

Cheryl Bartlett

Professor of Biology

Canada Research Chair

In Integrative Science



**Aboriginal & Western sciences:
pattern consciousness**

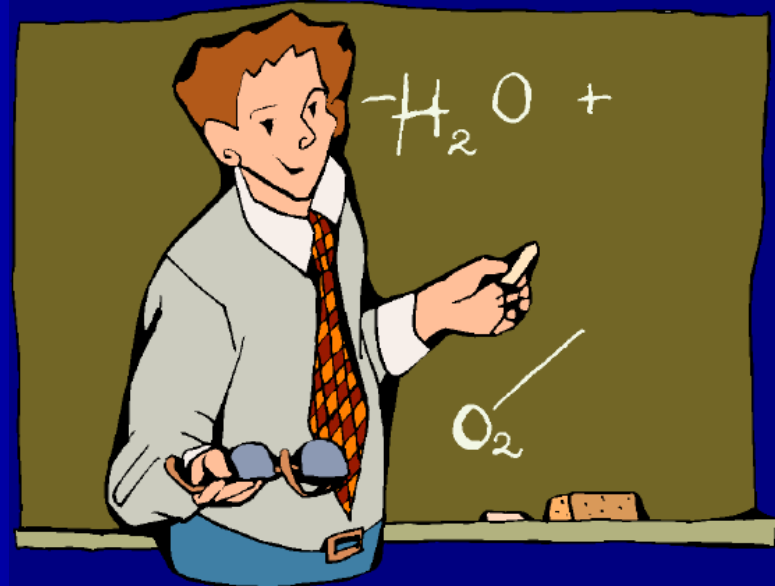
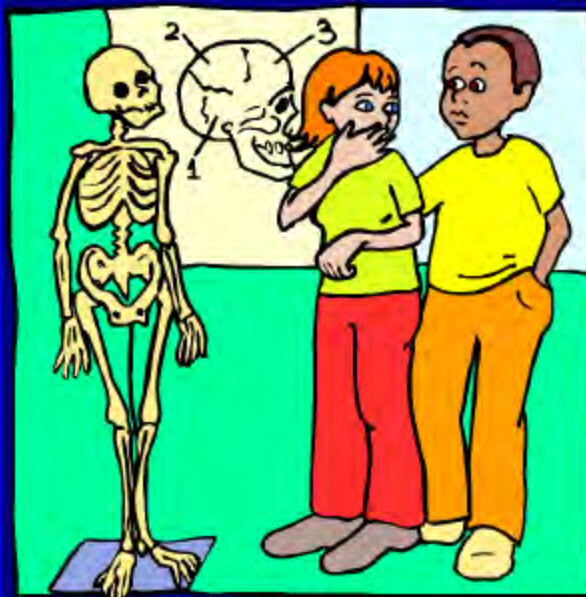
Association of Science Teachers – Nova Scotia – Conference 2004

“SLIDE into Science, Literacy, Inquiry, Discovery, Educate”

Halifax, NS; 22 October 2004

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, Univ. of New Mexico

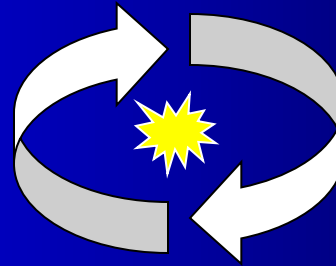


Outline of presentation

1. science education ... dilemma re cultural diversity
2. all cultures converse with Nature ... what language?
3. pattern & pattern smarts

4. Integrative Science ... "co-seeing":
bringing Western & Aboriginal knowledges together

- aspects
- common ground
- differences
- forward together

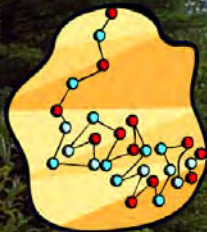


5. human consciousness
6. metaphor
7. conclusion

A photograph of a sunset over a body of water. The sun is a bright orange-yellow orb on the horizon, with a horizontal lens flare extending across the sky. The sun's reflection is visible in the water below. In the upper right quadrant of the sky, there is a large, faint, reddish circular object, possibly a planet or a moon. The sky transitions from a dark blue at the top to a deep orange near the horizon. The water is dark and calm.

**... “converse” with Mother Nature
... what language?**

recognize
pattern





pattern

A wide-angle photograph of a winter landscape. In the foreground, there is a snow-covered bank with some dry, thin plants. A large body of water, possibly a lake or wide river, occupies the middle ground, reflecting the overcast sky. The right side of the image shows a dense forest of trees along the water's edge. The sky is filled with heavy, grey clouds, with some light breaking through near the horizon. In the upper right corner, the word "pattern" is written in a white, lowercase, sans-serif font inside a black rectangular box.

pattern



pattern

pattern



pattern



pattern

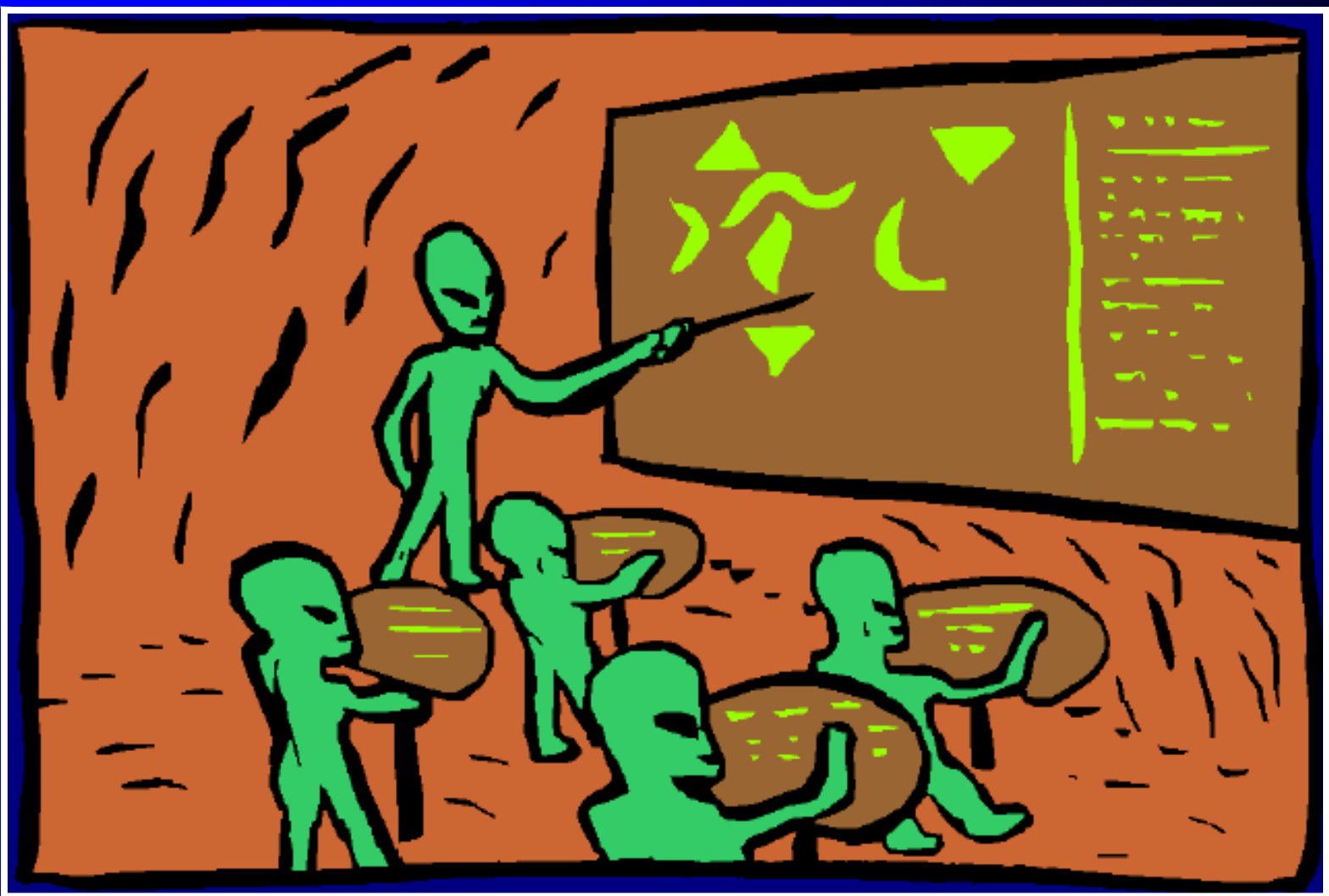


pattern





pattern



after conversing with Mother Nature
... what language do we use to
express and share our understandings?

“pattern smarts”

multiple intelligences theory

(H. Gardner, Harvard Univ.)

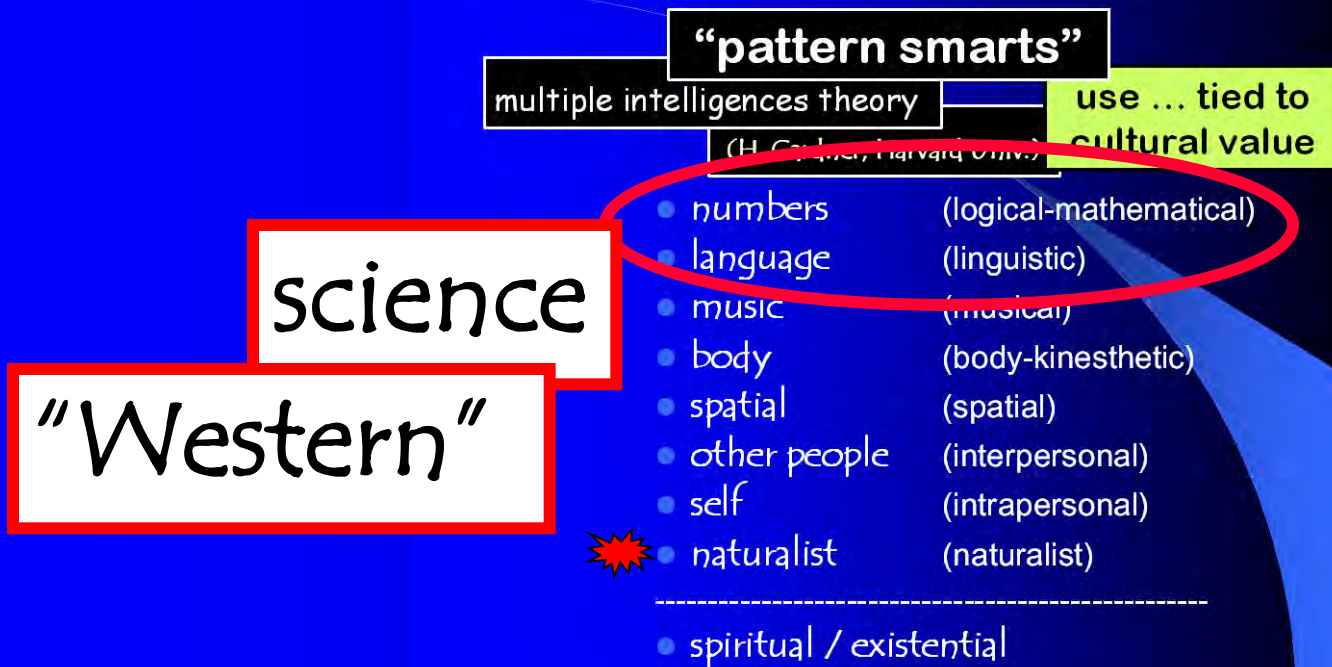
use ... tied to
cultural value

- numbers (logical-mathematical)
- language (linguistic)
- music (musical)
- body (body-kinesthetic)
- spatial (spatial)
- other people (interpersonal)
- self (intrapersonal)
- naturalist (naturalist)

-
- spiritual / existential

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.

