The Role of Science Education in Strengthening Public Trust in Science

IAP Webinar:
Building Trust in Science Through Science Education

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The central lessons from my 17 years in Washington, DC -- first as president of the US National Academy of Sciences and then as Editor-in-Chief of *Science* magazine

1) It is critically important that science, science teachers, and scientists, achieve **a much higher degree of influence** throughout both their own nations and the world.

2) Redefining what is meant by "**science education**" will be critical for producing a scientific temper across the globe.

Important values of science

- Honesty
- Generosity
- A strong demand for evidence, with openness to all ideas and opinions irrespective of their source

To create a scientific temper for the world, we will need a new type of science education for all

THIS SEEMS ESPECIALLY URGENT DUE TO RECENT EVENTS

- It is deeply discouraging that in the United States today, so many Americans feel comfortable **denying what science knows** – on issues that range from protecting us from the COVID-19 virus to climate change.

- The widespread acceptability of this evidence-free thinking, **which extends far beyond science**, is a danger to any democracy, and it represents a massive failure of science education.

SCIENCE EDUCATION IS THUS A CRITICAL TOOL FOR HUMANITY

What 5 year-old students can do

1) Put on clean white socks and walk around school yard.
2) In class, collect all black specks stuck to socks and try to classify them: which are seeds and which are dirt?
3) Start by examining each speck with a 3 dollar, plastic “microscope”.
4) End by planting both those specks believed to be dirt and those believed to be seeds, thereby testing their own idea that the regularly shaped ones are seeds.

To remove a major barrier to progress, science education at the college level must also change

Active learning in college biology class

What is effective "active learning"?

A critical finding from education research

(2023 Yidan Education Research Prize)

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Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities

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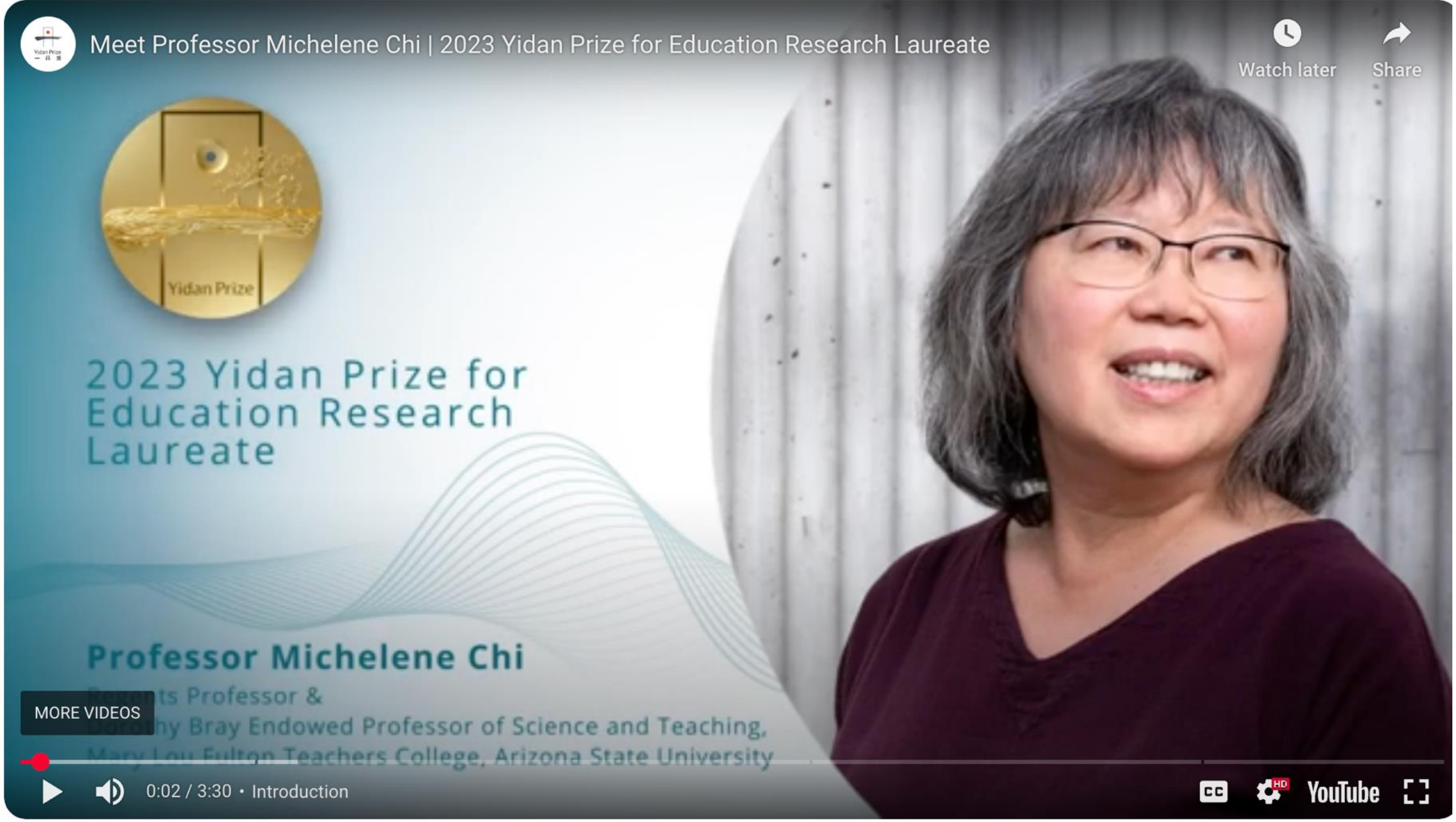
Abstract

