The great contemporary problem for science education

How to engage students with science?

- *fascinate them with natural phenomena?*
- *interest them in science, currently and for the future?*
- *imbue them with a sense of its personal and social worth?*

An international issue that goes beyond the teaching/learning of established scientific knowledge

WIDESPREAD DISINTEREST IN STUDYING SCIENCE

- Enrolments in the sciences are down
  (senior secondary and university)
- Lack of recognition of worth of science education
- Other subjects more extrinsically and intrinsically attractive

Strategy of Paper

I. Research relevant to the nature of the problem

II. Research relating to possible solutions

III. Research about impediments to solutions

Japan: National survey
Attitudes to school subjects

Ogura, 2003

- **From Years 6-9 students' interest in all subjects went down**

If the role of this subject in university entrance is discounted, is it worth studying?

All subjects, except Science and mathematics went up.

Secondary students' experiences of school science

Recent studies-

Australia (Lyons), Sweden (Lindahl), England (Osborne and Collins)

Strong common themes:

- School science as knowledge transmission
- School science content as irrelevant and boring
- School science as difficult *(compared with other subjects)*

Conclusion: Only continue studying science if you have to for future reasons.

Some educational reasons for this lack of interest

- structure of curriculum
- content for learning
- separation of technology from science
- unauthentic assessment systems
- conceptually-socialised science teachers
- preparation of science teachers
- influence of academic science

Structure of Curriculum and its content for science learning

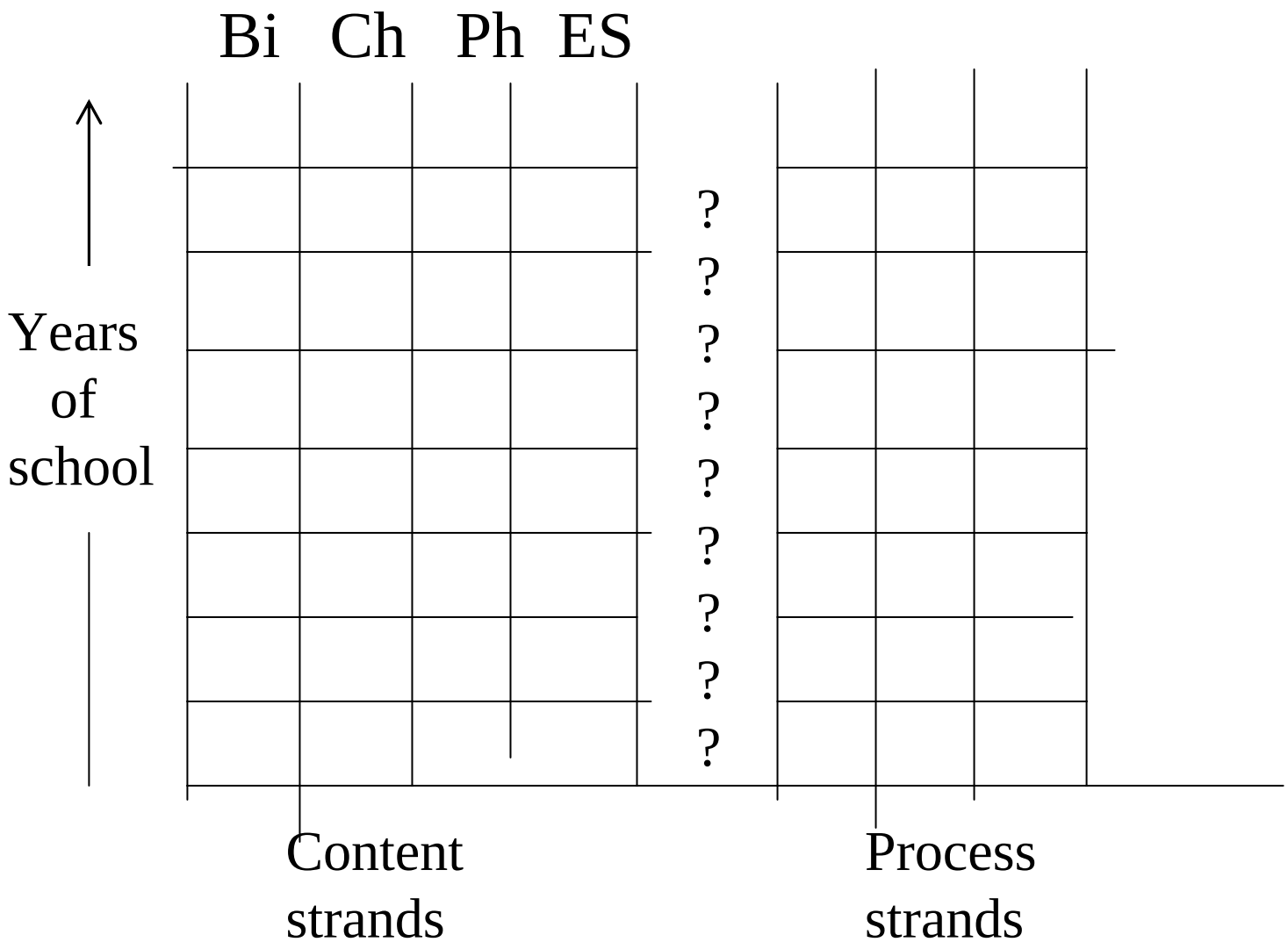
Following the national curriculum in England/Wales in 1991

