

Scientific Literacy (SL)

How can we define SL? How and what should we teach to ensure that our students attain a high level of SL?

What is SL?

According to the United States National Center for Education Statistics,

Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities.

SL...

- A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it.
- Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately.

National Science Education Standards.

- Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.
- It also includes specific types of abilities. In the National Science Education Standards, the content standards define scientific literacy.

National Science Education Standards

- Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena.

National Science Education Standards

- Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions.
- Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed.

National Science Education Standards

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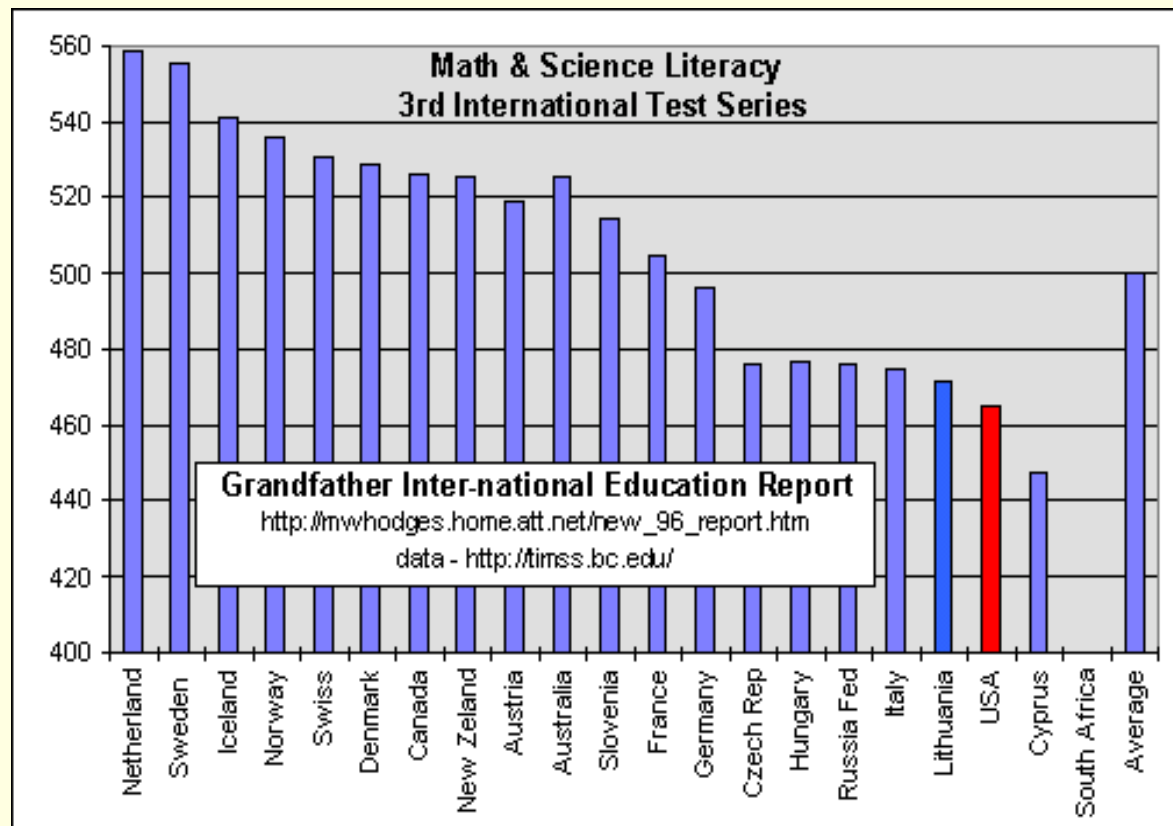
Research and SL: An Example

- **Dr. Miller, 63, a political scientist, who directs the Center for Biomedical Communications at an American medical school, studies how much Americans know about science and what they think about it. His findings are not encouraging.**

Research and SL...

