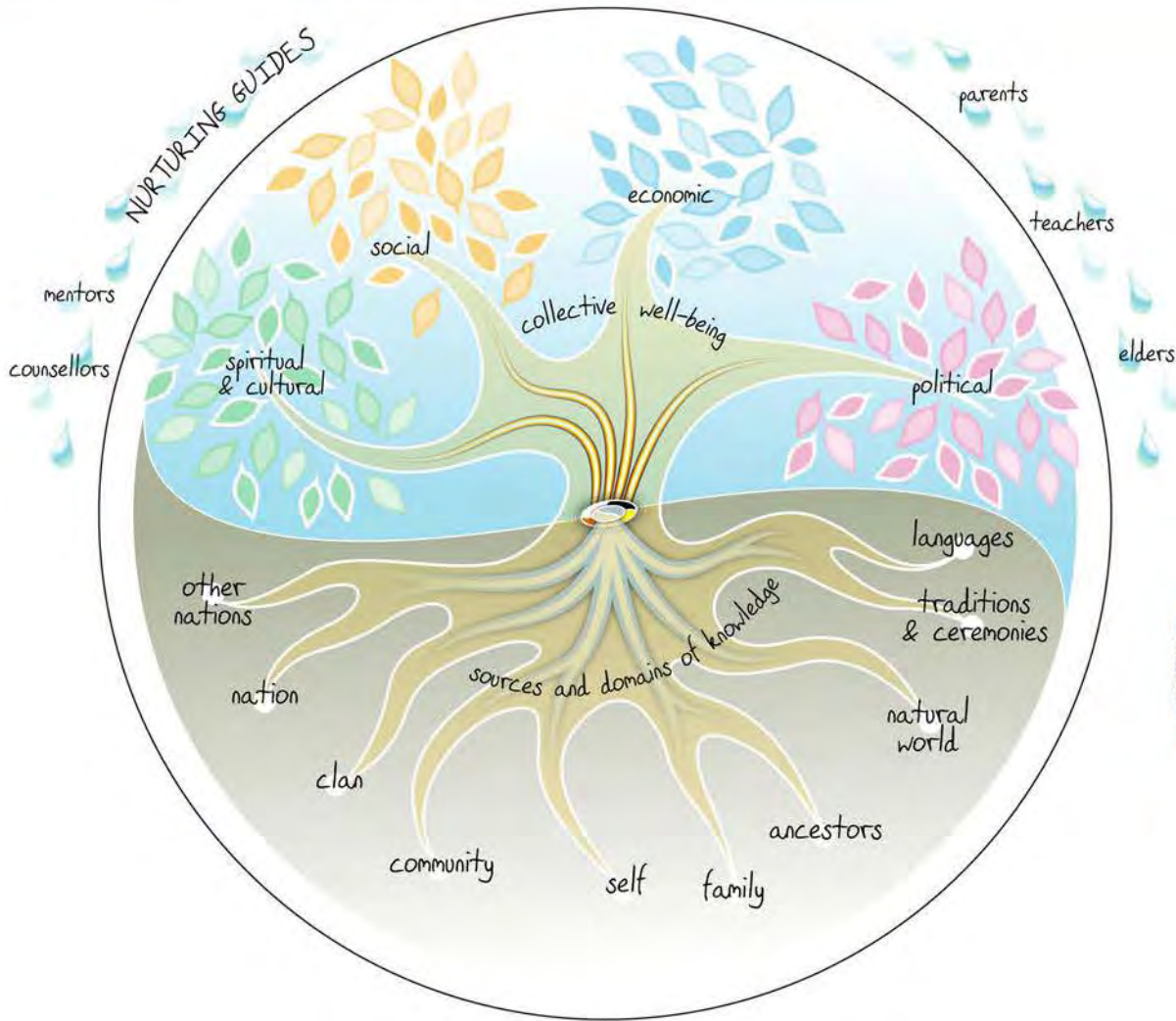


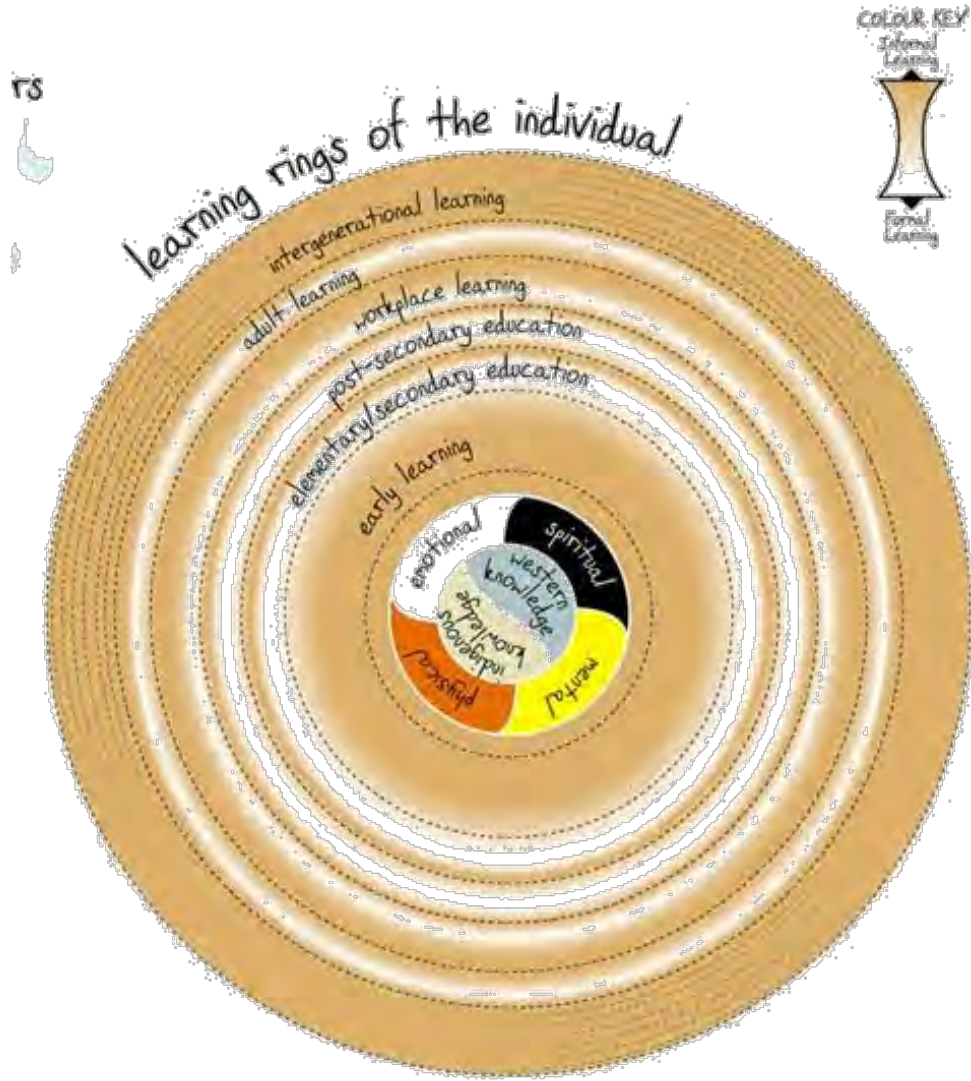
The Collective: Its Parts (example = the living cell)



Traditional Aboriginal