Building the Scientific Mind through planned intervention in structured settings

Convergence and Divergence in Children's Attitudes Toward the Sciences and Science Education

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Connection to BtSM Aims

1. Determine the conditions that foster development of the scientific mind: formal settings
2. Establish practical ways to improve and complement existing efforts to develop the scientific mind
3. Break open the too narrowly defined research agendas and practices

Science and the economy

- In the UK, there will be a 12% increase in demand for Science professionals from 1996-2006

- Number of scientists per million of populace (1993):

Japan	3500
USA	2700
Europe	1600
Latin America	209
Asia	99
Africa	53

Attitudes

- Express our *evaluation* of something or someone
  - evaluative consistency
  - Target
- Stable: Once acquired, they are hard to change
- Lack of generally accepted terminology - (Encyclopædia Britannica Online)

Why attitudes matter

1. The “swing from science”

2. Attitudes impact implicit motivation, which impacts
   - academic effort
   - future activities in school and society

Attitude toward Science and Science Education

Intrinsic Motivation

Enhanced Effort & Processing

Continuing Motivation

The good news

- Applications-based Physics course results in positive attitude toward Physics
- Attitude strongly impacted by quality of teaching - In our control
- Much evidence that students feel science is useful and interesting
- % of girls going into science-related fields in the UK has increased from 1979-2000

The not-so-good news

"the absence of history or context, the tyranny of technique, the isolation of the learner and the struggle to attend in a sea of inattentiveness"

- Student explanation for turning away from Science in college (Tobias, 1990)

The not-so-good news

- The number of students taking science and math at A–level (in the UK):
  - 42% in 1963
  - 16% in 1993.

- One of the variables most strongly impacting attitudes is gender

- Attitude toward (school) science declines with entry into secondary school
  - especially for girls

The not-so-good news

- Recognized value of science does not imply appreciation for science education:
  - 72% of sample indicated science is important
  - 40% of sample indicated science class is boring (Ebeneezer and Zoller, 1993)

- Boys have a consistently more positive attitude toward school science than girls
  - effect is stronger in Physics than in Biology
  - effect is strongest in general science (Weinburgh, 1995)

World Year of Physics

- % of girls in Physics college degrees is not increasing in the UK
  - Rates *have* increased in all other science programs
- Male:female ratio:
  - Physics is 3.4:1
  - Biology is 1:1.6
- Physics rates poorly in terms of attitudes:
  - 50% do not enjoy Physics at all or very little
  - 60% enjoy Biology quite a lot

World Year of Physics

- Scotland & The Netherlands
  - attitudes toward Physics *not* lower
  - Physics taught by qualified Physics teachers

- Decision to pursue Physics most strongly impacted by math and science scores
  - Reinforcing that physics is for the intelligent, and therefore difficult

The unexpected news

- "Science after Grade 10 will cheat me out of well-rounded liberal education"
  - Girls: limited to unappealing scientific careers
- Survey of students who dropped science courses:
  - 71% rated science as interesting
  - 79% felt practical work was enjoyable
  - 76% felt that it helped you to understand things in everyday life

The unexpected news

- Curriculum materials and instructional techniques doesn't seem to significantly impact student attitudes
  - as opposed to teaching quality
- Lower SES associated with higher interest in school science
- Science attitudes may not be correlated with achievement
  - Children can achieve in school science without a positive attitude

The useful news

- Science attitude most strongly affected by science teaching
- Most positive attitudes toward school science with:
  - High level of involvement
  - Very high level of personal support
  - Strong positive relationships with classmates
  - Use of variety and unusual techniques
- Teachers are happiest and most enthusiastic when teaching the subject they specialize in

What "BtSM-ers" might explore & ask questions about

1. Scientific training is a type of education that produces a "useful specialist" but not "a truly educated man" (Mathew Arnold, 19th Century)
   - What are the implications for BtSM?

2. Difference in girls and boys attitudes toward science courses is strongest in general science
   - Does this doom girls in developing nations, where few make it past general science courses?

What "BtSM-ers" might explore & ask questions about

3. "Actual experience with science at school does not seem to be related to attitude toward science as a worthwhile societal enterprise…Science at school should and science out of school should be treated as distinct and separate entities"
   - Is this really what we should be doing?

4. The smallest school
   - How do we use ensure it contributes to BtSM?

What "BtSM-ers" might explore & ask questions about

5. "The essential irony of a discipline that offers intellectual liberation from the shackles of received wisdom is that the education it offers is authoritarian, dogmatic, and non-reflexive"
   - What can be done to modify this?

6. Little is known about how and why attitudes toward science change.
   - Attitudes are integral to BtSM. Knowledge is often ephemeral. How can we bring clarity to this topic?