Australia and many other countries set out the school curriculum as a number of Key Learning Areas of which Science was one.

Each Key Learning Area was set out in a vertical template form, with columns of content and process learning from Year 1 to Year 10/11

Curriculum by Vertical Template in 1990s

For Science



Problems in science teaching

- confidence and PCK among primary teachers
- unfamiliarity of secondary teachers with contextual teaching
- separation of technology from science
- disconnection between science teachers and developments in science

Goodrum, Hackling and Rennie, 2001; SIS project (Deakin) 2000; EdQ 2003; Beyond 2000, 1998

II. Research relating to possible solutions

Science content for learning at different levels of schooling?

Relevance of Science Education ROSE in 40+ countries

This major study involves a sample of 15 year olds respond on a 4-point Likert scale to sets of items relating to:

- Sections A,C,&E. *Science topics I want to learn about*
- Section B *Future occupations*
- Section D *Statements about the environment*
- Section F *Views on school science*
- Section G *Statements about science and technology*
- Section H *Out-of-school experiences*
- Section I *If a scientist, What I would do? and Why?*

242 items in total plus OE for section I

ROSE Project

Student responses from more developed countries are generally very similar

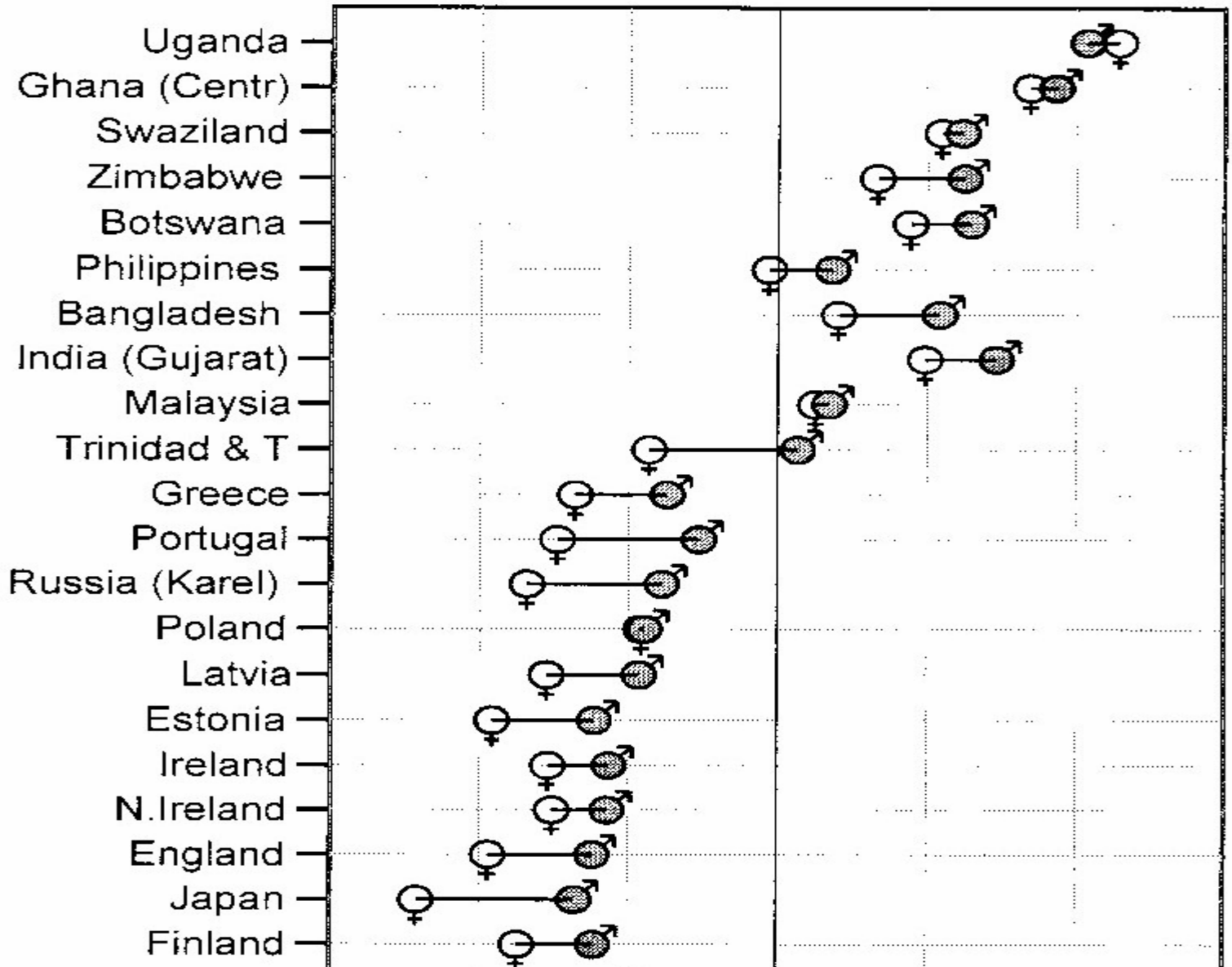
and

are much less positive about S&T and S&T education than those from students in less developed countries

- *The correlation of mean responses with the national HDI (Human Development Index) is high*

I would like to be a scientist

Sjøberg& Schreiner, 2005