Knowledge Collective (Elder Murdena Marshall BA, MEd)







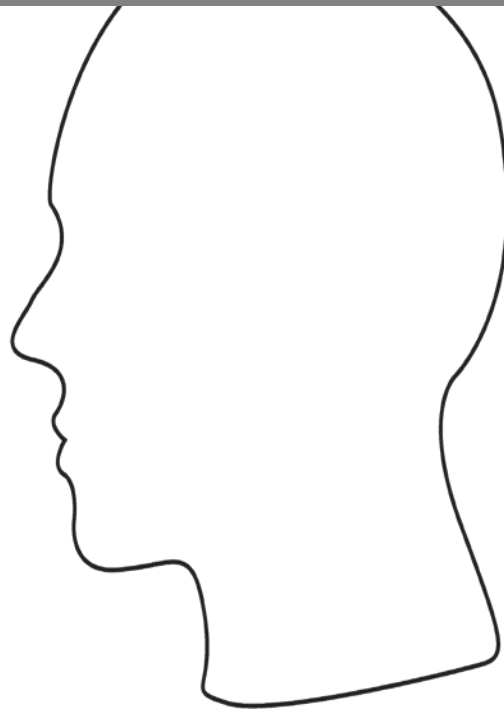
Aboriginal Learning Knowledge Centre – Canadian Council on Learning

PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



muin / Ursa major

SANCTIONED

PERSPECTIVES & INTELLIGENCES:

who we are; where we are; where we were;
what we know, do and value

PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



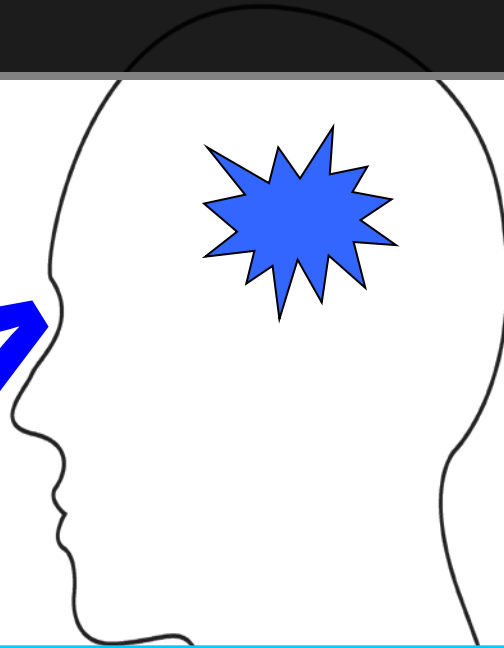
Big
Dipper



**SANCTIONED
PERSPECTIVES & INTELLIGENCES:**
who we are; where we are; where we were;
what we know, do and value

PATTERN CONCEPTUAL FRAMEWORK

outer

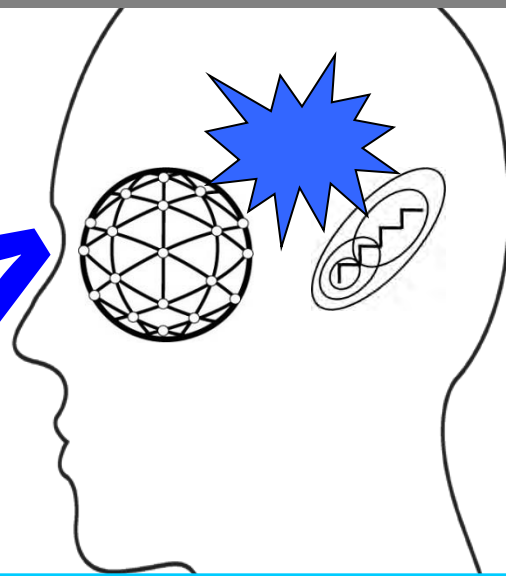


**SANCTIONED
PERSPECTIVES & INTELLIGENCES:**
who we are; where we are; where we were;
what we know, do and value

PATTERN CONCEPTUAL FRAMEWORK

outer

inner



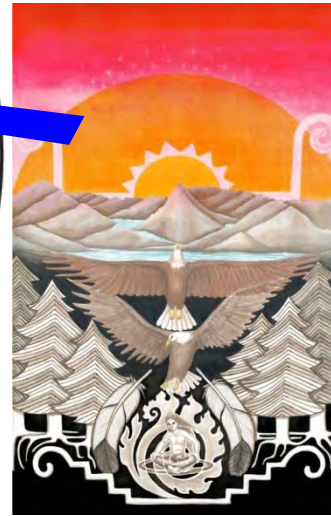
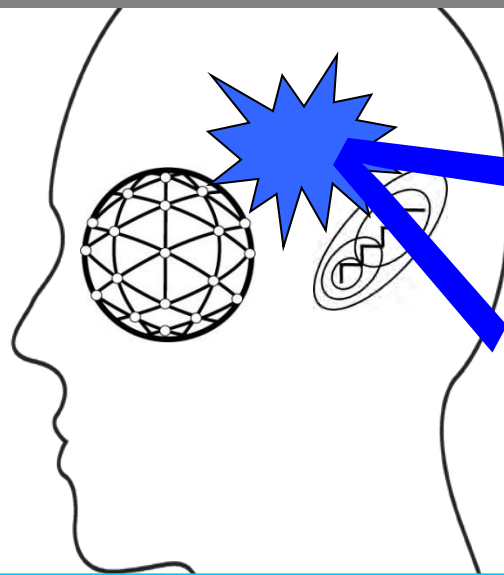
**SANCTIONED
PERSPECTIVES & INTELLIGENCES:**
who we are; where we are; where we were;
what we know, do and value

PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
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SANCTIONED
PERSPECTIVES & INTELLIGENCES:
who we are; where we are; where we were;
what we know, do and value

**participatory &
creative choice**



Artist Basma Kavanagh

**Wjipenuk Etek
Lnuimlkikno'ti
- Spirit of the East -**

East (sunrise)

**... a place of
beginnings and
enlightenment**

**... where new
knowledge can be
created or received
to bring about
harmony or right
relations.**

Physical Direction

detached & instrumental

East (sunrise)

... measurement of the time of sunrise

... for each new day over the course of one full year.

