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Learning to Learn

The Art of Doing Science and Engineering

Session 30:
How Do We Know What We Know

Background

Epistemology

- The study of what is meant by "knowledge"

Early History

- Primitive Tribes – creation myths of the world. Attempting to answer the question:
  - *"Why is the world there?"*
- Beliefs lent themselves to theology –
  - *"The Gods did it, and that's the way it is"*

Background (cont.)

Greece (Circa 600 BC) – Rational Approach

- What is the world made of?
- Foundations of beliefs that have evolved into knowledge today.
- Belief that Geometry was "certain" knowledge.

No "absolute" truth

- Mathematics is consistent based on rules and assumptions. Change the assumptions or rules and the knowledge is changed.

Why is the topic important?

Science is constantly appealed to:

- Science has shown that…
- We know from Science that…

Do We?

- How certain are we about what we know

How do Children Learn

Learn from Experience

- All children babble and make noises when born
- Depending on culture, different noises (e.g. "mama") solicit a response from others
- These experiences build a supply of 'knowledge' that is drawn upon

Dealing with inconsistency

Knowledge base constantly filled with inconsistencies:

- "Gladly the cross I'd bear"
- "Gladly, the cross-eyed bear"

Resolving misconceptions

- May never truly understand what is meant
- Humans can get very far without true understanding
  - *"I can do the mechanics of a math problem, but I still don't understand what I'm doing"*

Meaning is constructed

No first word in the dictionary

- All words are defined by other words – circular

Children can learn any language

- Children develop an understanding of language by filtering out noises that mean something vs. those that do not.
- Children quickly abandon experiences that are wrong or knowledge that is mistaken
  - *The ability to do so diminishes with age!!!*

What is Science?

Make experiments, draw data, form theories

- But the theory comes first
  - Directs what data you want to collect
  - Cannot interpret results without a theory
  - Process guided by preconceived notions

Notions through Osmosis

Many of our preconceived notions develop through osmosis

- We learn how to behave from our surroundings and interactions, even when not told
- We adopt clothing styles from our environment

Aging makes it harder to abandon notions

- People who act or dress like they did twenty years ago, and can't change

Words and knowledge

We tend to think in words when trying to understand something

However this is not always possible

- "I understand this but I can't explain it."

Knowledge vs. words

- If you explain some event that happened, gradually the explanation becomes the event.
- Possible reason why witnesses to crimes are separated.

Science and knowledge

All previous scientific theories are wrong

- They've been replaced by the present theories.

Is it correct to assume that the current theories are true and there will be no others

- No. History dictates otherwise.
- Chances are that almost all of the theories we now have will be shown in the future to be in some sense, false.

Knowledge and logic

Logic has many pitfalls

- PhD students in mathematics normally spend time "patching up" holes in well regarded mathematician's proofs.

The 'Rising standard of Rigor'

- We are starting to realize that things are not black or white, right or wrong.
- There are things that we have developed notions about but they are not always right.

Science and Society

Putting a man on the moon

- Society decided that engineering was the best approach in accomplishing that task.
- Society often relies on science to answer questions or solve problems, perhaps too much.

Scientist's Dilemma

Many scientific claims fell short of their original promised potential

- Cold Fusion
- Potential of AI

What about tomorrow

- No one can prove that these claims will not be achieved tomorrow since "no one can prove anything in science"
- Circular dilemma

Continuous change

The world is constantly changing.

- What we couldn't do yesterday, we may be able to do tomorrow
- What we thought we could do today, or thought we knew today, may be proven wrong or false tomorrow

The limits of Science

Reductionism

- General approach of science to take apart something and study its parts to gain understanding

The whole is greater than the sum of its parts

- Some things cannot be taken apart without destroying the whole (e.g. psychologist view on situations)

Summary

Science does not produce the knowledge we wish we had

- Rather, we wish that we have certain truths so we assume that we have them.

Wishful thinking is a curse of man

- A scientist believes something might be possible with no evidence to support it and attempts to do it.
- Overtime, after working on it, and talking about it, what they thought might be possible can transition in their mind to absolutely achievable.