Relevance of Science Education (ROSE project)
five most popular topics (England)

Boys	Girls
1. explosive chemicals	1. why we dream and their meaning
2. weightlessness in space	2. cancer, what we know and treatment
3. how atom bomb functions	3. performing first aid
4. biological and chemical weapons and human bodies	4. how exercise keeps the body fit
5. black holes, supernovae in space	5. sexually transmitted disease and protection

Relevance of Science Education (ROSE project)
five least popular topics (England)

Boys	Girls
1. alternative therapies	1. benefits and hazards of modern farming
2. benefits and hazards of modern farming	2. plants in my area
3. famous scientists and their lives	3. organic and ecological farming
4. organic and ecological farming	4. treatment of wastes, garbage and sewerage
5. how plants grow and reproduce	5. atoms and molecules

ROSE Project: Sweden

Jidestjø and Oscarsson, 2006

Reports many mismatches between the responses of students and their teachers

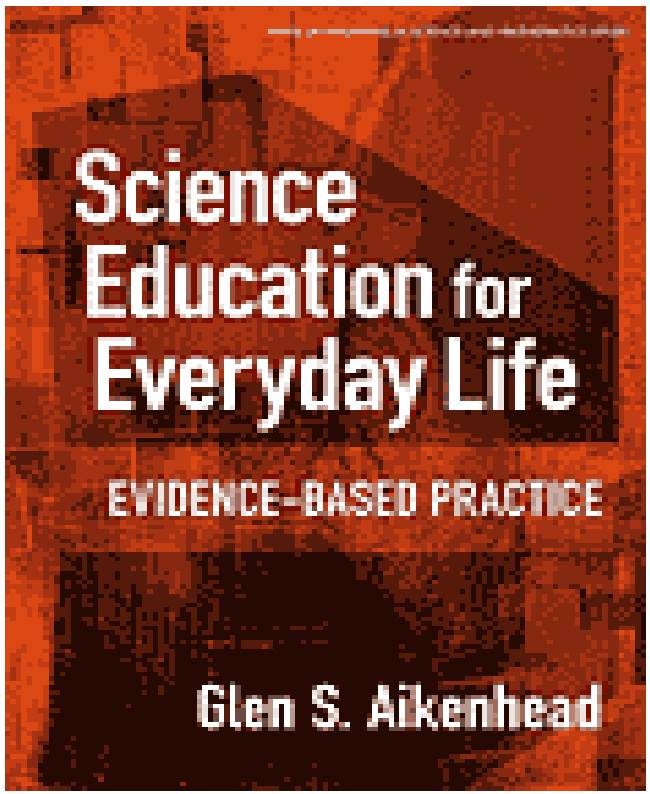
for example

only four of the top 15 items for boys and girls were recognised as such by the teachers

Successful innovations as Curricula for Science

Improvements in practice

From within science education, 2005



Science Education for Everyday Life

Glen Aikenhead, 2005

Humanistic Science Education

- citizen preparation for the everyday world
- attention to several sciences (established, frontier, citizen, etc.)
- scientific and moral reasoning with values
- knowledge about scientists and science

Traditional Science Education

- pre-professional training for scientific world
- emphasis on established science
- solely scientific reasoning
- knowledge of canonical science