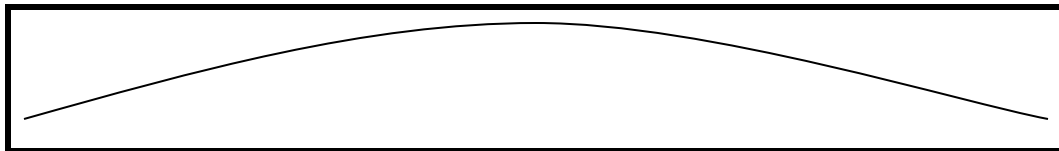
SYDNEY, NS
Rise and Set for the Sun for 2004

Location: W060 11, N46 09 Zone: 4h West of Greenwich

Astronomical Applications Dept.
U. S. Naval Observatory
Washington, DC 20392-5420

Day	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
01	0743	1625	0724	1705	0639	1748	0540	1830	0447	1910	0413	1945	0413	1956	0443	1930	0522	1839	0600	1740	0642	1646	0723	1617
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X



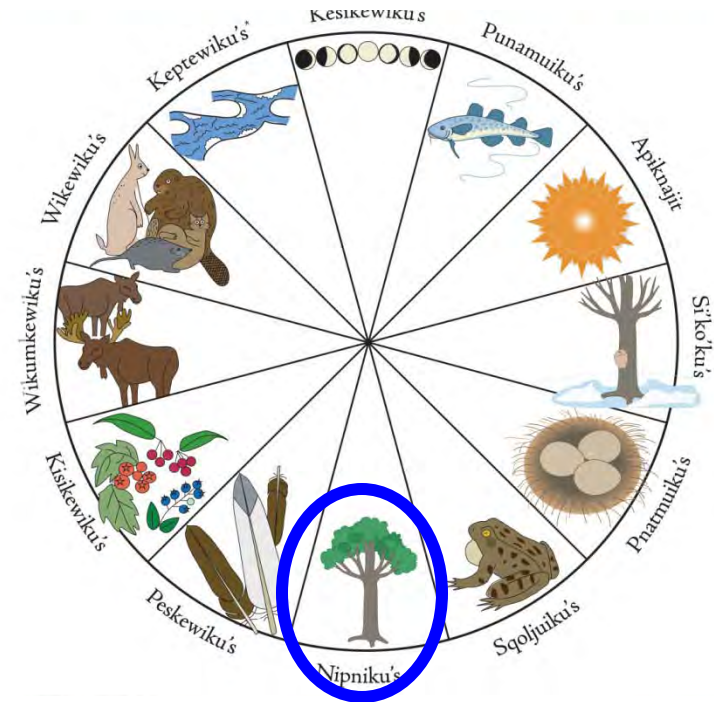
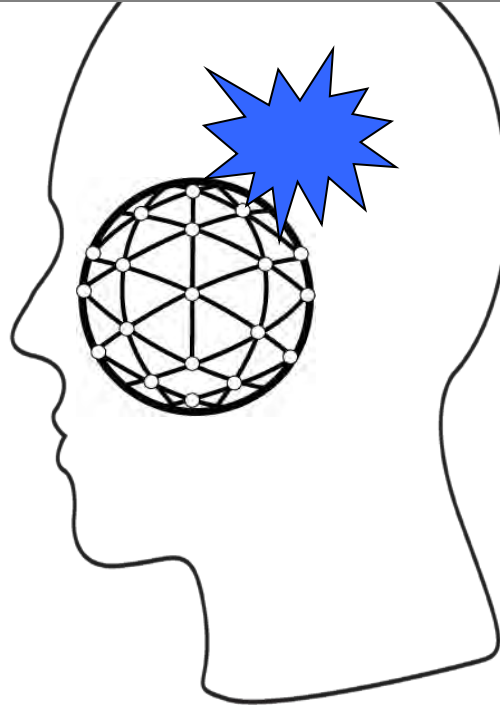
y

PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



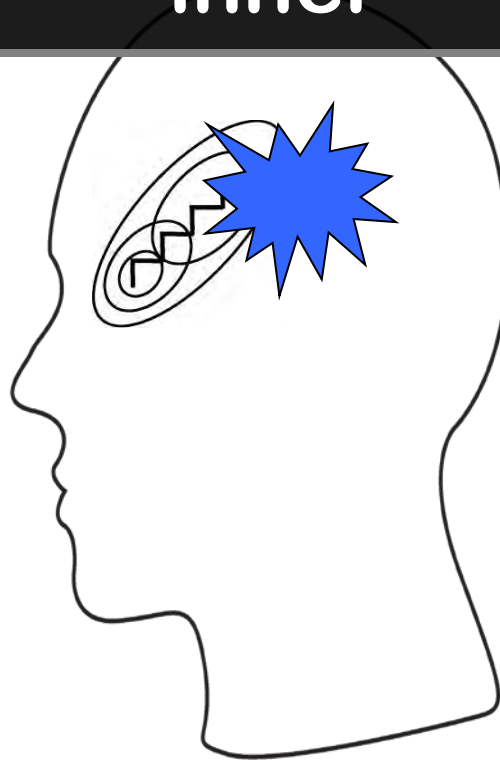
PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer

X



June

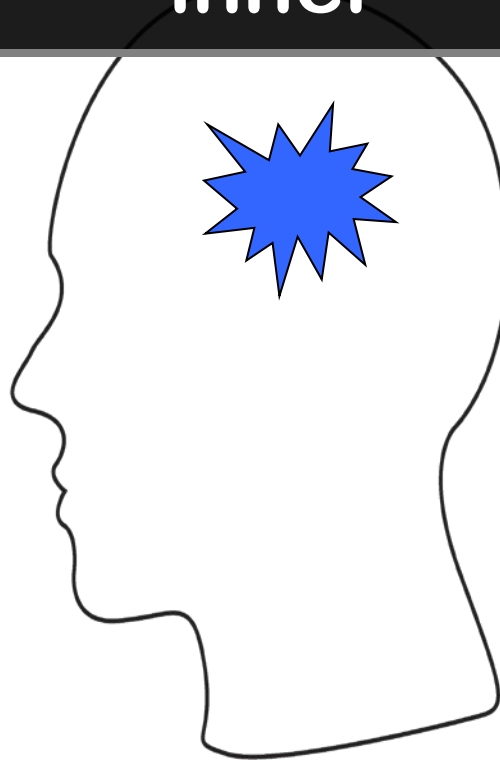
... in honour of
"Juno", the
Roman Queen
of the Gods

PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



Attu'tuejualu



millefolium

1000



Yarrow

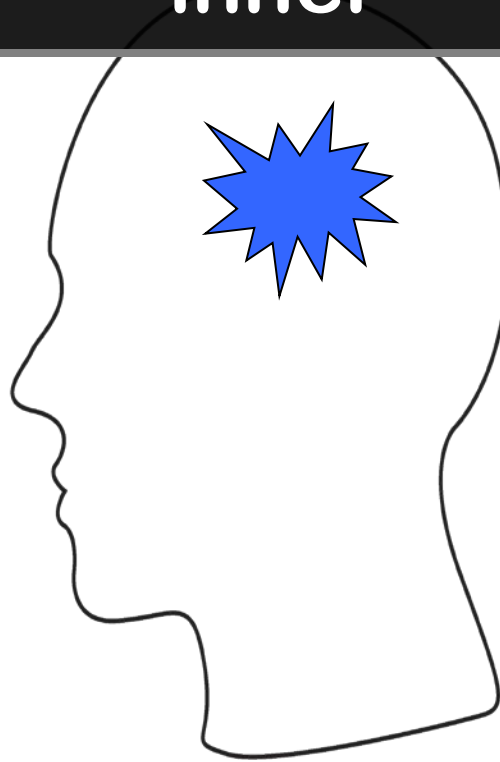


PATTERN CONCEPTUAL FRAMEWORK

outer

inner

outer



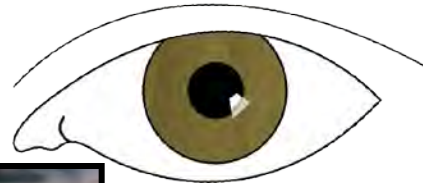
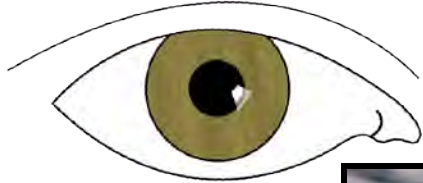
Mtèskmwaqsil



