EPO and Science Literacy: a Match Made in Heaven

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Why do astronomy EPO?

- Promotes rational thinking and understanding of the nature of science
- Interdisciplinary & spans the entire curriculum
- Attracts people to science & technology
- Increases public awareness, understanding & appreciation of science & technology
- **Ultimate EPO goal: understand science enough to support science in social and political context**

More than pretty pictures

- Astronomy is a springboard into STEM subjects
- Ignites interest, excites thirst for knowledge
- But EPO must do more than engaging audiences with images and large numbers
- EPO must strive to raise levels of science literacy among the population
- This is a different challenge from doing EPO for EPO's own sake

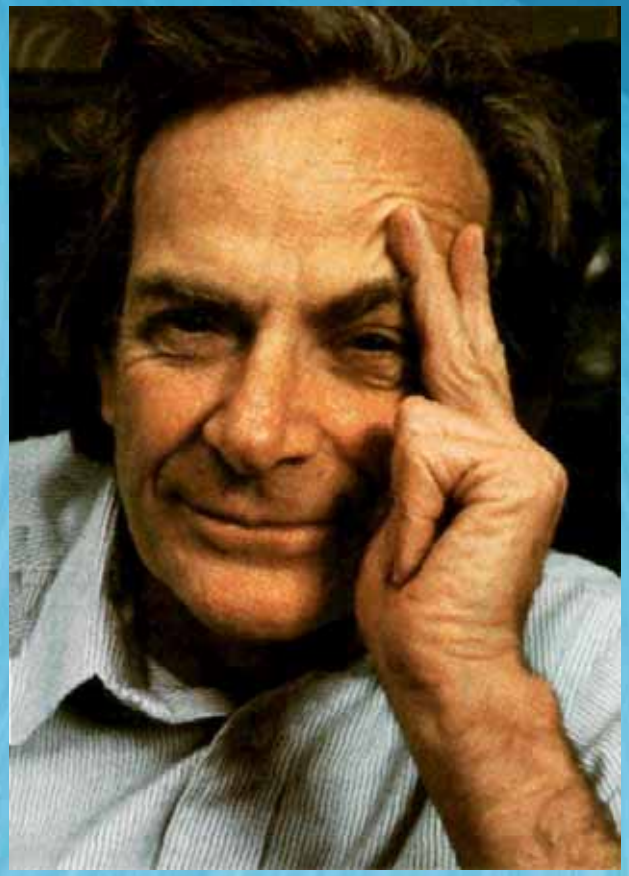
Why do we need a science literate population?

- Science is not merely an indulgence for the curious
- It is vital to:
  - Our lives
  - Our culture
  - Our economic well-being
- Yes, I'm preaching to the choir

From this comes four questions:

1. What is science?
2. What is literacy?
3. What is science literacy?
4. Why is science literacy so important?

1. What is science?



- The short answer
- Richard Feynman
- “Science is what we have learned about how not to fool ourselves.”

Science is:

- Carried out under, and defined by, one single over-arching condition: it is always subject to being replaced by better information.
- It is a way of doing and of thinking, underpinned by a few fundamental beliefs not always held by non-scientists:

Fundamental beliefs of science:

- By working together over time, people can figure out how the world works.
- The universe is a unified system, and knowledge gained in one area often applies to other areas.
- Knowledge is both stable and subject to change.

- Science is not a rigid body of facts, but a process subject to continuous revision and improvement.
- The AAAS, in *Benchmarks for Science Literacy* (1993) reminds us that:
- *Students (and the public) should not be allowed to conclude, however, that the mutability of science permits any belief about the world to be considered as good as any other belief. Theories compete for acceptance, but the only serious competitors are those theories that are backed by valid evidence and logical arguments.*

2. What is literacy?

- The ability to read and write to a competent level
- Knowledge of or training in a particular subject or area of activity
- ***Functional literacy*** is being able to acquire, understand and appropriately use information in today's increasingly complex and technological world

Canada doesn't fare well

A 1994 Stats Canada study reveals:

- 20% of population attains level 4 or 5 on functional literacy scale
- 57% of population is at "minimally functional" literacy level
- What does this mean?
- Here are sample tasks used in determining functional literacy…

Scale Score Ranges and Task Samples

Level	Score	Prose	Document	Quantitative
1	0–225	Use the instructions on the bottle to identify the maximum duration recommended for taking aspirin.	Identify the percentage of Greek teachers who are women by looking at a simple pictorial graph.	Fill in the figure on the last line of an order form, "Total with Handling," by adding the ticket price of $50 to a handling charge of $2.
2	226–275	Identify a short piece of information about the characteristics of a garden plant, from a written article.	Identify the year in which the fewest Dutch people were injured by fireworks, when presented with two simple graphs.	Work out how many degrees warmer today's forecast high temperature is in Bangkok than in Seoul, using a table accompanying a weather chart. .
3	276– 325	State which of a set of four movie reviews was the least favourable.	Identify the time of the last bus on a Saturday night, using a bus schedule.	Work out how much more energy Canada produces than it consumes, by comparing figures on two bar charts.
4	326–375	Answer a brief question on how to conduct a job interview, requiring the reader to read a pamphlet on recruitment interviews and integrate two pieces of information into a single statement.	Summarize how the percentages of oil used for different purposes changed over a specified period, by comparing two pie charts.	Calculate how much money you will have if you invest $100 at a rate of 6% for 10 years, using a compound interest table.
5	376–500	Use an announcement from a personnel department to answer a question that uses different phrasing from that used in the text.	Identify the average advertised price for the best-rated clock radio in a consumer survey, requiring the assimilation of several pieces of information.	Use information on a table of nutritional analysis to calculate the percentage of calories in a Big Mac that comes from total fat.