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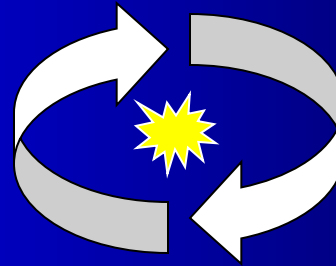


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INTEGRATIVE SCIENCE



Artist Basma Kavanagh

INTEGRATIVE SCIENCE



Artist Basma Kavanagh

INTEGRATIVE SCIENCE

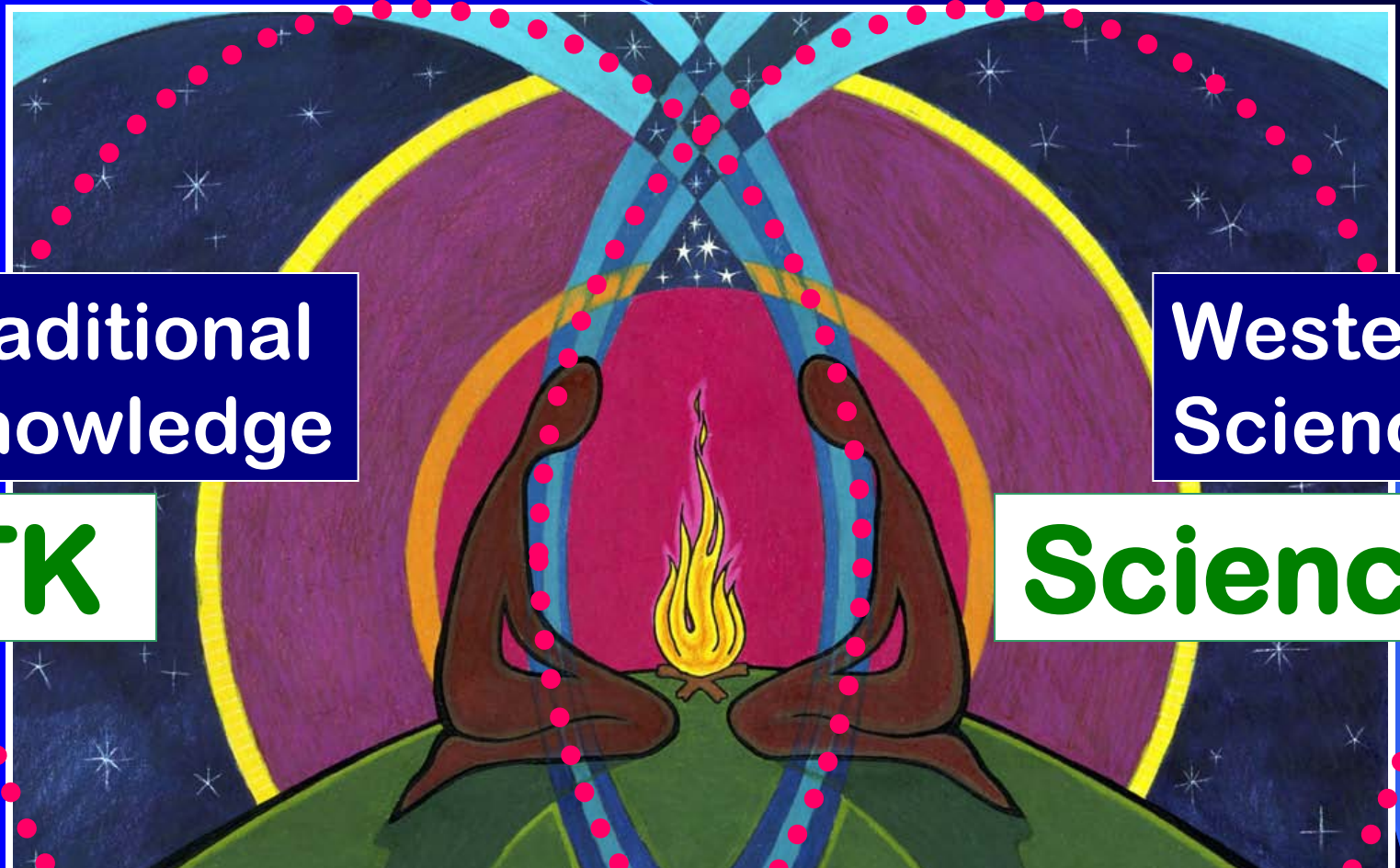
Traditional
Knowledge

TK

Western
Science

Science

“bringing knowledges together”
Aboriginal – Western scientific



Integrative Science ... is:

university
science
education

*

plus other arenas
of relevance



UCCB

University College of Cape Breton

**Sydney
Nova Scotia**

4 year
degree program

Integrative Science ... relevance:



Artist Basma Kavanagh

Community

Resource management

Health

“Sense of ...”

Stewardship/Sustainability

Environmental issues

Ecology

Interpretation

Education

TK & Science ...

"integrative framework"

"integrative" ... both, plus

- our role (you & me) in "the knowing"
- our common ground
- our differences
- our journey forward, together

vs.

"integrated" ... science, plus
bits and pieces of TK

KNOWLEDGE

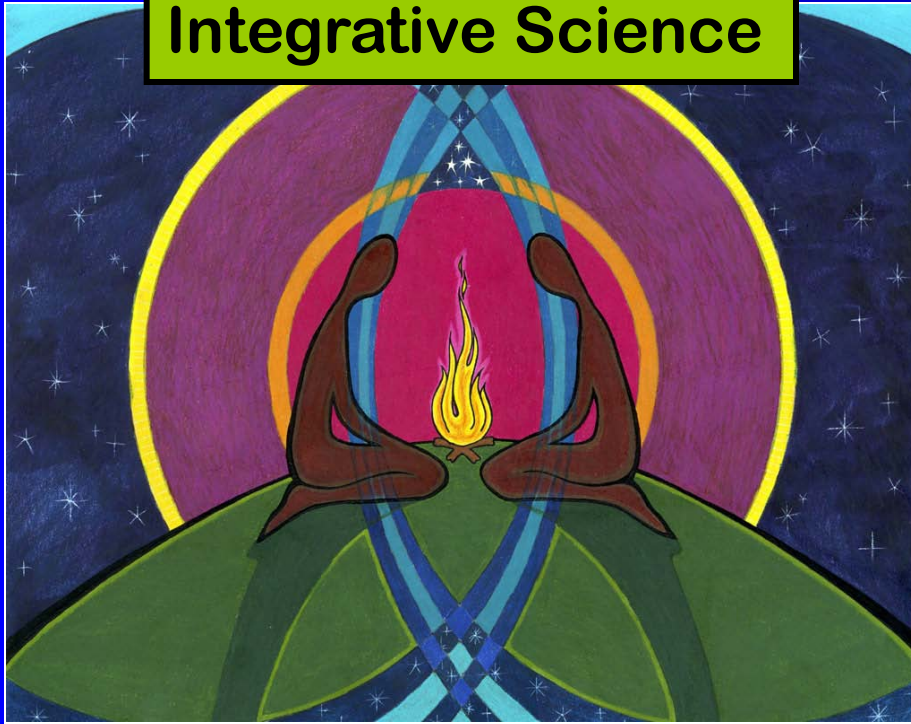
... a resourceful capacity of being that creates the context and texture of life, a living process to be absorbed and understood ... in a specific ecological context (Battiste 2002)

... awareness and understanding of facts, truths, or information gained in the form of experience or learning ... and an appreciation of interconnected details (all-science-fair-projects.com)

... understanding accumulated by systematic study and organized by general principles, with mathematics as much of the basis (FreeDictionary.com)

How?

Integrative Science



Mi'kmaq community Elders,
resource people & organizations,
TK events in community

1

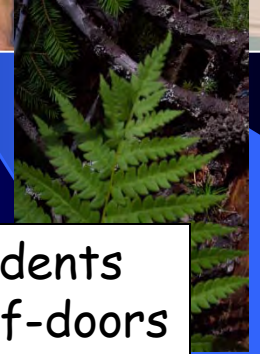


2

TK literature

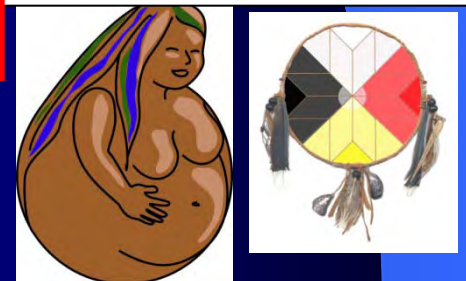
3

students
out-of-doors

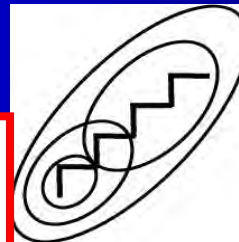


Aboriginal concepts
& pedagogy

4

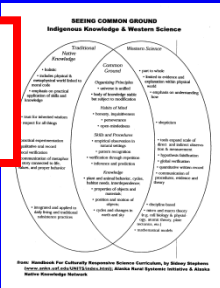


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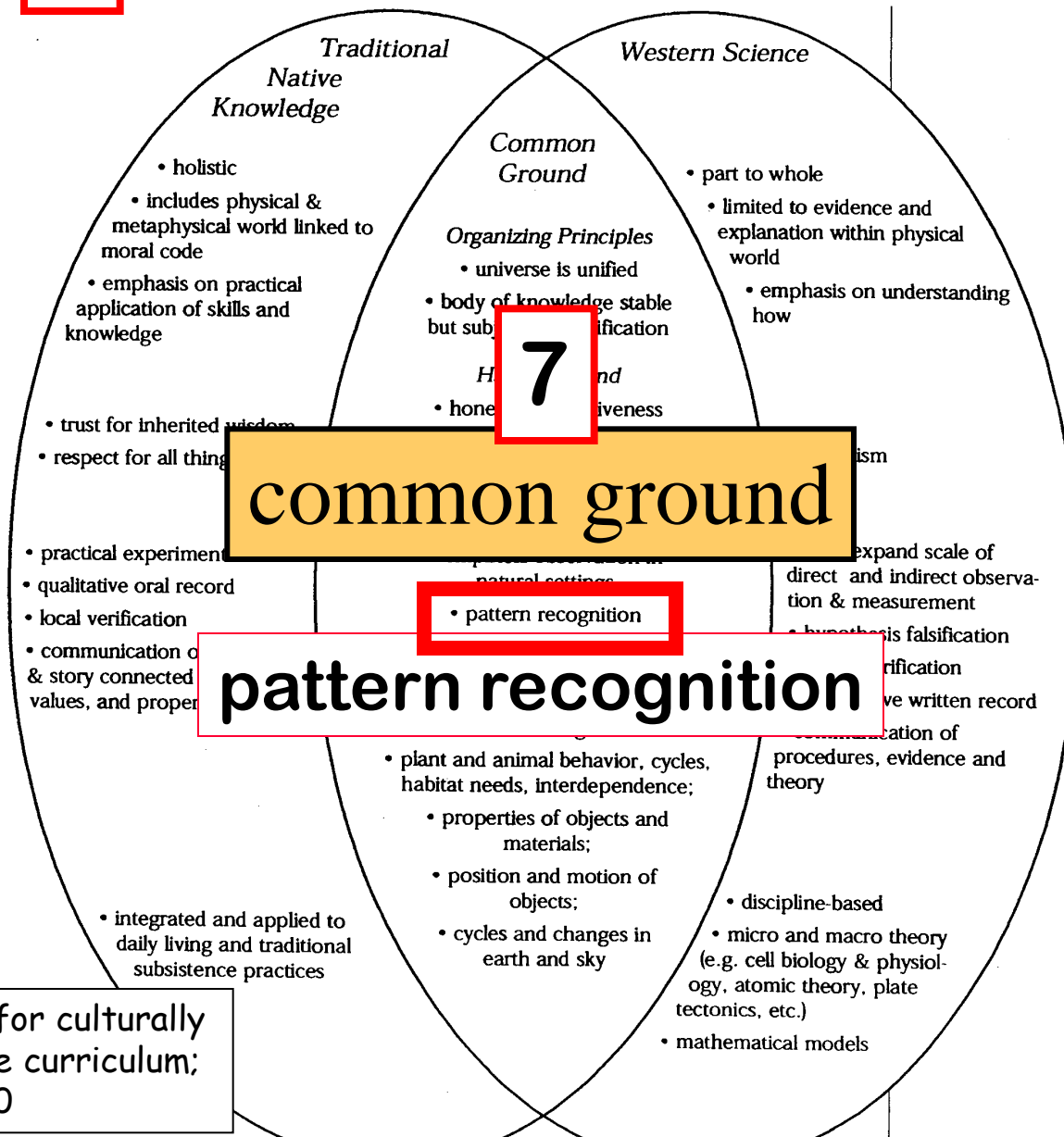
Western science: cosmology-physics-
chemistry-geology-biology-consciousness

6



6

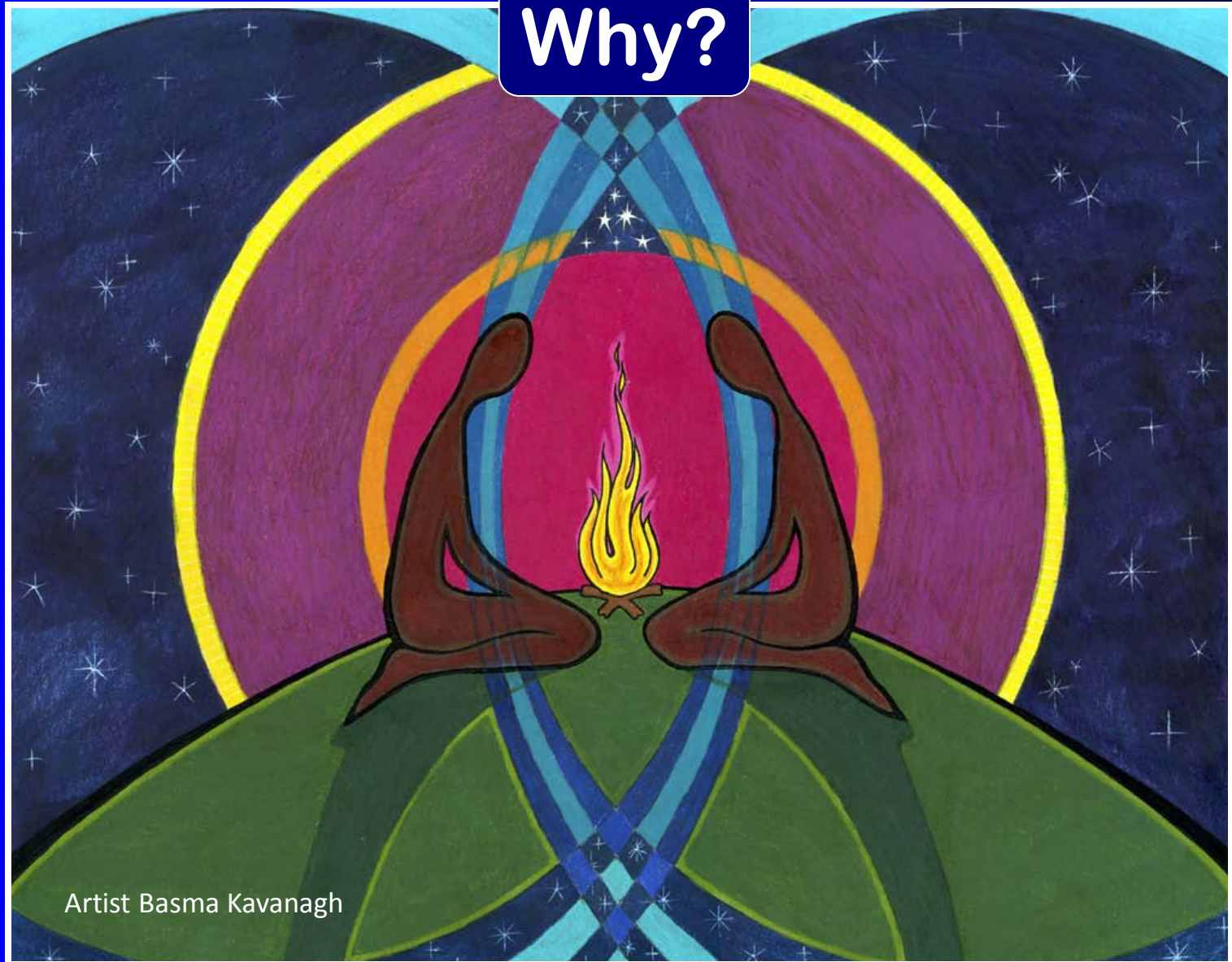
Univ. of Alaska (Fairbanks) Indigenous Knowledge & Western Science



from: Handbook for culturally responsive science curriculum; S. Stephens, 2000

INTEGRATIVE SCIENCE

Why?