Active, constructive, and *interactive* are terms that are commonly used in the cognitive and learning sciences. They describe activities that can be undertaken by learners. However, the literature is actually not explicit about how these terms can be defined; whether they are distinct; and whether



Teachers should challenge students to make <u>inferences</u> -- producing outputs that contain ideas that go beyond the information provided to them

Three increasingly ambitious goals for science education

1. Provide all adults with a general sense of **what scientists have discovered** about the world. (The vast expanse of the universe, all life is made of cells, the dangers of greenhouse gas accumulation in the atmosphere, etc.)

THIS HAS LONG BEEN A <u>STANDARD</u> VIEW OF THE PURPOSE OF SCIENCE EDUCATION

2. Provide all adults with an ability to **investigate scientific problems** as scientists do, using logic, experiment, and evidence.

THIS IS A FOCUS OF INQUIRY BASED SCIENCE EDUCATION

(Think of those 5-year-olds with the seeds on white socks!)

Three increasingly ambitious goals for science education (continued)

3. Provide all adults with an **understanding o**f **how the scientific enterprise works** – and why they should therefore trust the consensus judgements of science on issues like smoking, vaccination, and climate change.

WE NEED A MUCH STRONGER FOCUS ON THIS GOAL

HOW BEST TO DO?

A summary of the "Osborne project" sponsored by the Gordon and Betty Moore Foundation

Science magazine
Oct. 21, 2022

With the internet and social media providing a vehicle for conspiracy theorists and snake-oil salesmen, education must provide tools to help make informed choices.

EDUCATION

Science, misinformation, and the role of education

"Competent outsiders" must be able to evaluate the credibility of science-based arguments

By **Jonathan Osborne** *and* **Daniel Pimentel**

Because of the limits to our knowledge and time, we all depend on the expertise of others. For example, most readers of *Science* accept the anthropogenic origin of climate

The increasing complexity of modern society makes us ever more dependent on expertise (*1*). As outsiders to any domain of knowledge, we are forced to make judgements of credibility and expertise. Even being an expert in one scientific domain (e.g., cosmology) does not make one an expert

their identity or worldview. Nevertheless, the task of a liberal education is to provide individuals with the knowledge required to critically evaluate claims. This is particularly important for young people before their ideologies and identities become entrenched. How they choose to then act is the individ-

My current focus: Why Trust Science?