Evidence from Practice

- positive affect from students and teachers involved
- deeper learning of fewer concepts
- appreciation of applications of science

but

➢ failure to be adopted as main stream

Exemplary types of Humanistic science curricula

- Science/Technology/Society (STS Science)
- Environmental Science
- Concepts in Contexts
- Gender-inclusive Science
- Culturally–aware Science
- Science as a Story
- Science for Nurturing

Common features in positively received science curricula

- Science as a Story (involving persons, situations, action)
- Real world situations involving science
- Focal questions that attract interest
- Contexts as the source and power of concepts in science
- Science-related issues of personal and social significance
- Personally engaging, open problems for investigation
- Asking questions about natural phenomena

Always targetted at the interests of specific groups of students – age groups or needs groups

21st Century Science, 2003 -

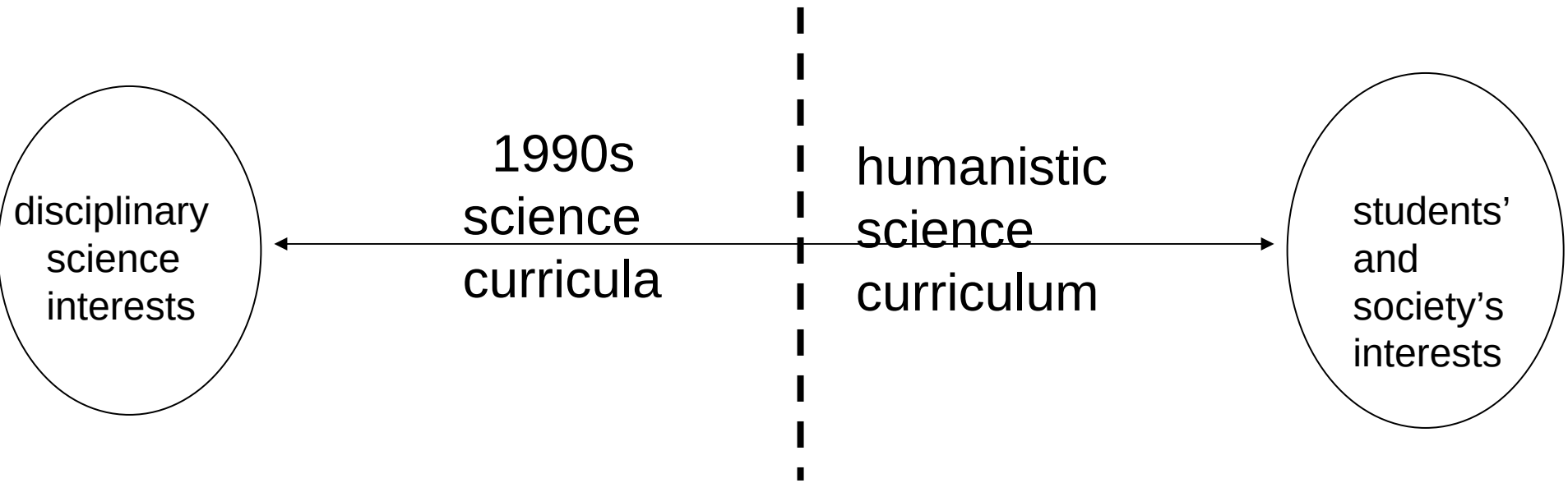
A positive evaluation of this new contextually-based approach to science curriculum in England and Wales.

An example of science curricula that target the particular needs and interests of different groups of students.