Artist Basma Kavanagh

University Science Students

**UCCB 1999-2004:
80-90 Mi'kmaq
students ...
1st year science**



University Science Students



UCCB 2004-2005: Mi'kmaq science students (approx.)

- 1st yr: 10
- 2nd yr: 12
- 3rd yr: 6
- 4th yr: 10

• grads: 4

Integrative Science



Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada

SSHRC

**Our Journey, forward ...
together**

enriching the common ground ...

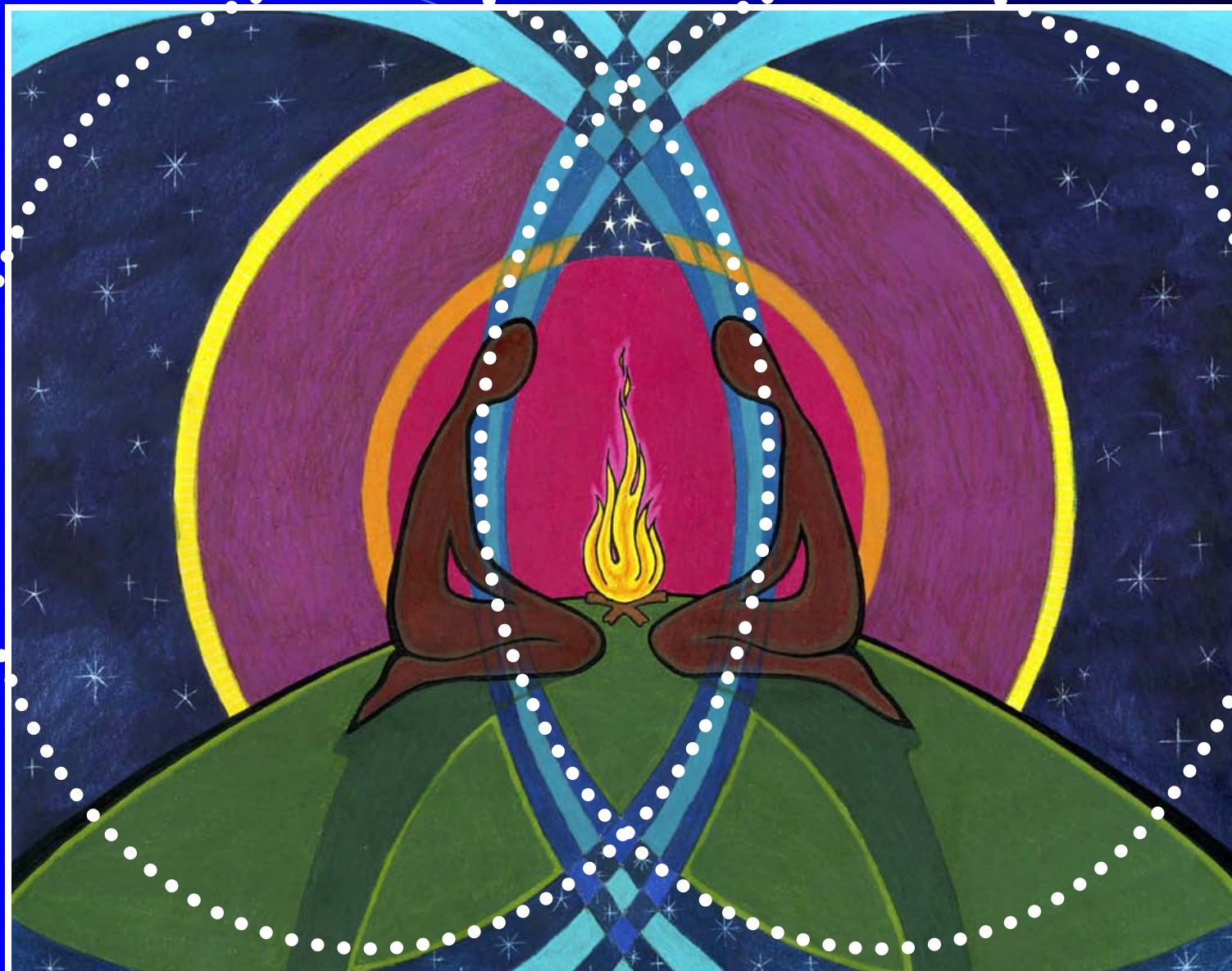
pattern recognition
... into **science curricula**

common ground

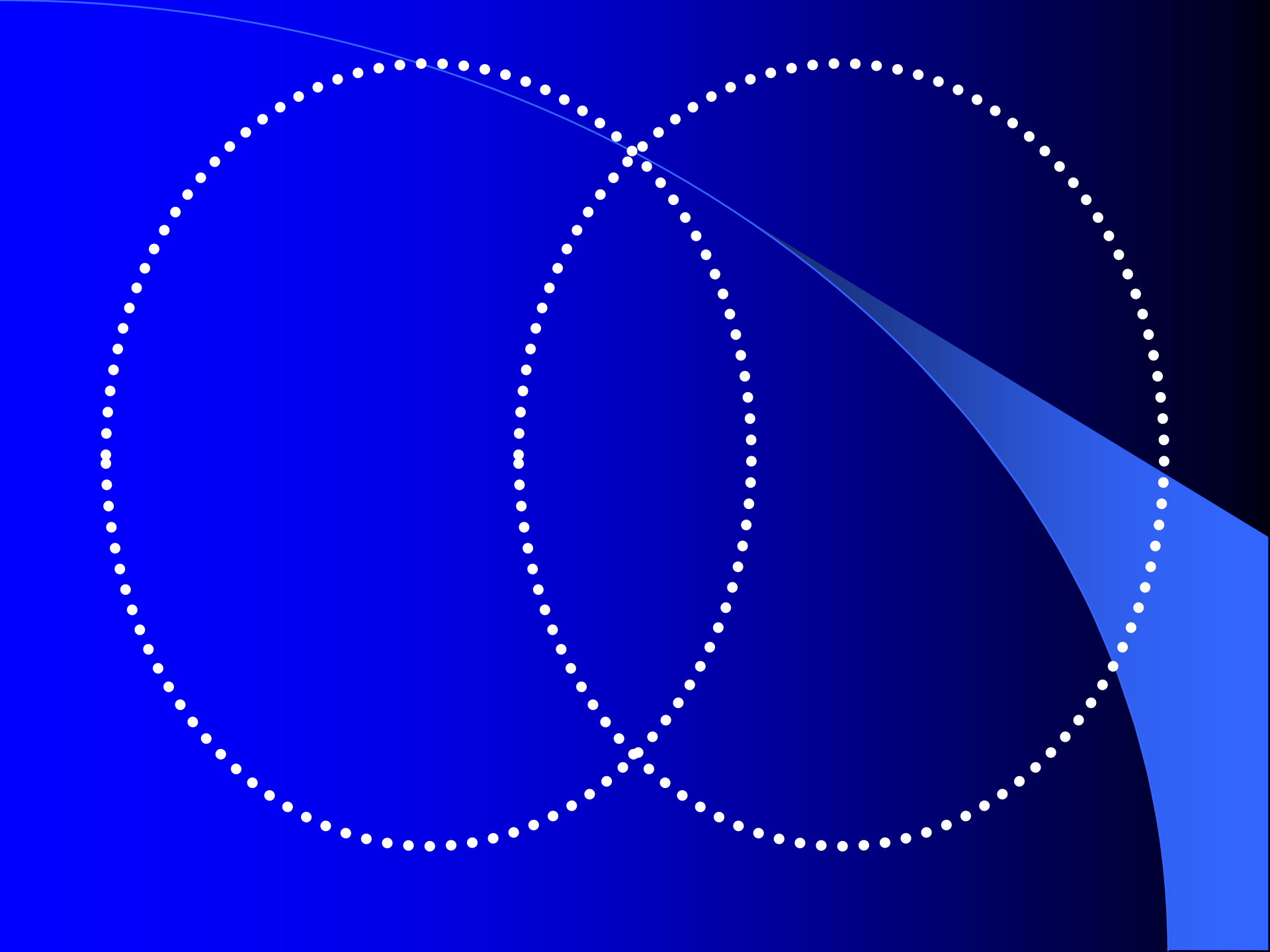
PATTERN RECOGNITION



Artist Basma Kavanagh



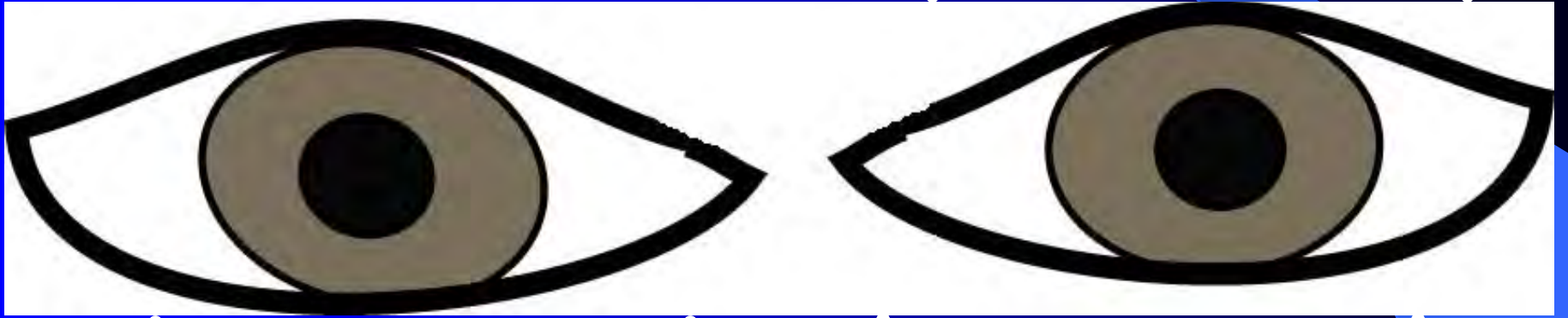
Artist Basma Kavanagh





TK

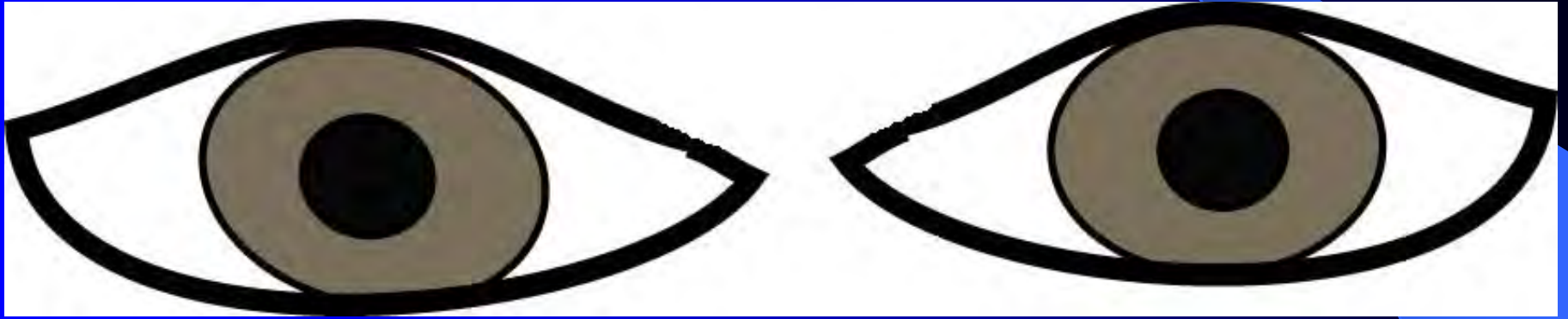
Science



TK

Science

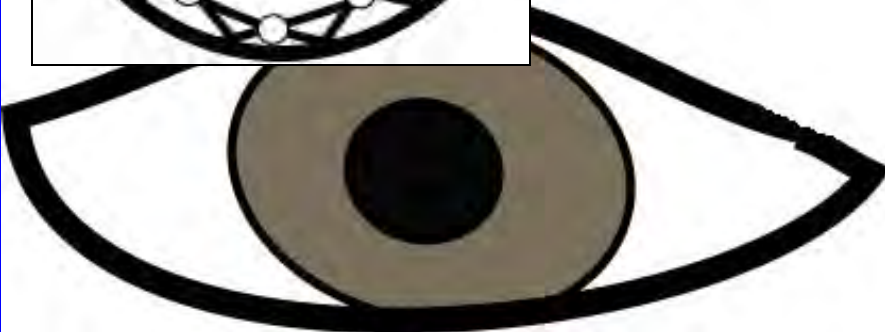
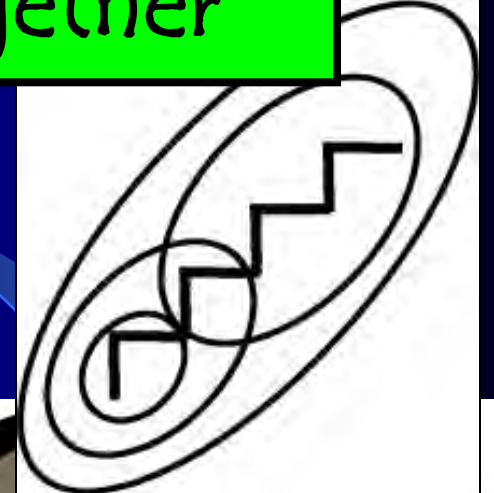
“co-seeing”