Scientific judgements are NOT merely what scientists happen to believe, as far too many think.

Correcting such misunderstandings will require that **science education focus on teaching how reliable knowledge is actually produced --** through the remarkable, community based human invention that we call science.

My current focus: Why Trust Science?

We have therefore created a **new website** to encourage an **explicit teaching** of how the science community creates reliable knowledge.

It contains our 6000-word ***Essay*,**
and a curated set of **free *Teaching Tools*** collected from others
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Coauthors:

Karen Hopkin & Keith Roberts

https://whytrustscience.org.uk

Why Trust Science?

Empowering Humanity with Reliable Knowledge

Search this site...

Home | Essay | Teaching Tools | Assessments | Teaching Standards | Key Takeaways | About Us

Why Trust Science?

Teaching Tools

We invite you to explore our selection of free high-quality teaching tools, a curated set of outstanding materials previously produced by others to support the explicit teaching of how the scientific community produces reliable knowledge.

These contain a mix of in-class activities and out-of-class references to aid student learning, and they represent some of the best resources we could find for teaching how science works and why evidence-based judgments are more credible than a simple belief.

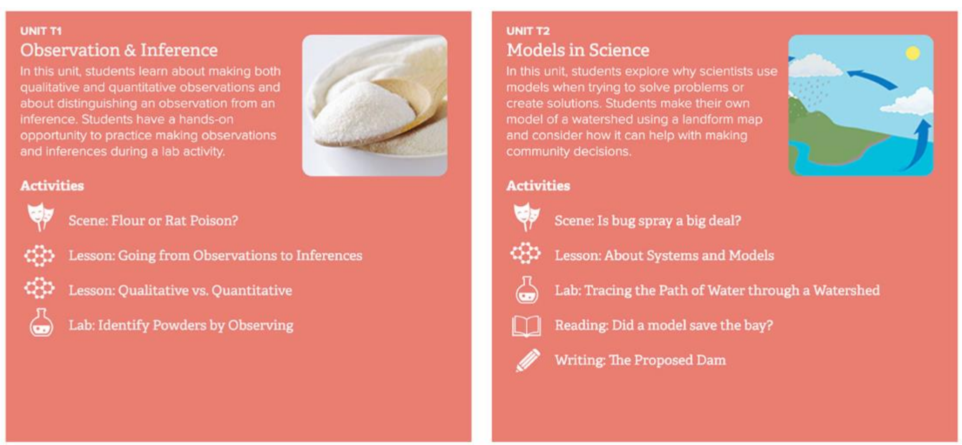
Some of the free Teaching Tools

- Making curricula maximally accessible for busy teachers
- Teaching scientific thinking
- Teaching that science often involves making inferences that are based on circumstantial evidence: "Mystery boxes"
- Teaching how science produces evidence through experiments
- Teaching how science can explore questions about the past, without experiments
- Teaching the difference between those questions that can and cannot be addressed by science
- Teaching even 5 year-olds how to argue productively, like scientists
- Teaching the critical role of peer review in science
- Teaching how scientists determine the safety of medical treatments through clinical trials
- Teaching why the textbook description of science is much too simple.

Teaching Scientific Thinking

The Strategic Education Research Partnership (SERP) presents its free middle school science curriculum as “units” on a Teacher Dashboard. Each of the 24 units has lesson plans, interactive media, downloadable documents, and projectable visuals.

“Scientific Thinking” is the first of five general themes, and it consists of six units: *Observations and Inference, Models in Science, Claims and Evidence, Designing a Fair Test, Exploring an Hypothesis,* and *Investigating a Question*.