- **While scientific literacy has doubled over the past two decades, only 20 to 25 percent of Americans are "scientifically savvy and alert," he said in an interview. Most of the rest "don't have a clue."**
- **At a time when science permeates debates on everything from global warming to stem cell research, he said, people's inability to understand basic scientific concepts undermines their ability to take part in the democratic process.**

Research and SL



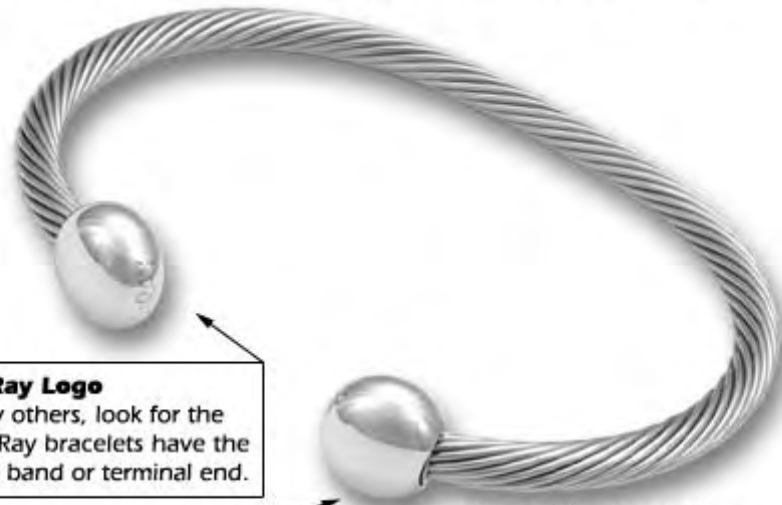
Research and SL

The Q-Ray Difference

Often Imitated, NEVER Duplicated®

Design Patent

Q-Ray® is dedicated to the continued research and development of alternative, natural products to enhance individual performance and support active lifestyles. The Q-Ray bracelet's attractive design is so unique, it carries a U.S. Government design patent.



Look for the Q-Ray Logo

Don't be fooled by others, look for the Q-Ray logo! All Q-Ray bracelets have the Q-Ray logo on the band or terminal end.



Silver Deluxe Model Shown

1. Screw Capsule System

Q-Ray deluxe bracelets are manufactured with a unique, screw capsule system. Others often glue a round terminal ball to the bracelet.

2. Flat Terminal Ends

Q-Ray bracelets are engineered for comfort. Not only is the band manufactured to naturally fit around your wrist, it also has flat terminal ends. Others have round terminal balls that put pressure on your wrist.

Research and SL

- **An authentic Q-Ray Bracelet is based on Traditional Chinese Medicine (TCM) that has been practiced for centuries. Q-Ray is designed to balance the negative (Yin) and positive (Yang) energy forces in your body to achieve the state of “Chi.”**
- **According to tradition, Chi has been described as the natural vital force that allows body and mind to perform to its fullest potential.**

Research and SL...

- ***Objective:***

To assess objectively the perceived benefits of wearing an “ionized” wrist bracelet to treat muscle or joint pain.

Research and SL...

- ***Subjects and Methods:*** This study was performed at the Mayo Clinic in Jacksonville, Fla, in 2000 and 2001.
- In a randomized, double-blind design, 305 participants wore an ionized bracelet and 305 wore a placebo bracelet for 4 weeks.
- For each location where pain was present at baseline, participants rated the intensity of pain.

Research and SL...

- **Follow-up ratings were made after 1, 3, 7, 14, 21, and 28 days of wearing the bracelet. Two primary end points were defined for evaluating efficacy.**
- **The first was the change at 4-week follow-up (day 28) in the pain score at the location with the highest baseline value (maximum pain score). The second was the change at 4-week follow-up in the sum of the pain scores for all locations.**

Research and SL...

■ ***Results:***

Analysis of the data showed significant improvement in pain scores in both groups, but no differences were observed between the group wearing the placebo bracelet and the group wearing the ionized bracelet.

Research and SL...

Conclusion:

The finding that subjective improvement in pain scores was equivalent with ionized and placebo bracelet use questions the benefit of using an ionized bracelet.