TK

Science

“co-seeing”
how the world hangs together



TK

interconnected

Science

parts & wholes

“co-seeing” methodology



TK

WEAVING



Science

UN-WEAVING

“co-seeing”
language & methodology

“vigour” & “rigour”



TK



Science

WEAVING

UN-WEAVING

**“co-seeing”
overall knowledge objective**



**towards resonance
of understanding**



**towards construction
of understanding**

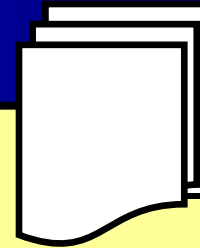
WEAVING

UN-WEAVING



WEAVING

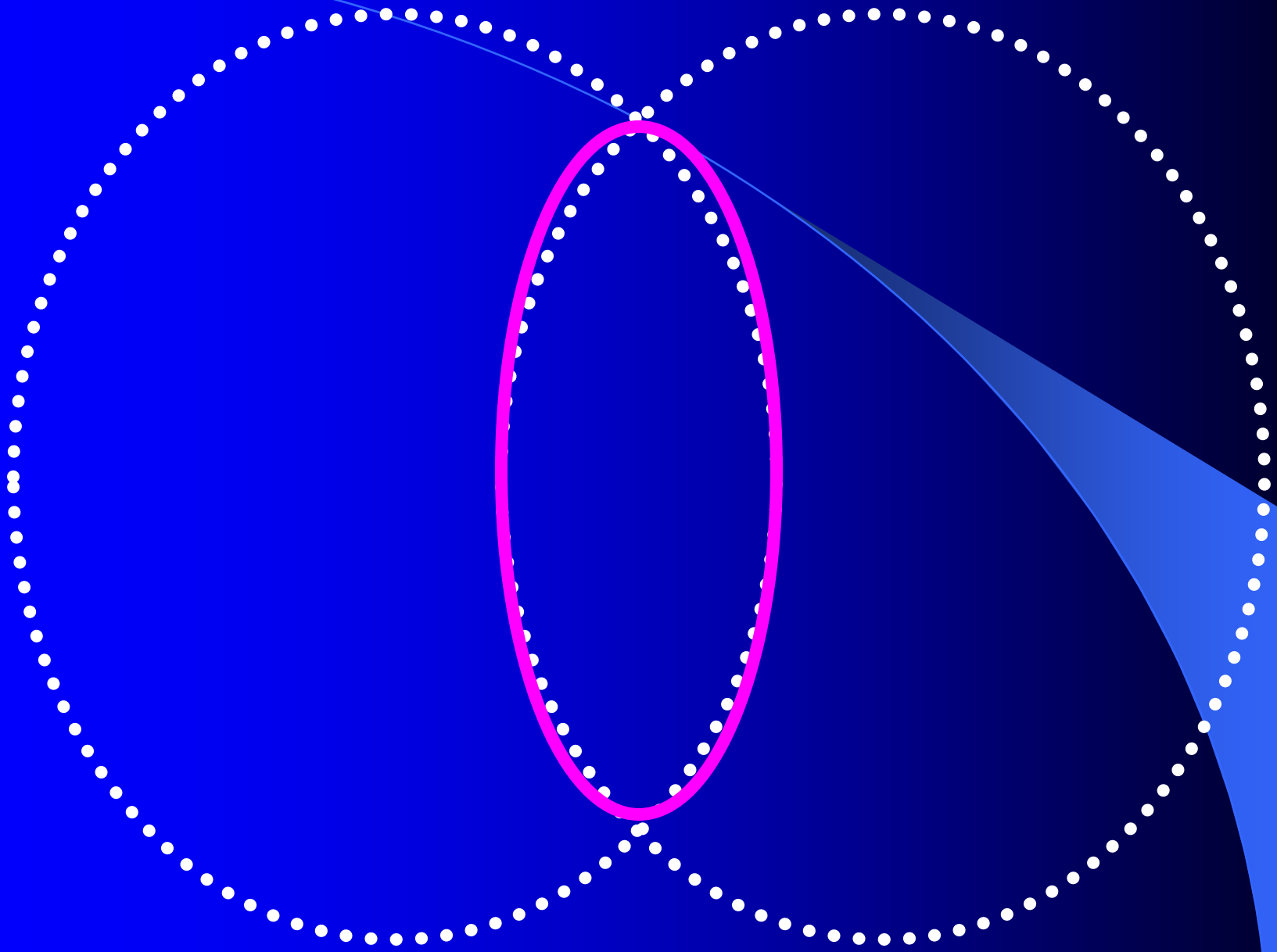
- relationship
- respect
- reverence
- reciprocity
- ritual
- repetition
- responsibility



UN-WEAVING

- data collection
- data analysis
- hypothesis
(induction, deduction)
- testing
- theory

“vigour language” & “rigour language”



common ground

recognize



environmental
patterns

express





common ground

“pattern smarts”

express

recognize

environmental
patterns



common ground

“pattern smarts”

participatory
interconnectedness

masterful
prediction & control

all my relations

- numbers
- language
- music
- body
- spatial
- all creatures
- self
- naturalist
- spiritual

mathematical models

- numbers
- language
- naturalist

environmental
patterns

WEAVING

UN-WEAVING

differences

PATTERN CONCEPTUAL FRAMEWORK



**Mother
Earth**

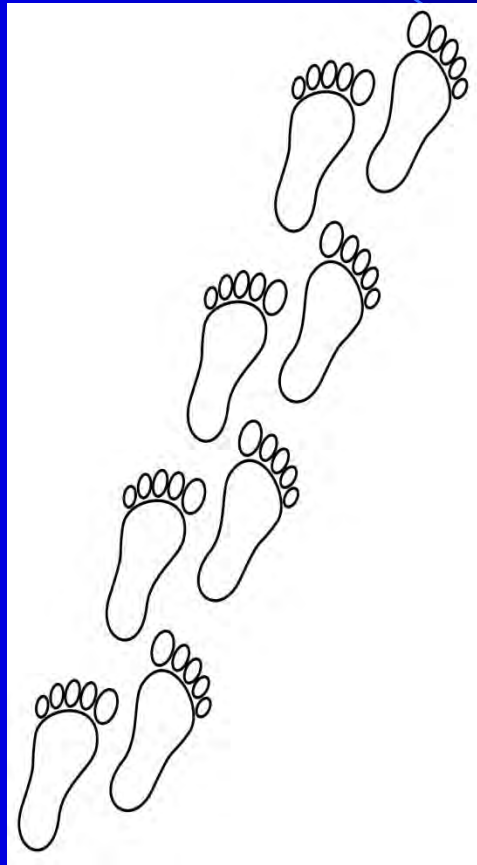
PATTERN CONCEPTUAL FRAMEWORK

natural

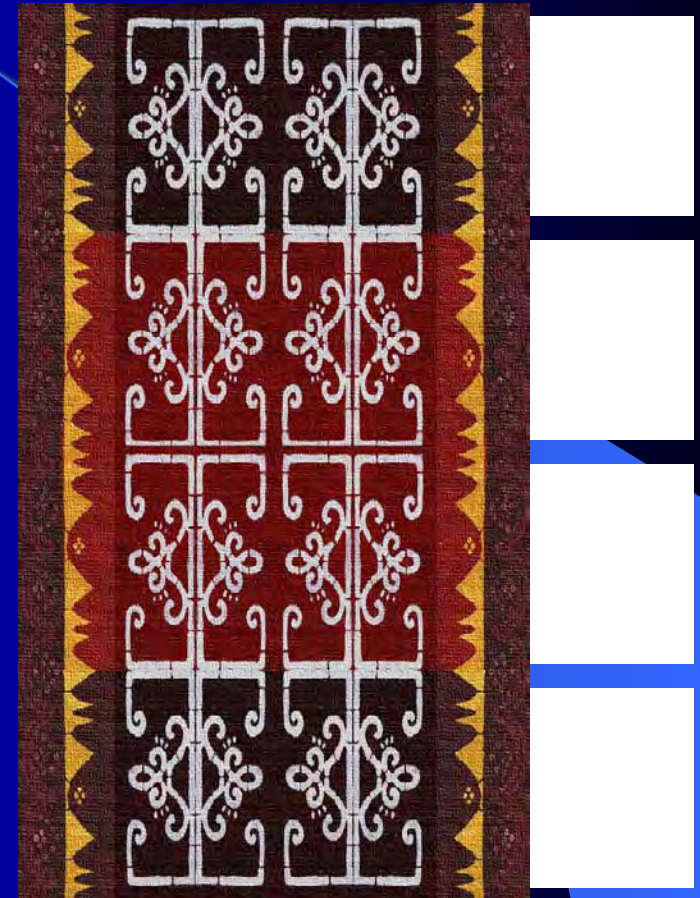


Mother
Earth

ideal



abstract



PATTERN CONCEPTUAL FRAMEWORK

natural

ideal

abstract

outer

inner

outer



Mother
Earth

recognize pattern

express pattern

PATTERN CONCEPTUAL FRAMEWORK

natural

ideal

abstract

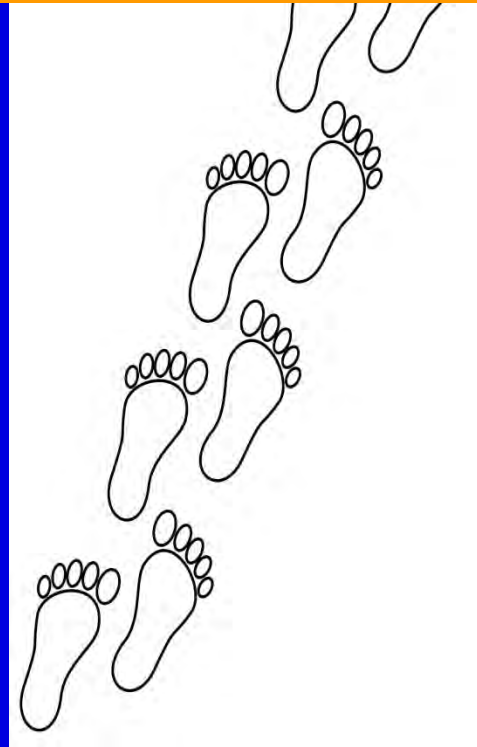
outer

inner

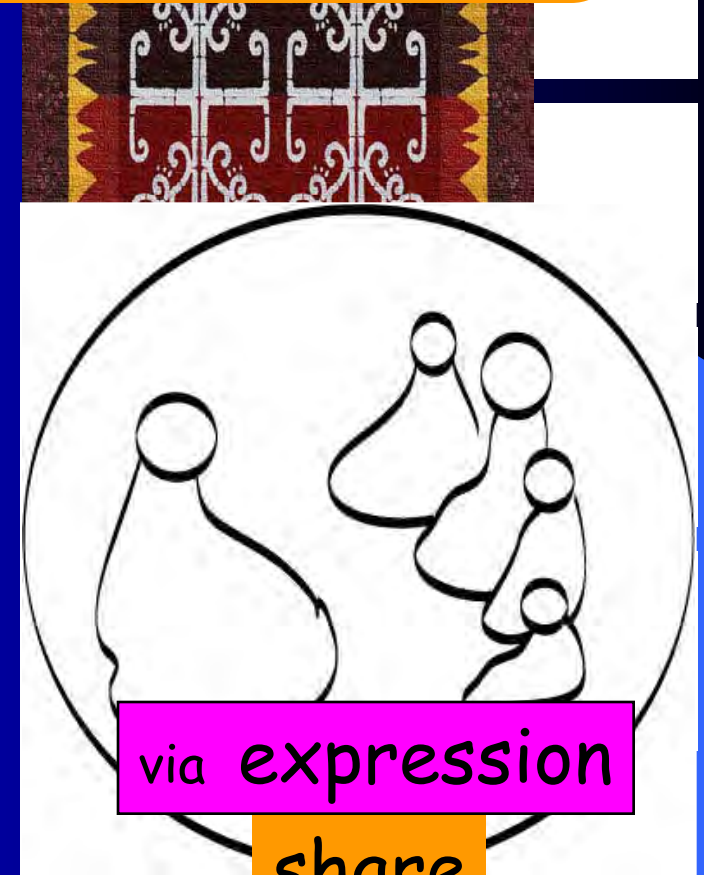
outer



observe



interpret



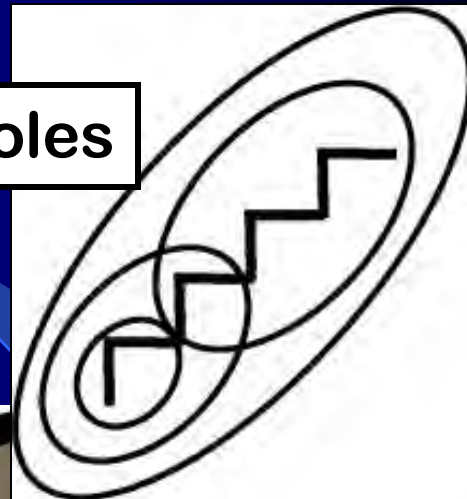
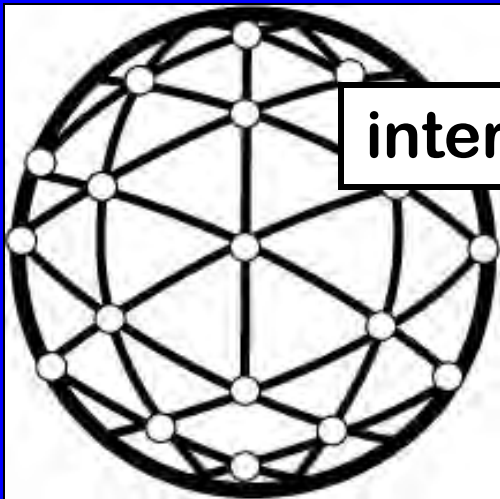
via expression