R. Millar, *IJSE,* 2006 (in press)

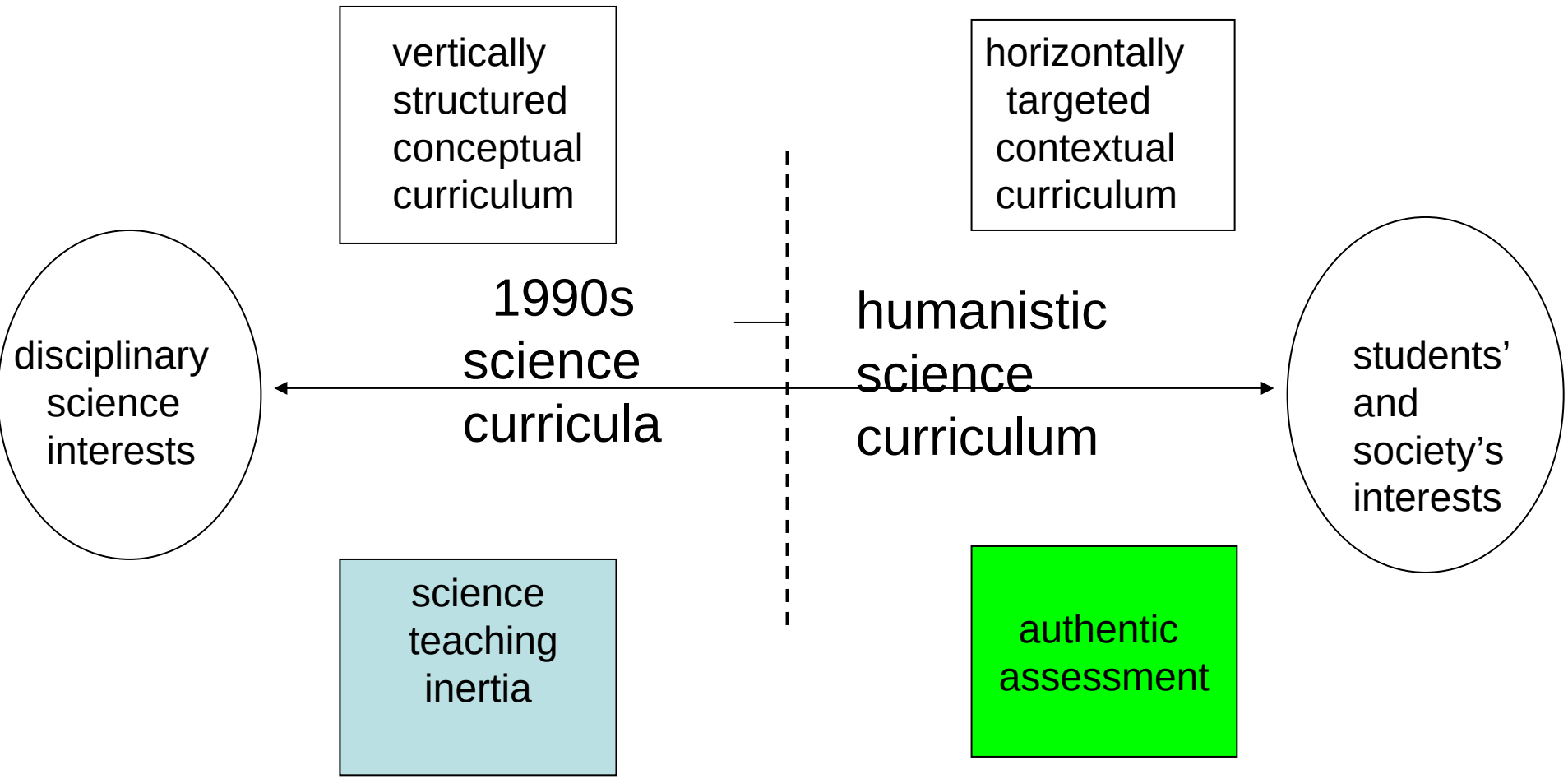
for change from within

consider interest priorities served in different science curricula



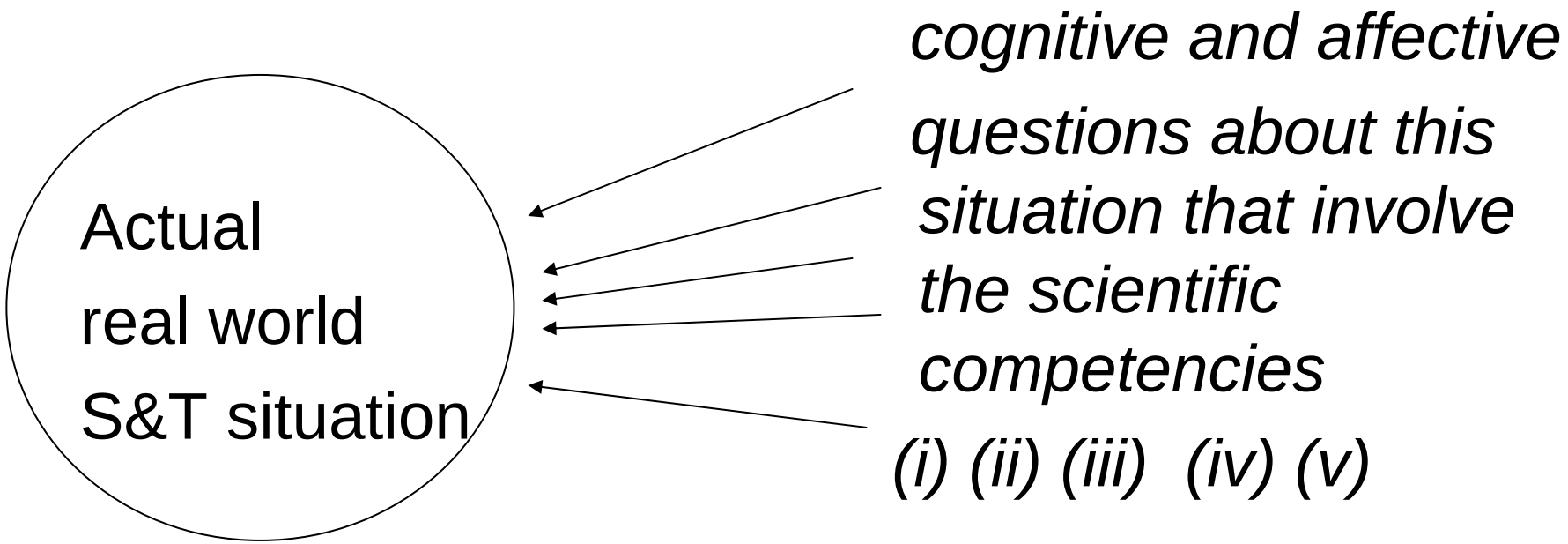
for change from within

Interest priorities served in different science curricula



Authentic modes of assessment

OECD's PISA Test of Scientific Literacy 2000,2003,2006



PISA Test of Scientific Literacy 2000, 2003

- **Each part of this test begins with a description of an actual S&T situation.**
- ***This means there is substantial reading before the questions can be answered.***

- **In the Reading test of PISA, girls significantly performed better than boys in every country.**

- **In the Science test there was <u>no</u> significant difference between boys and girls in most countries.**
- *Despite the extensive reading, these S7T situations engaged both boys and girls!*

PISA: Test of Scientific Literacy

four clearly defined scientific competencies

- *applying science knowledge to new situations*
- *recognising and asking scientific questions*
- *identifying science claims and explanations with data*
- *willingness to engage with science*

Note: cognitive and affective learning are both expected outcomes of science education

III. Research about Impediments to Solutions

Contemporary Impediments in Australia (and NZ)

- The new Essentials curricula