New treatments in alternative medical therapy must be shown to be effective through vigorous, unbiased, objective testing before physicians acknowledge potential benefits or recommend these treatments to patients.

- *Mayo Clin Proc.* 2002;77:1164-1168

SL...



SL.

Periodic Table of the Elements

1869, by Dmitri Mendeleev, Russian Bigamist

Some scientists think Helium should go here.

1914: They reorganized the table by atomic number instead of atomic weight.

1940s: They added two rows.

Some scientists think Hydrogen should go here.

Warning. Warning. Warning.
Chemical Periodicity is a theory.
The theory keeps changing.
The theory is under dispute.
Teach alternative theories to children.

1903: They added a whole column.

26 elements have been added since 1923. When will it end?

IA																	VIIIA						
1 H 1.00794																	2 He 4.00260						
3 Li 6.941	4 Be 9.01218																	5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
11 Na 22.9898	12 Mg 24.3050																	15 P 30.9738	16 S 32.066	17 Cl 35.453	18 Ar 39.948		
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 52.004	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80						
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	Warning. Warning. Warning.																51 Sb 121.75	52 Te 127.60	53 I 126.905	54 Xe 131.29	
55 Cs 132.905	56 Ba 137.33	57 La 138.906	Teach alternative theories to children.																83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra 226.025	89 Ac 227.028	90 Th (232)	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (260)	102 No (259)	103 Lr (262)							

58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
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90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (260)	102 No (259)	103 Lr (262)
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State of Kansas Table of the Elements

Earth	Fire	Air	Water
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evolution
plate tectonics
big bang

Truth is Constant



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A Template for Scientific Literacy...

A scientific literate person is expected to, among other things,

1. Understand fundamental concepts, laws, principles, and facts in the basic sciences.
2. Appreciate the variety of scientific methodologies, attitudes and dispositions, and appropriately utilize them.
3. Connect scientific theory to everyday life and recognize chemical, physical and biological processes in the world around them.
4. Recognize the manifold ways that science and its related technology interact with economics, culture and politics of society.

A Template for Scientific Literacy

5. Has developed science-related skills that enable him or her to function effectively in careers, leisure activities, and other roles;
6. Has developed interests that will lead to a richer and more satisfying life and one that will include science and life-long learning.
7. Understands significant parts of the history of science, and the ways in which it has shaped, and in turn has been shaped by, cultural, moral and religious forces.

SCIENTIFIC LITERACY: A Model

Aristotle:

It is not enough to know what a scientific fact is, you must also know why it is a scientific fact.

SCIENTIFIC LITERACY: A Model

Theoretical background

Fact or Claim

Evidential Argument

Empirical, experimental base



SCIENTIFIC LITERACY

Level 1 (Recitation, Identification):

Can you recall the fact or claim, identify the fact or claim?

Level 2 (Evidential Argument):

What are good reasons for believing the fact or claim?

Level 3 (Theoretical background):

What are the diverse connections of the fact or claim?

HOW SCIENTIFICALLY LITERATE ARE YOU? (A Canada-wide SL test)

True or false?

1. The center of the earth is very hot.
2. The oxygen we breathe comes from plants.
3. Radioactive milk can be made safe by boiling it.
4. Lasers work by focusing sound waves.
5. Sunlight can cause skin cancer.
6. Hot air rises.
7. Human beings, as we know them today, developed from earlier groups of animals.
8. Air pollution can cause a green house effect.

HOW SCIENTIFICALLY LITERATE ARE YOU?

9. Electrons are smaller than atoms.
10. The earliest humans lived at the same time as dinosaurs.
11. The continents are moving slowly about the surface of the earth.
12. Which travels faster, sound or light?
 - a. Sound travels faster.
 - b. Light travels faster.
13. Does the sun go around the earth, or does the earth go around the sun?
 - a. Sun around earth ,
 - b. Earth around sun.
14. How long does it take for the earth to go around the sun?
 - a. One day,
 - b. One month,
 - c. One year.