share

“co-seeing”

interconnected

parts & wholes



towards resonance
of understanding

towards construction
of understanding

WEAVING

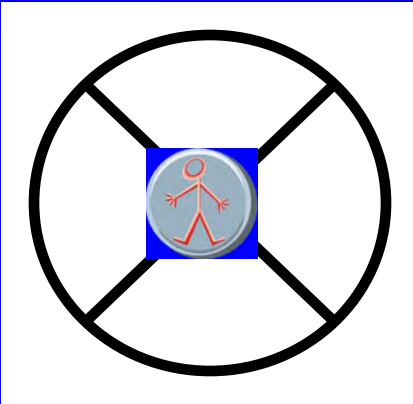
UN-WEAVING

“co-seeing”

“The fool on the hill sees the sun going down,
while the eyes in his head see the earth spinning round.”



see the sun going down / see the earth spinning round



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

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

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
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02	0743	1626	0723	1706	0637	1749	0538	1831	0445	1911	0412	1946	0414	1955	0444	1929	0523	1837	0601	1738	0644	1644	0724	1616
03	0743	1627	0722	1708	0635	1750	0536	1833	0444	1912	0412	1947	0415	1955	0446	1927	0524	1835	0602	1736	0645	1643	0725	1616
04	0743	1628	0720	1709	0634	1752	0534	1834	0442	1913	0411	1947	0415	1955	0447	1926	0525	1833	0604	1734	0646	1642	0727	1616
05	0743	1629	0719	1711	0632	1753	0532	1835	0441	1915	0411	1948	0416	1954	0448	1925	0527	1831	0605	1732	0648	1640	0728	1615
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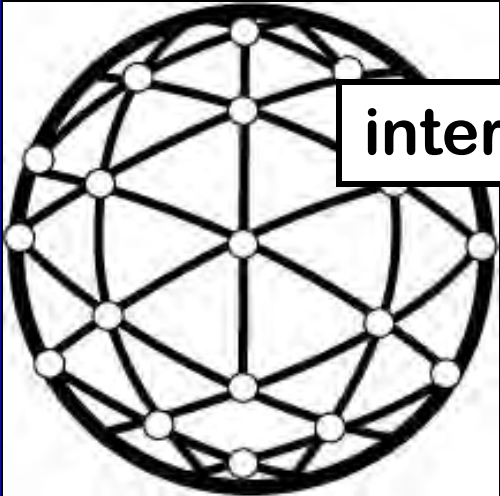
TK

Science

WEAVING

UN-WEAVING

“seeing”



interconnected

pa



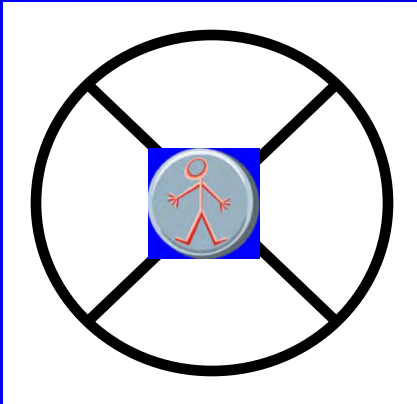
towards resonance
of understanding

n

WEAVING

UN-... G

see the sun going down



towards resonance
of understanding

WEAVING

Medicine Wheel

layered pattern (weave towards resonance):
natural ideal abstract



sunset
WEST sunrise
EAST

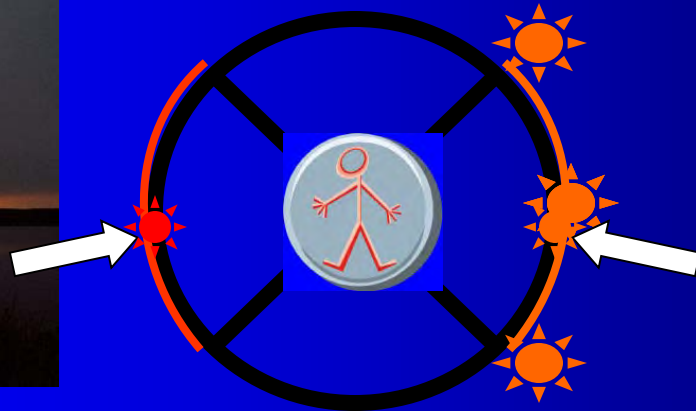


PATTERN

Grandfather Sun & Mother Earth
... "lived relationships"

Medicine Wheel

layered pattern (weave towards resonance):
natural ideal abstract



sunset
WEST

sunrise
EAST

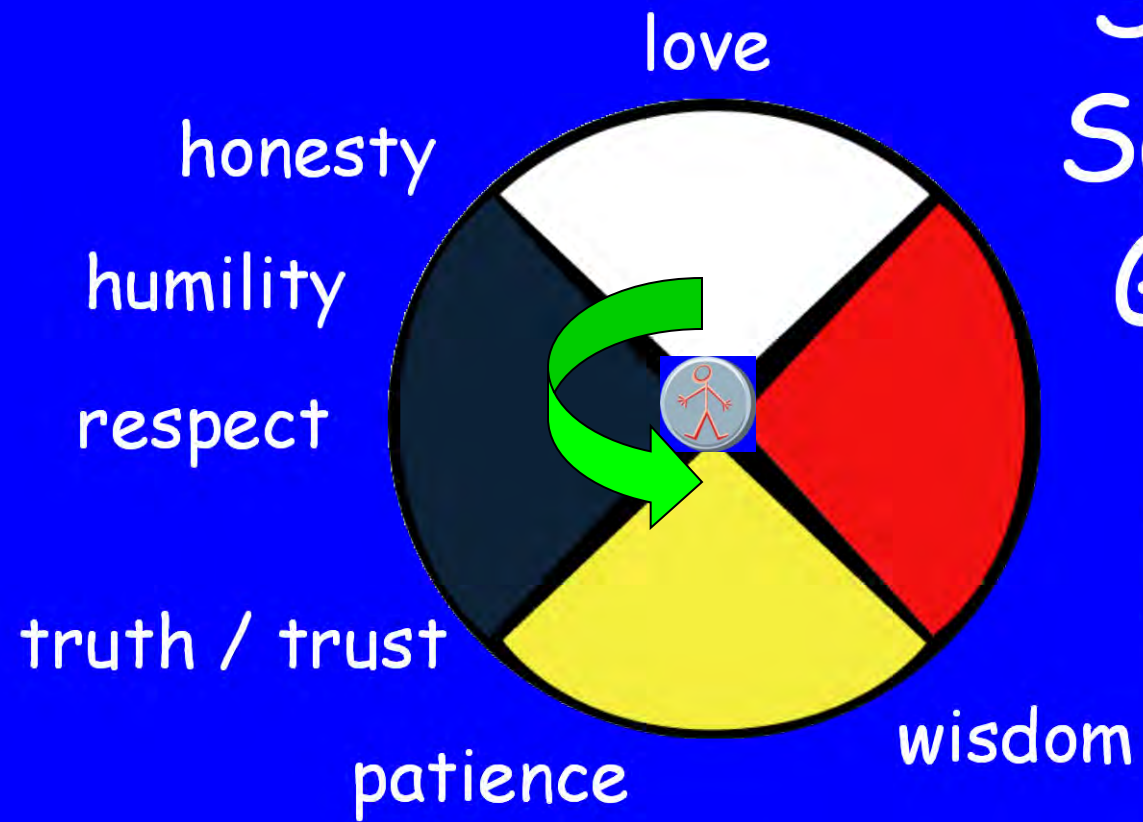


Grandfather Sun & Mother Earth
... "lived relationships"

PATTERN

Murdena Marshall, Elder, Eskasoni First Nation

Seven Sacred Gifts Of Life

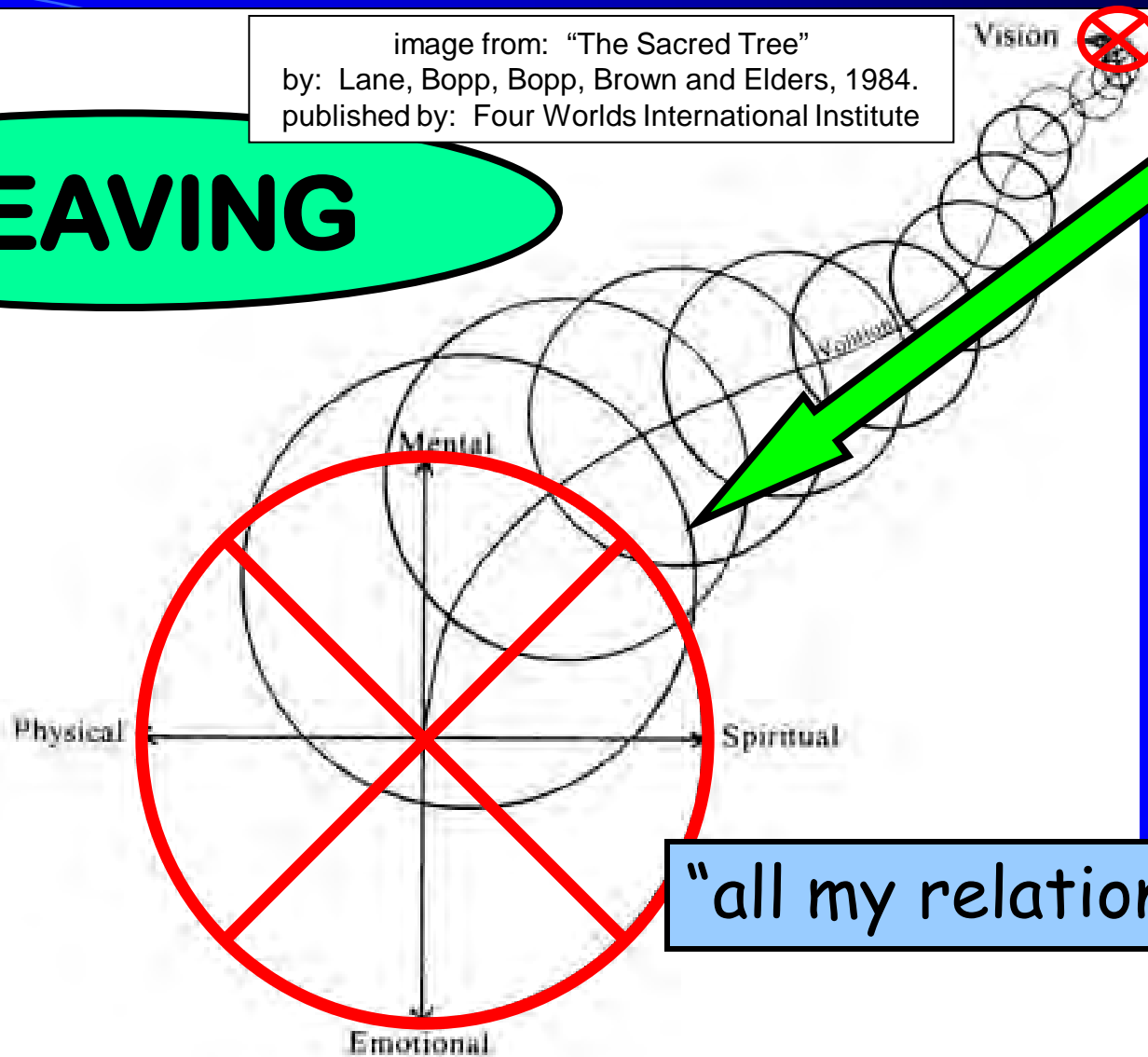


WEAVING

image from: "The Sacred Tree"
by: Lane, Bopp, Bopp, Brown and Elders, 1984.
published by: Four Worlds International Institute