Fiddlehead
fern

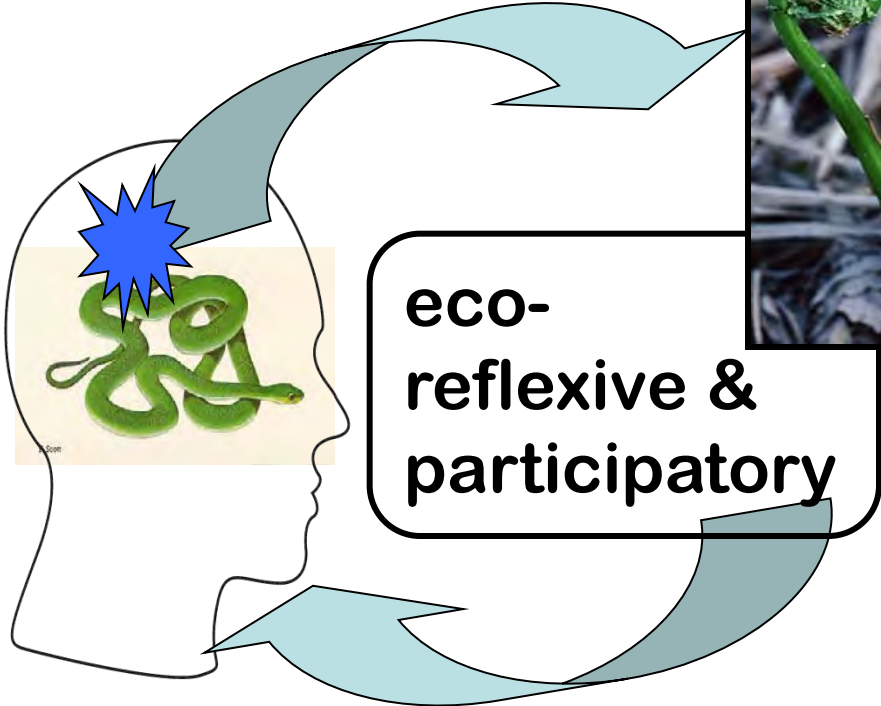


what our "pattern seeing" (re)generates



subject-subject

subject - object



**eco-
reflexive &
participatory**



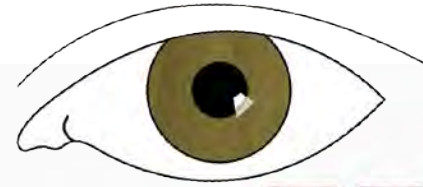
**cogno-
centric &
detached**

connectedness

disconnectedness

stories of our interactions with and within nature

Science



1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium															10 Ne Neon	
11 Na Sodium	12 Mg Magnesium															18 Ar Argon	
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt							36 Kr Krypton		
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium							54 Xe Xenon		
55 Cs Cesium	56 Ba Barium	57-71	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium							86 Rn Radon		
87 Fr Francium	88 Ra Radium	89-103	104 Unq Unnilquadium	105 Unp Unnilpentium	106 Unh Unnilhexium	107 Uns Unnilseptium	108 Uno Unniloctium	109 Une Unnilennium									
			57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium									
			89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium									

																3 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine										
																13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine										
28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine						36 Kr Krypton																	
46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine						54 Xe Xenon																	
78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine						86 Rn Radon																	
																63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium						
																95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium						

Periodic Table of the Elements

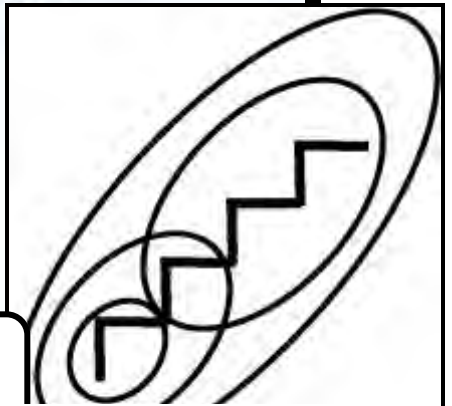
Universe: Visible Matter (levels of organization - biology)

Setford, Steve. 1996. Science Facts. Firefly Books Ltd., Willowdale, ON. (pp. 36-37)

- Universe
 - super clusters (Local)
 - clusters (Local Group)
 - galaxies (Milky Way)
 - star systems (Sun)
 - planet Earth
 - ecosystems
 - communities
 - populations
 - organisms
 - organ systems
 - organs
 - tissues
 - cells
 - organelles
 - molecules & minerals
 - atoms (natural elements #1-92; artificial elements #93 & higher)
 - baryons (neutrons & protons)
 - fundamental particles (quarks & leptons)

stories of:

parts & wholes



towards construction
of understanding
of environment

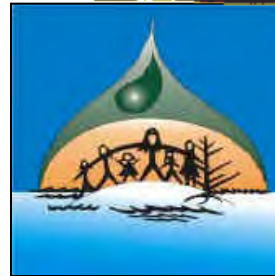


stories of our interactions with and within nature

Science



Life
Love
Land



stories of:

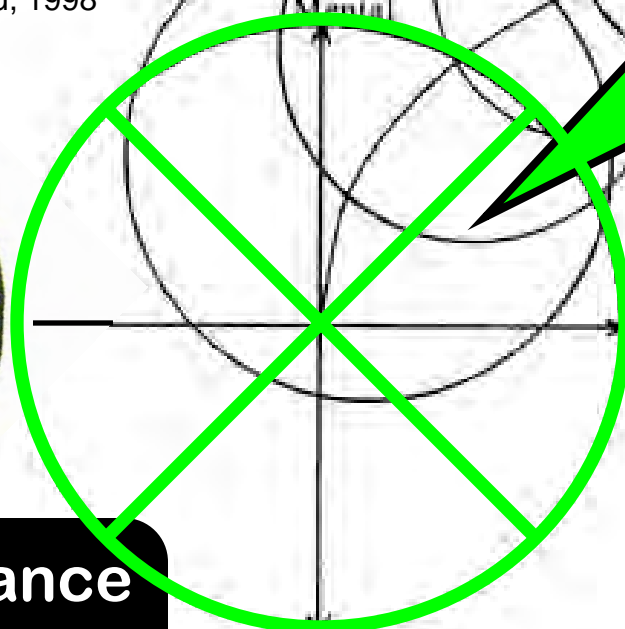
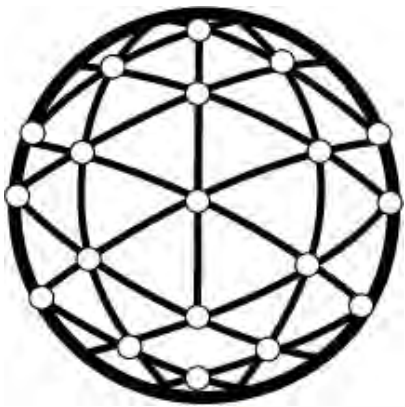
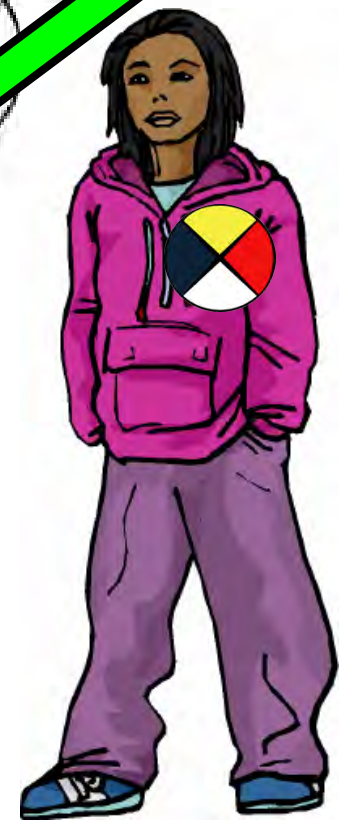
interconnectiveness

~~Vision~~

Artist: Rod Restoule
from: Into the Daylight;
C. Morrisseau, 1998

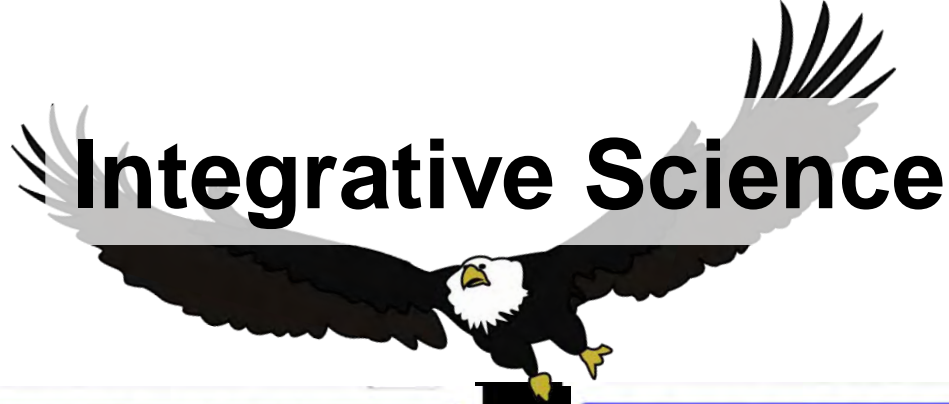
Spiritual

Emotional



**towards resonance
of understanding
within environment**

"all my relations"



Integrative Science

stories of our interactions with and within nature

Science

Life
Love
Land

stories of our interactions with and within nature

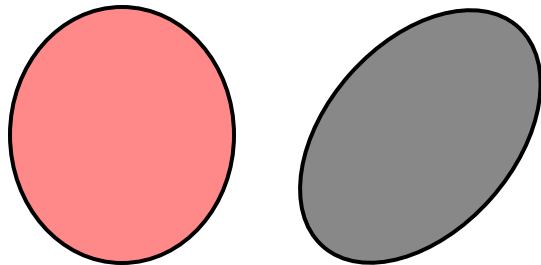
Science

H																	He					
Li	Be											B	C	N	O	F	Ne					
Na	Mg											Al	Si	P	S	Cl	Ar					
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Cu	Zn	Ga	Ge	As	Se	Br	Kr							
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe					
Cs	Ba											Pb	Bi	Po	At	Rn						
Fr	Ra																					
																		Ho	Er	Tm	Yb	Lu
																		Es	Fm	Md	No	Lr

stories of our interactions with and within nature

Science

**Science is
dynamic,
pattern-based
knowledge.**



PATTERNS ...