57% Canadians have minimal functional literacy:

- Prose
  - State which of a set of four movie reviews was the least favourable
- Document
  - Identify the time of the last bus on a Saturday night from a bus schedule
- Quantitative
  - Work out how much more energy Canada produces than it consumes, by comparing figures on two bar charts

Functional literacy

- 23 % of Canadians cannot function even at this level
- Only 20 % function above this level
- Very few function at the top level tested by Stats Canada

2003 Stats Canada found:

- Nationally, 48 percent adult population below Level 3 on prose and document literacy scales
- Level 3 proficiency considered as "desired level" of competence for coping with increasing skill demands of emerging knowledge and information economy.
- At 55%, the proportion of the Canadian population aged 16 and over with numeracy scores below Level 3 was even more pronounced.
- Overall, little change in literacy performance between 1994 and 2003.

3. What is science literacy?

Science literacy is being able to think like a scientist, in terms of process:

- 15%-20% of Americans are science literate
- 80%-85% are not
- 47% of 17-year-olds tested could not convert "nine parts in ten" to a percentage
- 20% of U.S. adults can't tell you if Earth goes around the Sun or the Sun around the Earth
- Most people don't understand the process part of science

Science literacy pet peeve

Meaningless questions

- **Q: Do you believe in science?**
  - Unlike religion, science is not a belief system
- **Q: Do you believe in evolution? (or the big bang? Or climate change?)**
  - They are not ideologies
  - They either happened or they didn't
  - These are matters to be solved with more data and better theory

Speaking of "Theory"

- What does theory mean?
- How do we use the word "theory?"
- How does the general public use "theory?"
- Equates hypothetical with theory
- Does not understand theory is backed by evidence

EPO must communicate that scientific theory:

- Is backed by valid evidence and logical argument
- Makes testable predictions
- Is repeatable
- Can be disproved, and
- Is subject to revision as new and better information becomes available

We need to educate about science theory, not just science!

Why raise science literacy levels? - a political parable

- *UK House of Commons debated including homeopathy in the NHS*
- *Wisely concluded evidence did not support the idea*
- *Pro-homeopathy MP led effort to dismiss the above conclusions*
- *MP thinks science carries less weight than his personal beliefs*
- *He is in position to influence government policy decisions*

The UK Parliament:

- Only 27 out of 650 British MPs have a science degree
- That's only ~ 4%
- 584 MPs have no political interest in science & technology
- In a scientific age we need scientifically literate political leaders and policy makers

4. Why is science literacy so important?

- Today's big issues and challenges require the input of science and technology
- Ideology and religious beliefs can drive denial of strong - even overwhelming - scientific evidence
- These belief systems take precedence over hard evidence
- Leading to dangerous denial – ex:climate, evolution, AIDS, vaccines, tobacco

Denial: a good corporate strategy

- Certain corporate, religious or political interests deliberately spread doubt to undermine solid scientific evidence
- Demanding “Teach the controversy” where no controversy exists
- It works for big tobacco, big oil, and far right-wing fundamentalist interests
- Falsehoods acquire currency & credibility if enough people are inclined to believe them

Why the state of denial?

- Social psychologists believe denialism fills some need
- In an environment where people feel they have no control (=today's world), rejecting expert evidence returns a false sense of control
- But there may be some cognitive issues making some more vulnerable than others

Sad but true: not everybody reasons logically

- Most people think anecdotally, and
- Emotional thinking is prevalent
- These are normal “cognitive shortcuts”
- But just because B follows A, it doesn’t mean A causes B

Perceptions of science

- Sci & tech experts and science savvy politicians are sometimes viewed as arrogant and aloof
- Ex: in 2009 a Texas state committee member tried to have creationism added to state science standards, saying:
- “Somebody’s got to stand up to the experts.”

Image source: http://www.impactlab.com/2009/05/11/is-obama-the-present-day-mr-spock/

On the bright side: many people trust scientists!

- Public attitude surveys show that scientists are more trustworthy than politicians
- In an age of cynicism trust is a priceless asset
- Science is no mere indulgence
- Science is vital to our future
- Science literacy is a necessity!

Effective EPO influences people

- Easy to change opinions
- Harder to change attitudes (but it can be done)
- Hardest of all to change are beliefs:
  - When newly acquired opinions and attitude conflict with deeply held values and beliefs, those values and beliefs will prevail

EPO: striving for positive impact

Least impact

Greatest impact

1. Learn content of EPO program
2. Change opinions about science
3. Change attitude toward science
4. Understand how science works
5. Show support for science

Learning, impact & ultimate EPO goal

- React, learn, remember science EPO content
- Transfer and apply this learning to other areas of their lives
- Change opinions, attitudes and behaviour
- Understand science enough to support science in social and political context

In Summary, Astronomy:

1. Has tremendous appeal, visually, culturally, intellectually
2. Spans the entire school curriculum
3. Draws people to the STEM subjects
4. Enjoys a pro-am partnership without equal
5. Puts us in a unique position among all sciences to have the biggest impact on science literacy
6. We can bridge the gap, connecting people with the scientific process, thinking & reasoning
7. EPO & science literacy really is a match made in heaven!