Vision 

WEAVING



an expanding sense of
wholeness and connectedness

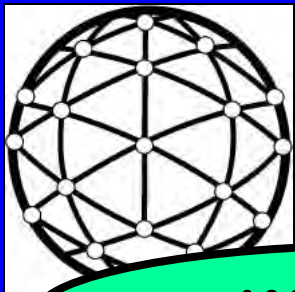
Medicine Wheel - multiple layers -



spiritual

in the **patterns** of the animals
... lessons for humans

PATTERN



PARTICIPATORY INTERCONNECTEDNESS

WEAVING

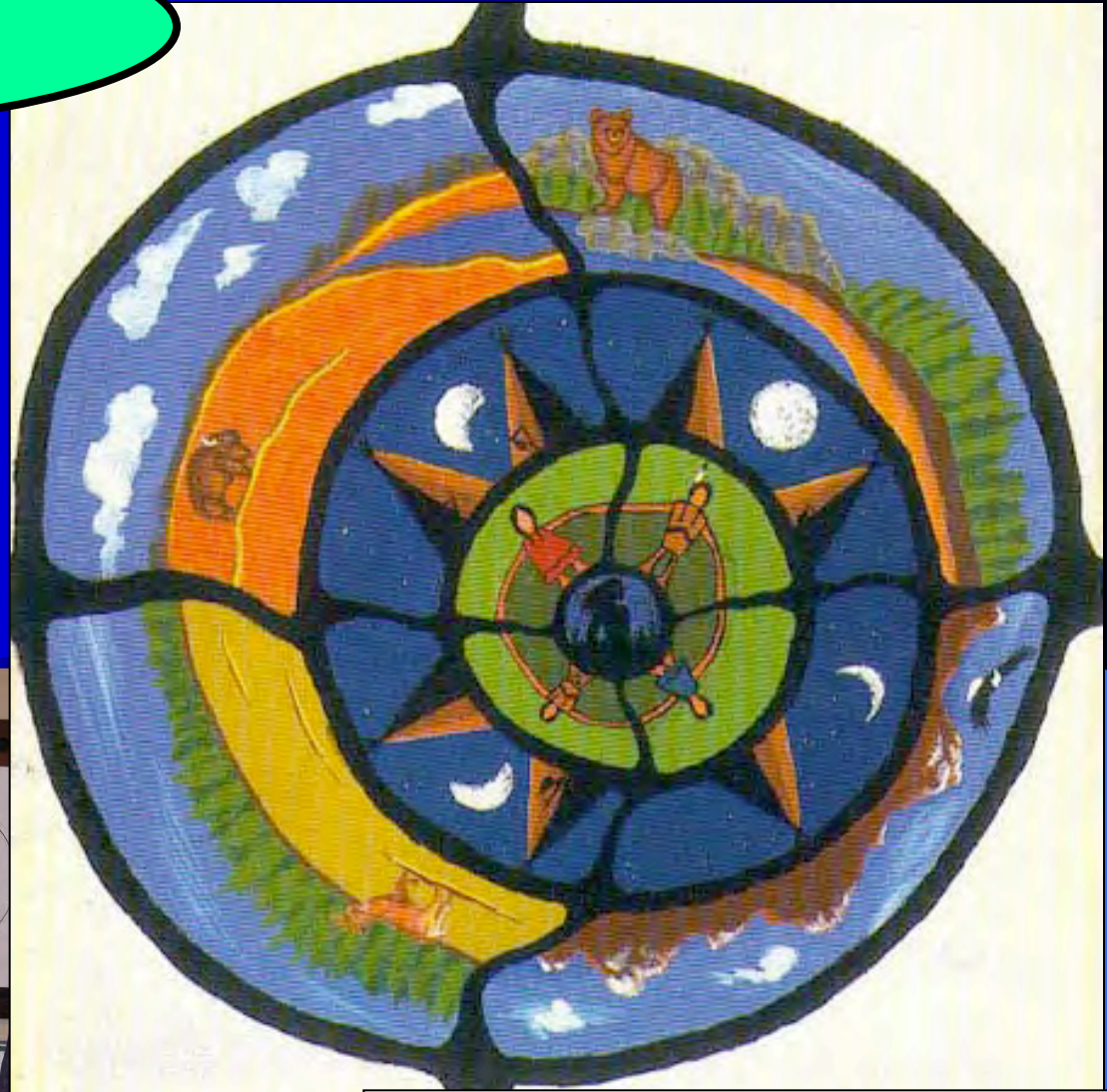
towards resonance
of understanding

WEAVING

“The younger generation has largely been denied the connection to see how Nature works.”



Albert Marshall, Elder, Eskasoni First Nation



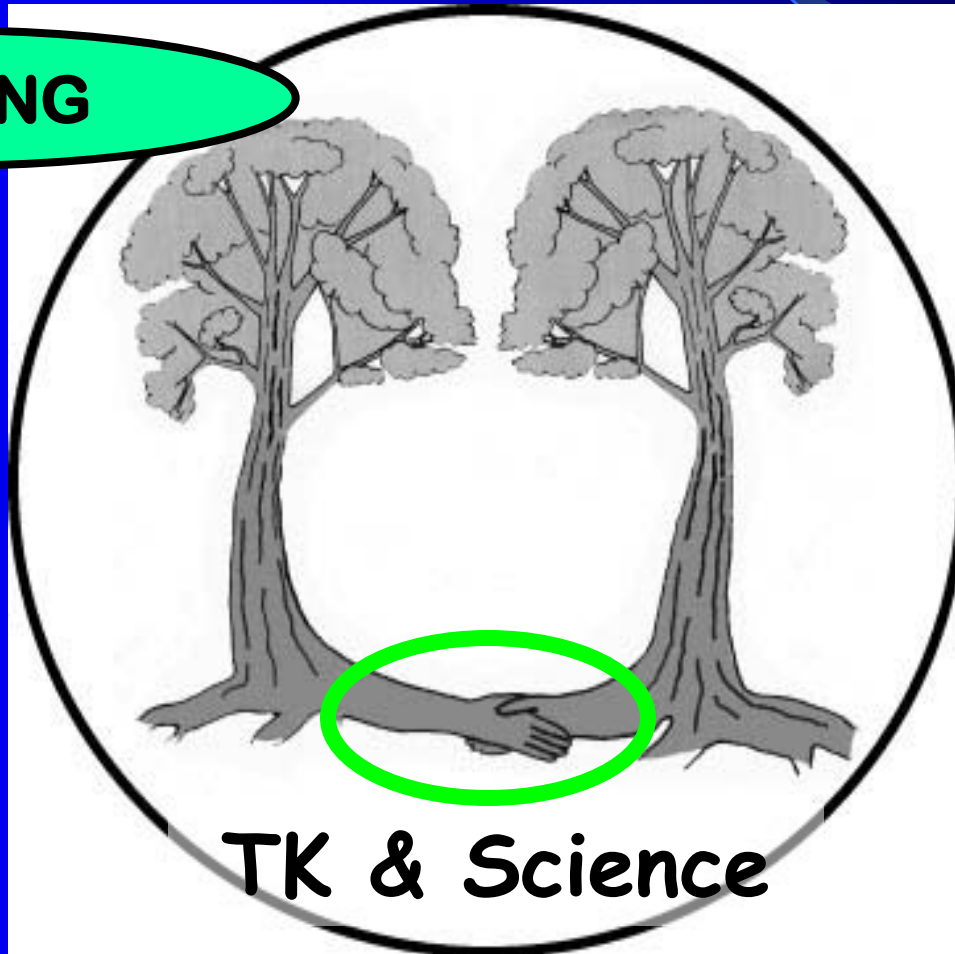
*Cover illustration by: Rod Restoule
From: Into the Daylight; C. Morriseau, 1998*

Go into a forest, you see the birch, maple, pine. Look underground and all those trees are holding hands.

We as people must do the same.

(late Mi'kmaq Chief, Spiritual Elder, and Healer Charlie Labrador)

WEAVING



TK & Science



WEAVING

The Whales that wash up on our shores bring a message: we must take better care of our waters.

(late Mi'kmaq Chief, Spiritual Elder, and Healer Charlie Labrador)

WEAVING

example

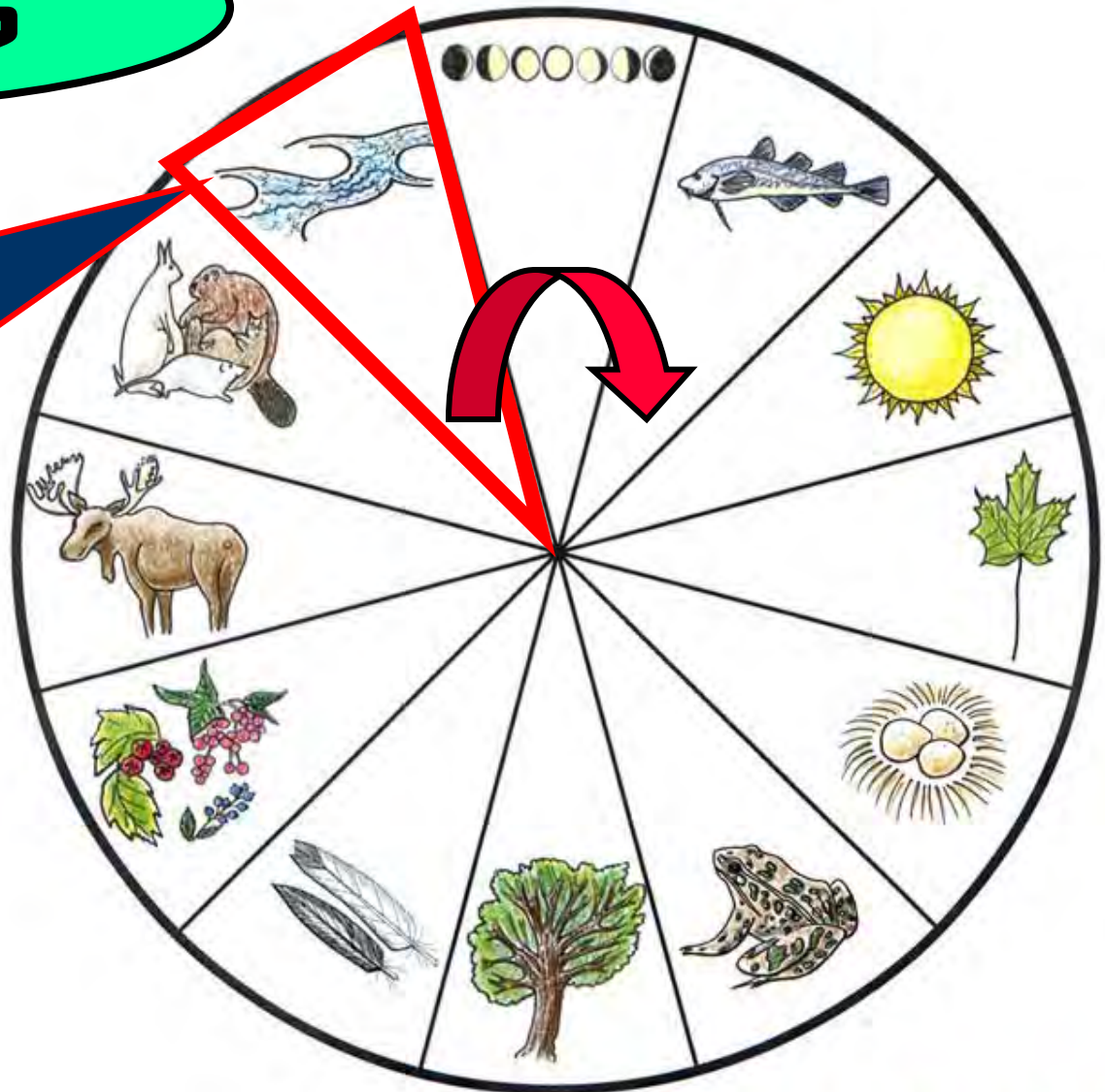
Keptewiku's

"thin ice
forming time"

(November)

landscape-in-
the-language

12 natural patterns of the year




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, Univ. of New Mexico

“pattern smarts”

multiple intelligences theory

use ... tied to cultural value

- numbers (logical-mathematical)
- language (linguistic)
- music (musical)
- body (body-kinesthetic)
- spatial (spatial)
- other people (interpersonal)
- self (intrapersonal)
- naturalist (naturalist) 

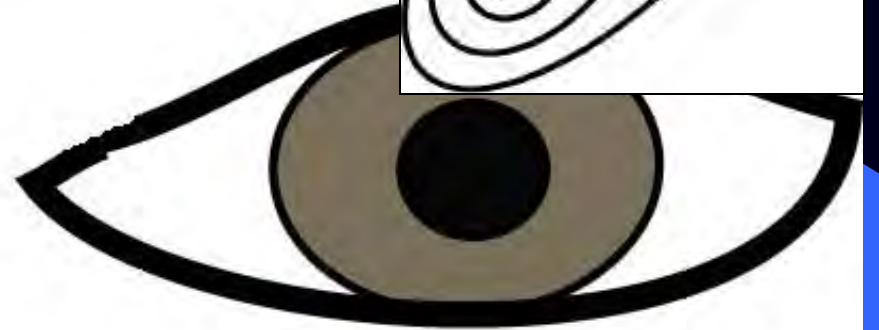
“Aboriginal”

“Western”

• spiritual / existential

“seeing”

parts & wholes



towards construction
of understanding

UN-WEAVING

see the earth spinning round



Periodic Table of the Elements

layered pattern (un-weave to re-build):
natural ideal abstract



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

PATTERN



SYDNEY, NS
Location: W060 11, N46 09 Rise and Set for the Sun for 2004 Astronomical Applications Dept.
U. S. Naval Observatory
Washington, DC 20392-5420