- spirits within ecosystem-wide minds
- ideas in brain-based minds



Artist Basma Kavanagh

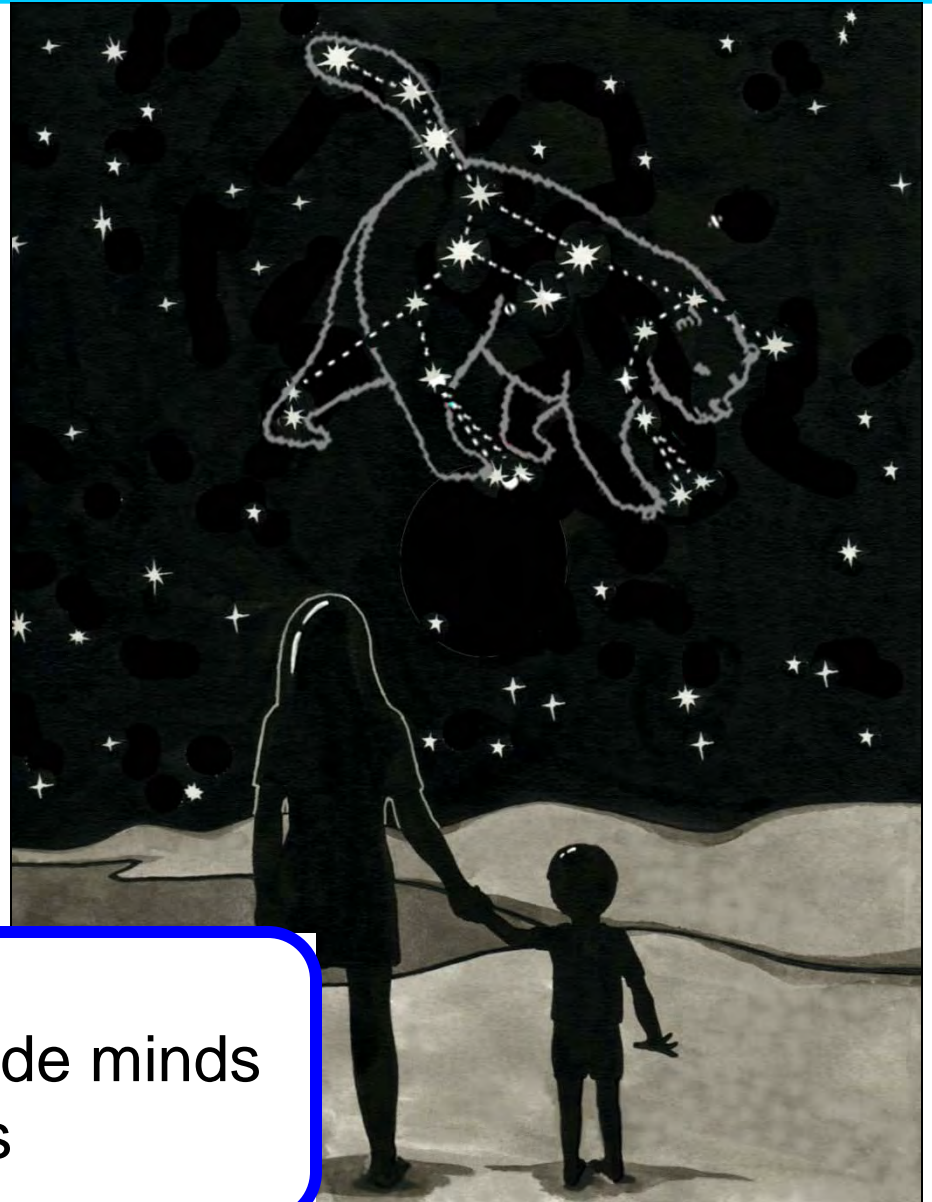
stories of our interactions with and within nature

Science

Sheridan, J. & Longboat, D.
2006. *The Haudenosaunee imagination and the ecology of the sacred.* *Space and Culture* 9(4): 365-381.

PATTERNS ...

- spirits within ecosystem-wide minds
- ideas in brain-based minds



Artist Basma Kavanagh

Canada Research Chairs / Chaires de recherche du Canada / Canada

Social Sciences and Humanities Research Council of Canada / Conseil de recherches en sciences humaines du Canada



Wela'ioq / Thank you



Mi'kmaq Elders