- The National Consistency Project

The new Essentials Curricula

Tasmania New Curriculum Essential Learnings Framework 2002

- ***Thinking***
- ***Communicating***
- ***Personal Futures***
- ***Social Responsibility***
- ***World Futures***

New Zealand Draft Curriculum, 2006

Key Competencies

- ***managing self***
- ***relating to others***
- ***participating and contributing***
- ***thinking***
- ***using language, symbols and text***

Victoria: New Curriculum 2007
Victorian Essential Learning Standard (VELS)

Three “interwoven” strands:

- Physical, Personal and Social Learning
  (managing personal learning, working in teams, etc.)
- Discipline-based Learning
  (Science is one of six)
- Interdisciplinary Learning
  (thinking, communicating)

Origins of Learning Competencies as Priorities in the Curriculum of Schooling

- OECD 1996:The Knowledge –based Economy
- OECD 1998 DeSeCo Report
- OECD 2000 From Initial Education to Working Life

- NZ: 2 Knowledge Wave Conferences
- USA: Reports from Achieve (inc) and Natl Governors Association, Business Higher Ed Forum, etc

- *The New World of Work*

and

- *The Knowledge Society*

Changes in the World of Work due to Knowledge Wave

- *change in nature of work*
- *change in the requirement of performance*
- *change in location of work*
- *change in permanence of engagement*

The Knowledge Society

"*Information is the currency of the economy.*"