Zone: 4h West of Greenwich

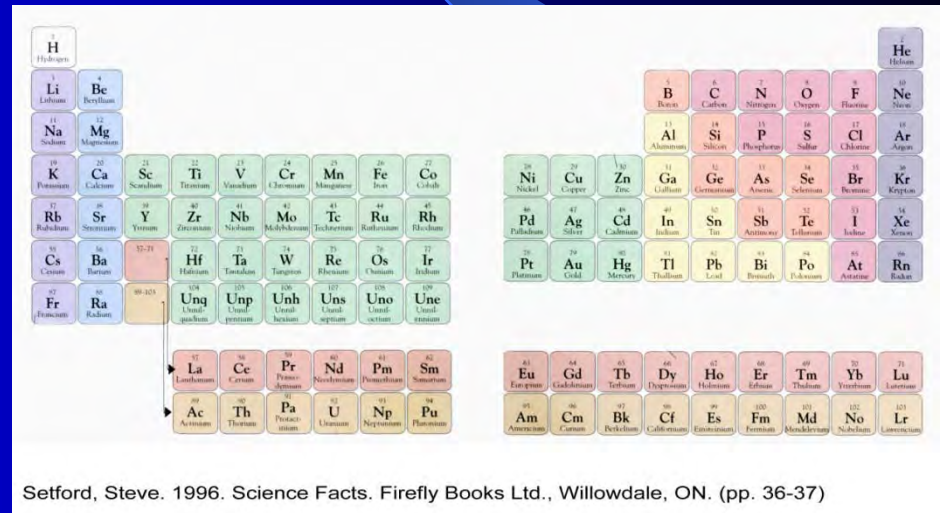
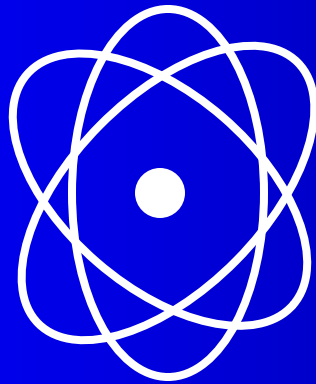
Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise
h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
01	0743 1625	0724 1705	0639 1748	0540 1830	0447 1910	0413 1945	0411 1956	0443 1930	0522 1839	0600 1740	0642 1646	0723 1617
02	0743 1626	0723 1706	0637 1749	0538 1831	0445 1911	0412 1946	0414 1955	0444 1929	0523 1837	0601 1738	0644 1644	0724 1616
03	0743 1627	0722 1708	0635 1750	0536 1833	0444 1912	0412 1947	0415 1955	0446 1927	0524 1835	0602 1736	0645 1643	0725 1616
04	0743 1628	0720 1709	0634 1752	0534 1834	0442 1913	0411 1947	0415 1955	0447 1926	0525 1833	0604 1734	0646 1642	0727 1616
05	0743 1629	0719 1711	0632 1753	0532 1835	0441 1915	0411 1948	0416 1954	0448 1925	0527 1831	0605 1732	0648 1640	0728 1615
06	0743 1630	0718 1712	0630 1755	0530 1837	0439 1916	0410 1949	0417 1954	0449 1923	0528 1829	0606 1730	0649 1639	0729 1615
07	0743 1631	0716 1714	0628 1756	0528 1838	0438 1917	0410 1950	0418 1953	0450 1922	0529 1827	0607 1729	0651 1638	0730 1615
08	0743 1632	0715 1715	0626 1757	0527 1839	0437 1919	0410 1950	0418 1953	0452 1920	0530 1825	0609 1727	0652 1636	0731 1615
09	0742 1633	0714 1717	0624 1759	0525 1841	0435 1920	0409 1951	0419 1952	0453 1919	0532 1823	0610 1725	0654 1635	0732 1615
10	0742 1635	0712 1718	0622 1800	0523 1842	0434 1921	0409 1952	0420 1952	0454 1917	0533 1821	0611 1723	0655 1634	0733 1615
11	0742 1636	0711 1720	0620 1802	0521 1843	0433 1922	0409 1952	0421 1951	0455 1915	0534 1819	0613 1721	0657 1633	0734 1615
12	0741 1637	0709 1721	0619 1803	0519 1845	0431 1924	0409 1953	0422 1951	0457 1914	0535 1817	0614 1719	0658 1631	0734 1615
13	0741 1638	0708 1723	0617 1804	0517 1846	0430 1925	0409 1953	0423 1950	0458 1912	0537 1815	0616 1717	0659 1630	0735 1615
14	0740 1640	0706 1724	0615 1806	0515 1847	0429 1926	0409 1954	0424 1949	0459 1911	0538 1813	0617 1716	0701 1629	0736 1615
15	0740 1641	0705 1726	0613 1807	0514 1848	0428 1927	0409 1954	0424 1948	0500 1909	0539 1811	0618 1714	0702 1628	0737 1615
16	0739 1642	0703 1727	0611 1808	0512 1850	0427 1928	0409 1954	0425 1948	0502 1907	0541 1809	0620 1712	0704 1627	0737 1616
17	0738 1643	0701 1729	0609 1810	0510 1851	0425 1930	0409 1955	0426 1947	0503 1906	0542 1807	0621 1710	0705 1626	0738 1616
18	0738 1645	0700 1730	0607 1811	0508 1852	0424 1931	0409 1955	0427 1946	0504 1904	0543 1805	0622 1708	0706 1625	0739 1616
19	0737 1646	0658 1732	0605 1812	0507 1854	0423 1932	0409 1955	0428 1945	0505 1902	0544 1803	0624 1707	0708 1624	0739 1617
20	0736 1648	0657 1733	0603 1814	0505 1855	0422 1933	0409 1956	0430 1944	0507 1900	0546 1802	0625 1705	0709 1623	0740 1617
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24	0733 1653	0650 1739	0555 1819	0458 1900	0418 1937	0410 1956	0434 1940	0512 1853	0551 1754	0631 1658	0714 1620	0742 1619
25	0732 1655	0648 1740	0553 1821	0456 1902	0418 1938	0411 1956	0435 1939	0513 1852	0552 1752	0632 1657	0716 1620	0742 1620
26	0731 1656	0646 1742	0551 1822	0455 1903	0417 1939	0411 1956	0436 1938	0514 1850	0553 1750	0634 1655	0717 1619	0742 1621
27	0730 1658	0644 1743	0550 1823	0453 1904	0416 1940	0411 1956	0437 1936	0515 1848	0554 1748	0635 1653	0718 1618	0743 1622
28	0729 1659	0643 1745	0548 1825	0451 1906	0415 1941	0412 1956	0438 1935	0517 1846	0556 1746	0636 1652	0720 1618	0743 1622
29	0728 1700	0641 1746	0546 1826	0450 1907	0415 1942	0412 1956	0440 1934	0518 1844	0557 1744	0638 1650	0721 1617	0743 1622
30	0727 1701	0640 1747	0545 1827	0449 1908	0414 1943	0412 1956	0441 1933	0519 1842	0558 1742	0639 1648	0722 1616	0743 1622
31	0725 1702	0639 1748	0544 1828	0448 1909	0413 1944	0412 1956	0442 1932	0520 1840	0559 1740	0640 1646	0723 1615	0743 1622

towards construction
of understanding

UN-WEAVING

Periodic Table of the Elements

layered pattern (un-weave to re-build):
natural ideal abstract



PATTERN

UN-WEAVING
RE-WEAVING

Universe: Visible Matter (levels of organization - biology)

Periodic Table of the Elements

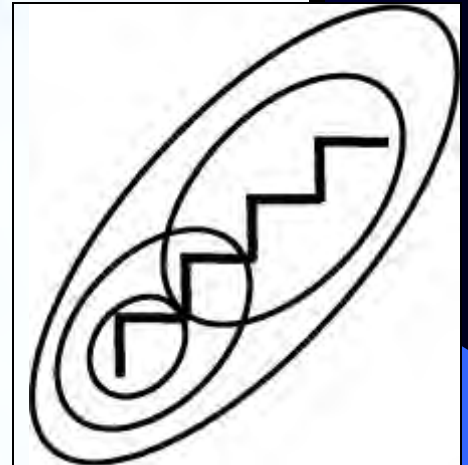
layered pattern (un-weave to re-build):
natural ideal abstract



PATTERN



- 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)



MASTERFUL PREDICTION & CONTROL

towards construction
of understanding

**UN-WEAVING
RE-WEAVING**

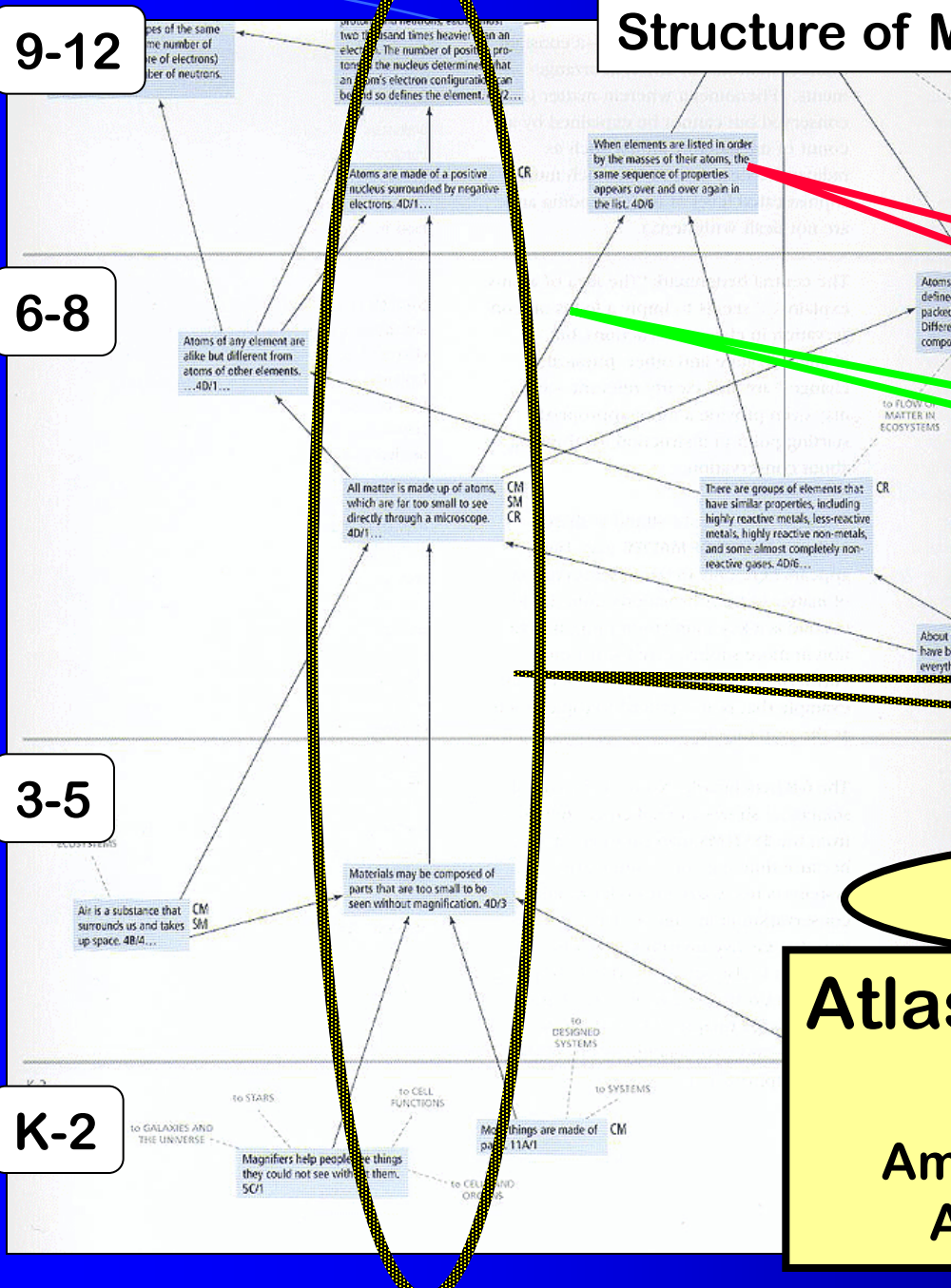
Structure of Matter: Atoms and Molecules

9-12

6-8

3-5

K-2



benchmark

connection

strand

RE-WEAVING

**Atlas of Science Literacy
Project 2061
American Association for the
Advancement of Science**

Fibre-optical features of a glass sponge

Some superior technological secrets have come to light from a deep-sea organism

Fibre-optical features of a glass sponge

Some superior technological secrets have come to light from a deep sea organism



Sponges are constructed from amorphous, hydrated silica¹. *Euplectella* builds an intricate cage (Fig. 1a), which typically houses a mating pair of shrimp (hence its nickname, 'Venus flower-basket') and is composed of a lattice of fused spicules² that provide extended structural support.

A network of anchorage spicules (basalia) extend outwards in a crown-like formation. These spicules are generally 5–15 cm long and 40–70 µm in diameter; their entire cross-section is homogeneous and they have no structural boundaries. Under stress or etching, the spicules reveal a characteristic layered morphology³ and cross-sectional variations in composition that appear as three distinct regions: a pure silica core of about 2 µm in diameter that encloses an organic filament; a central cylinder that has the greatest organic content of the three; and a striated shell that has a gradually decreasing organic content and which is glued together by organic filaments (Fig. 1b).