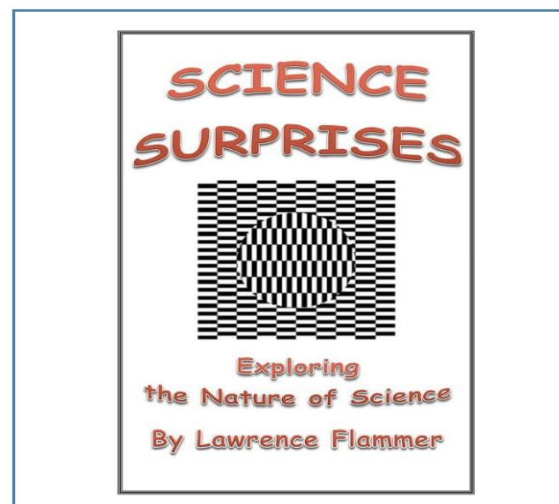
Teaching the Difference Between Those Questions that Can and Cannot be Addressed by Science

Larry Flammer was a highly skilled high-school science teacher who strongly promoted teaching the nature of science at the start of science courses. His 80-page book, entitled *Science Surprises: Exploring the Nature of Science*, features active learning and is designed to be used by high school students. Published in 2014, it includes chapters entitled "Why Science? What is Science?" and "Pseudoscience: a Major Misuse". (Flammer also produced a valuable website that can be accessed on the Wayback Machine.)

Chapter 2 of *Science Surprises*, entitled "What Science is Not" focuses on the questions that cannot be answered by science.

Click here to access a 9-page PDF for details.

Click on the image below to access the complete book:



We are also collecting good assessments

Assessments

To guide their teaching, teachers need to be able to assess student understandings — both of the scientific process and of how science is used to aid both personal and societal decision-making. As examples, we present the questions in the list below, encouraging readers to help us provide more.

Click on each link for both a question and some answers.

- Which of the Following is a Valid Scientific Argument?
- How to Use Science? Arsenic and Drinking Water
- How to Use Science? Covid-19 and Masks
- How do Scientists Come to a Consensus? Study Design
- What Is a Trustworthy Research Article?
- How to Use Science? Cancer and Power Lines
- What Is Good Science Advice? Drug Side-Effects

A stretch goal for the scientific enterprise

Can our scientific societies work together to establish systems that make it easy for every classroom in the world to **interact virtually** with a scientist or an advanced science student, at least once per year – starting at age 5?

The Amazing Power of Science-Education Partnerships

- Scientists and engineers are urgently needed to support teachers.

- And we all have a great deal to learn from outstanding teachers of children age 5 to 18 that will improve our own teaching.

UCSF’s 38 year-old Science Education Partnership

Each year:

» Scientist volunteers contribute >10,000 hours

» Are active in 90% of SFUSD schools

» Involve >350 Teachers and > 250 UCSF Volunteers

SCIENCE & HEALTH EDUCATION PARTNERSHIP
UNIVERSITY OF CALIFORNIA · SAN FRANCISCO

Another way to connect local scientists

As you will hear in detail from Carol O'Donnell:

SCIENCE DRIVEN BY LOCAL ACTION

The **Smithsonian Science for Global Goals** project provides new freely available community research guides for youth ages 8-17 developed by the Smithsonian Science Education Center in collaboration with the InterAcademy Partnership. These research guides use the **United Nations Sustainable Development Goals (SDGs)** as a framework to focus on sustainable actions that are student-defined and implemented.

developed by

Smithsonian
Science Education Center

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

Our Joint Mission: My favorite quote

"The society of scientists is simple because it has a **directing purpose: to explore the truth**. Nevertheless, it has to solve the problem of every society, which is to find a compromise between the individual and the group. It must encourage the single scientist to be independent, and the body of scientists to be tolerant.

From these basic conditions, which form the prime values, there follows step by step a range of values: dissent, freedom of thought and speech, justice, honor, human dignity and self respect.

Science has humanized our values. Men (and women) have asked for freedom, justice and respect precisely as the scientific spirit has spread among them."

Jacob Bronowski, Science and Human Values, 1956