Basic skills and competences

DeSeCo

Definition and Selection of Competence

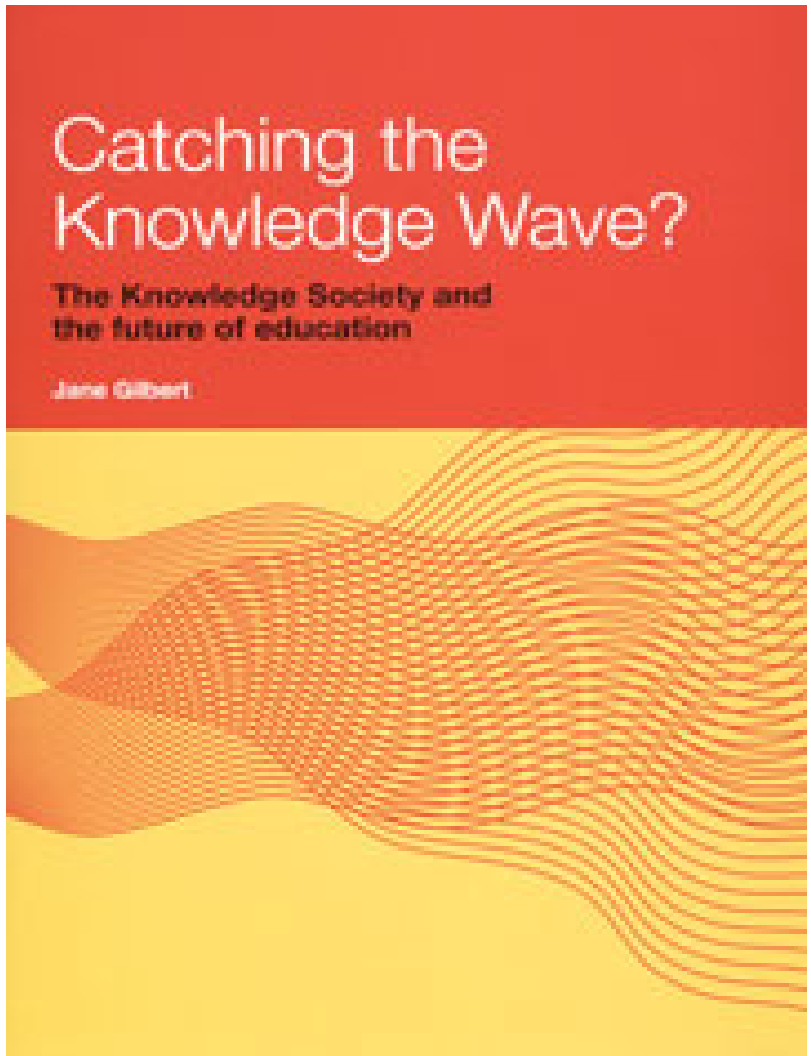
Three types:

communicative

analytical

personal

Challenges and threats to science education



Jane Gilbert, 2005

Educational consequences for the New World of Work and the Knowledge Society

Knowledge is a verb

rather than

a noun

Knowledge is about acting to produce new things

compared with

Knowledge is made of stored bits of established knowledge

Valued learning in Knowledge Society

- *Knowing how to learn*
- *Knowing how to keep learning*
- *Knowing how to learn with others*

compared with

- *Knowing many bits of knowledge*

Valued learning

being able:

- *to adapt to change*
- *to generate new knowledge*
- *to improve performance*

*(**learning is to be dynamic rather than** static)*

Valued Learning

- Acquiring skills and competencies

rather than

- Accumulating knowledge

“The new knowledge workers need to understand how different fields of old knowledge work”

“The new workers need to be adept at putting elements from one knowledge system with elements from another, arranging them so that they work in new ways and do new things”

Jane Gilbert, p 155/6

Interest in Learning
and

Interest in learning Science

Notably absent in these reports

The Key Issue

- do *Thinking, Communicating, Inquiring, Problem solving, Rich tasks, etc.* refer to learning that is in some way generic

or

- do they refer to new learning emphases in each subject area?

Three questions for science educators

1. *What is the place of science education in these new curricula?*
2. *Do they solve the problem of lack of interest in Science?*
3. *How will science teachers cope with the shift of emphasis from science knowledge to the new competencies –*

   thinking, communicating, adapting to change learning to learn, etc.?