We anticipated that the spicules' rich substructure should be reflected in their optical properties as well. Indeed, interferometric refractive-index profiling⁴ revealed three regions that correspond to the three regions of structural composition (Fig. 1c): a core with high refractive index that is comparable to (or higher than) that of vitreous silica; a cylinder of lower refractive index that surrounds the core; and an oscillating pattern with correspondingly increasing refractive

layers, connected by organic ligands at the fibre's exterior, provide an effective crack-arresting mechanism and enhance fracture toughness^{5,6}. Another superior feature of the spicules is their formation under ambient conditions, a process that is regulated by organic molecules^{7,8}. This ambient-temperature process, unlike the high-temperature manufacture of man-made fibres, allows the structure to be doped with specialized impurities that improve the refractive index and therefore the wave-guiding properties. Our preliminary elemental analysis

minuting sponge should also shed light on low-temperature, biologically inspired processes that could give rise to better fibre-optical materials and networks. Vikram C. Sundar¹, Andrew D. Yablon¹, John L. Girard¹, Micha Blant, Joanna Alzenberg²
¹Bell Laboratories/Lucent Technologies, Murray Hill, New Jersey 07974, USA
e-mail: jalsenberg@lucent.com
²ODS, Marine Hill, New Jersey 07034, USA
³Department of Zoology, UC, San Diego, San Diego 92093, USA

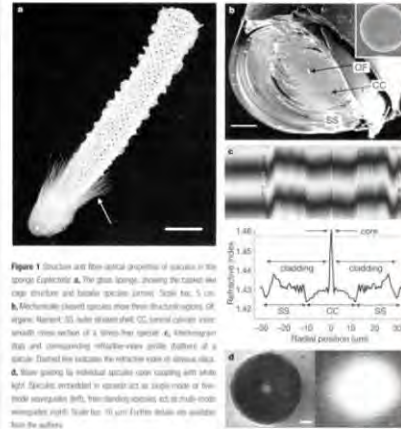


Figure 1 Structural and fibre-optical properties of spicules in the sponge *Euplectella*. **a**, The glass sponge, showing the typical cage structure and basalia spicules (arrow). Scale bar, 5 cm. **b**, Micrograph (polarized) captures show three structural regions: CR, organic filament; SS, outer striated shell; CC, central cylinder inner sheath (cross-section of a single fibre spicule). **c**, Interferometric refractive-index profile corresponding to the three regions of a spicule. Dashed line indicates the refractive index of vitreous silica. **d**, Close-up of individual spicule core (coupled with white light). Spicules are visible in cross-section as simple rods or fibre-like structures (left). Interferometric profiles of individual spicules appear as oscillating patterns (right). Scale bar, 10 µm. Further details are available from the authors.



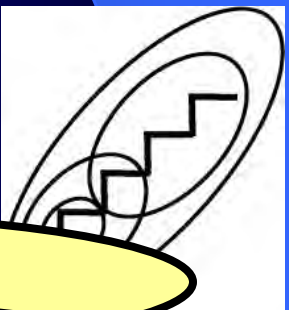
in the patterns of the animals
... lessons for humans

PATTERN

MASTERFUL PREDICTION & CONTROL

towards construction of understanding

UN-WEAVING RE-WEAVING

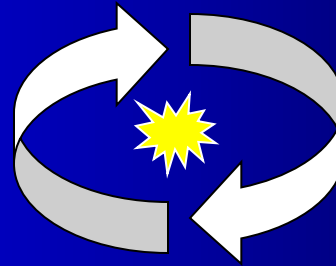


Outline of presentation

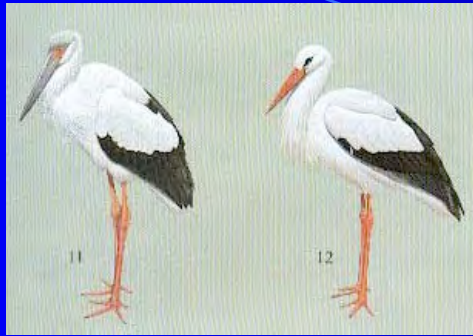
1. science education ... dilemma re cultural diversity
2. all cultures converse with Nature ... what language?
3. pattern & pattern smarts

4. Integrative Science ... "co-seeing":
bringing Western & Aboriginal knowledges together

- aspects
- common ground
- differences
- forward together



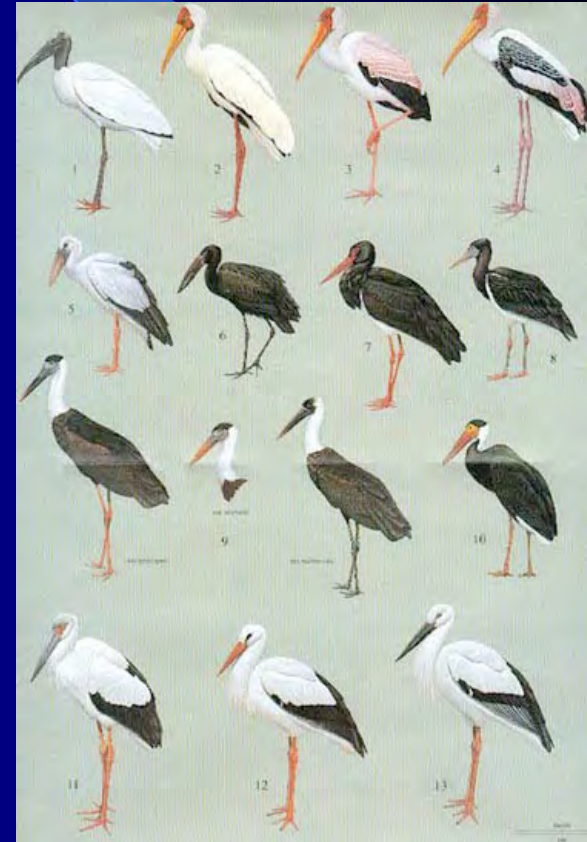
5. human consciousness
6. metaphor
7. conclusion

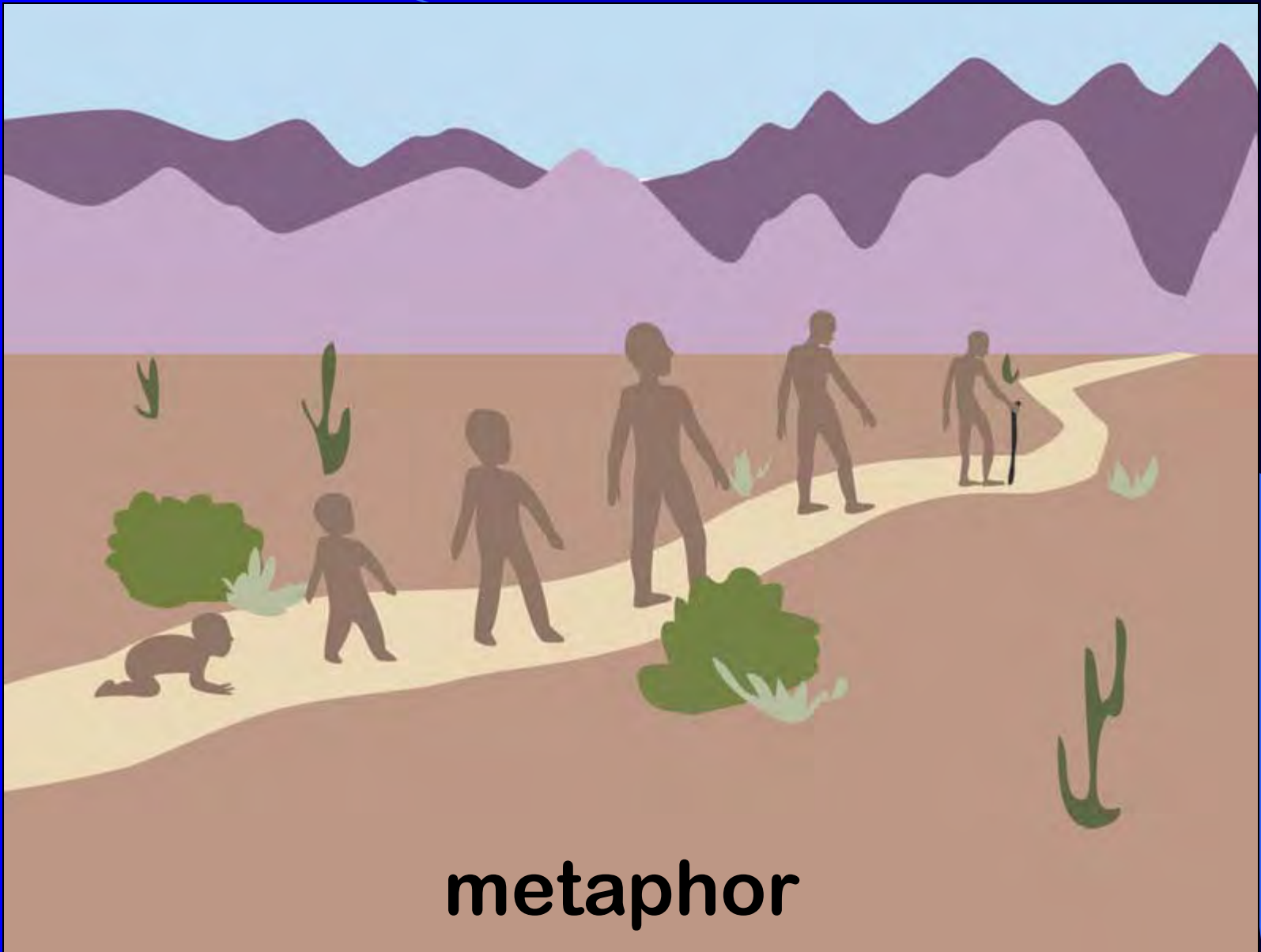


difference

human
consciousness

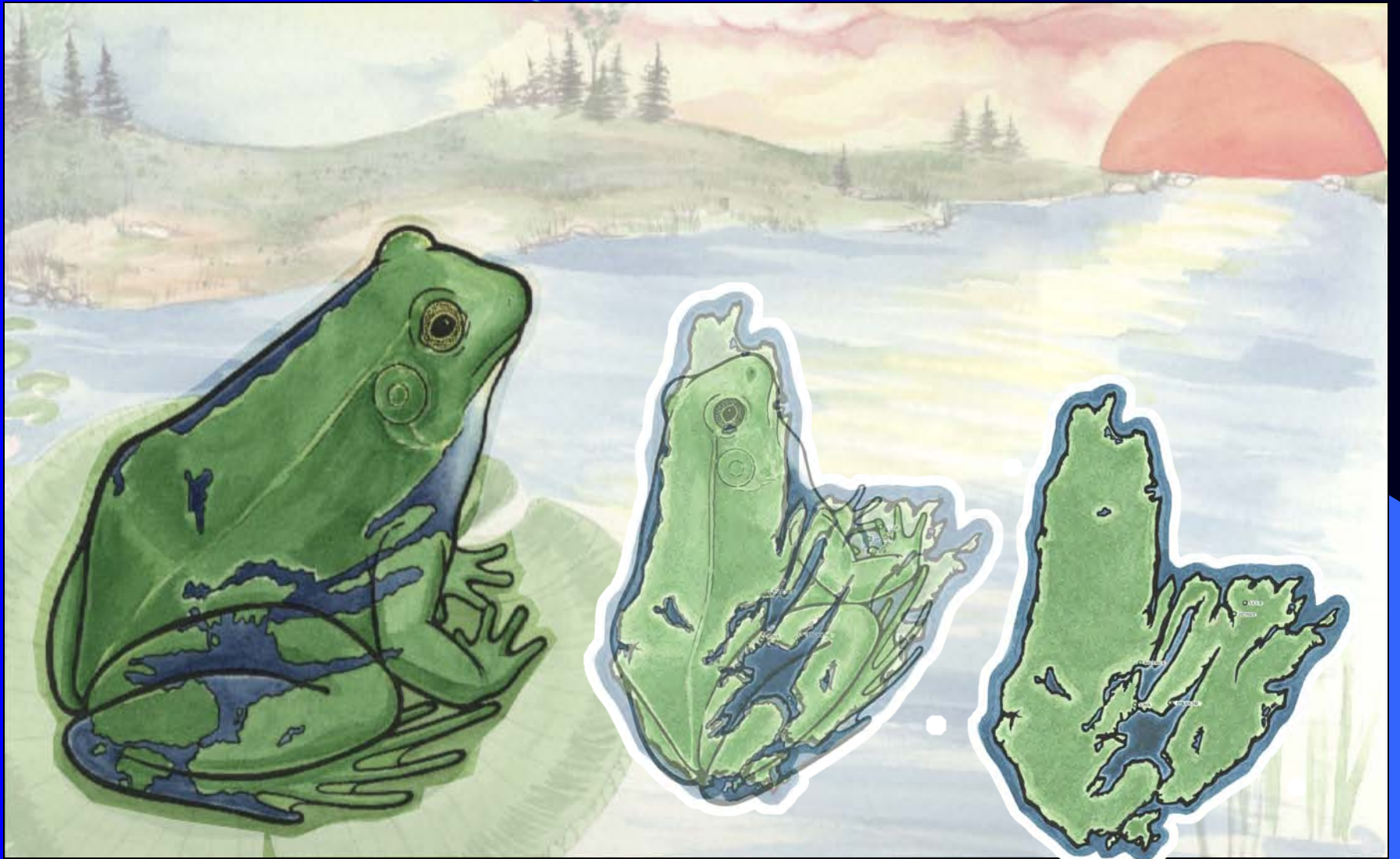
pattern
variation





metaphor





Collaborative Environmental Planning Initiative



Bras d'Or

Bras d'Or Lake

CEPI

*Collaborative Environmental
Planning Initiative*



acknowledgments



Canada Research
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Chaires de recherche
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Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada



Thank you
Wela'liog



Artist Basma Kavanagh