USA :12 major reports Preparing 21st C Workforce

Bybee and Fuchs, JRST, 43(4) 2006

Desired Competencies

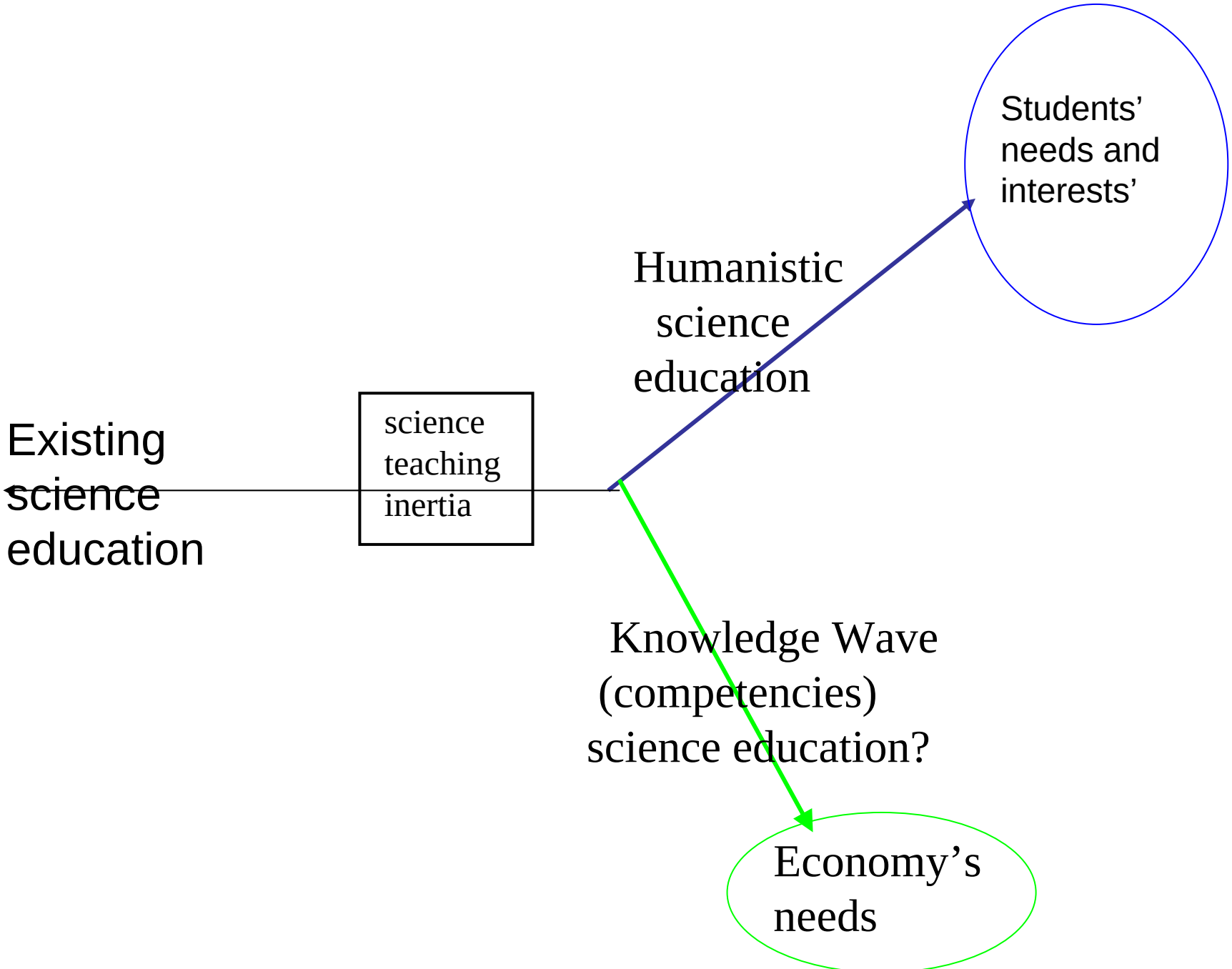
- ***Thinking***
- ***Communicating***
- ***Problem solving***

Role of S&T

in economy regularly noted

but

S&T education not addressed!!


Students' needs and interests'
Humanistic science education
Existing science education
science teaching inertia
Knowledge Wave (competencies) science education?
Economy's needs

Tasmania New Curriculum Essential Learnings Framework 2002

- ***Thinking***
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Science in Draft NZ Curriculum

Four processes

- ***understanding about science***
- ***investigating in science***
- ***communicating in science***
- ***participating and contributing***

are to be “overarching, unifying strands”, superimposed on the existing four content strands (biology, chemistry, physics, earth sciences)

stretching vertically through the years of compulsory schooling.

Victoria: New Curriculum 2007
Victorian Essential Learning Standard (VELS)

Three “interwoven” strands:

- Physical, Personal and Social Learning
  (managing personal learning, working in teams, etc.)
- Discipline-based Learning
  (Science is one of six)
- Interdisciplinary Learning
  (thinking, communicating)

In these new curricula, the structure and content of the curriculum for Science has not been changed.

Both continue to stretch vertically across the years of schooling

A failed curriculum has survived to give priority to the innovation of

essential learning competencies

“interest in science” as an issue has not been addressed

National Consistency Project

- **ignores critical issue of interest in science**

- reduces science learning to a set of concepts
- divorces these concepts from the natural phenomena (scientific contexts) for which they were invented
- gives little attention to applications of science in Australian society
- maintains vertically structured curriculum

National Consistency Project

fails to ensure that nationally important issues of S&T will consistently be addressed in school science, such as:

- *obesity-diet and exercise*
- *water availability and use*
- *practical energy conservation*
- *global warming*
- *weapons of mass destruction*
- *endangered species*
- *toxicity and household chemicals*
- *war on terror*
- *alternative energy sources, etc., etc.*

Science for All Canadians

Goals for science education 1984

- participate as informed citizens in technological society
- pursue further studies in S&T
- ***enter the world of work***
- develop intellectually and morally

Science for All 2006

- *to enter the world of work*

seems likely to become the dominant demand and priority,

reducing school science to becoming merely a vehicle for teaching these economically driven competencies

Achieving Balance

World Economic Forum ⟷ **World Social Forum**

Science Education for the World of Work ⟷ **Humanistic Science Education**