Teaching and Learning Science in a European Perspective

Doris Jorde
University of Oslo

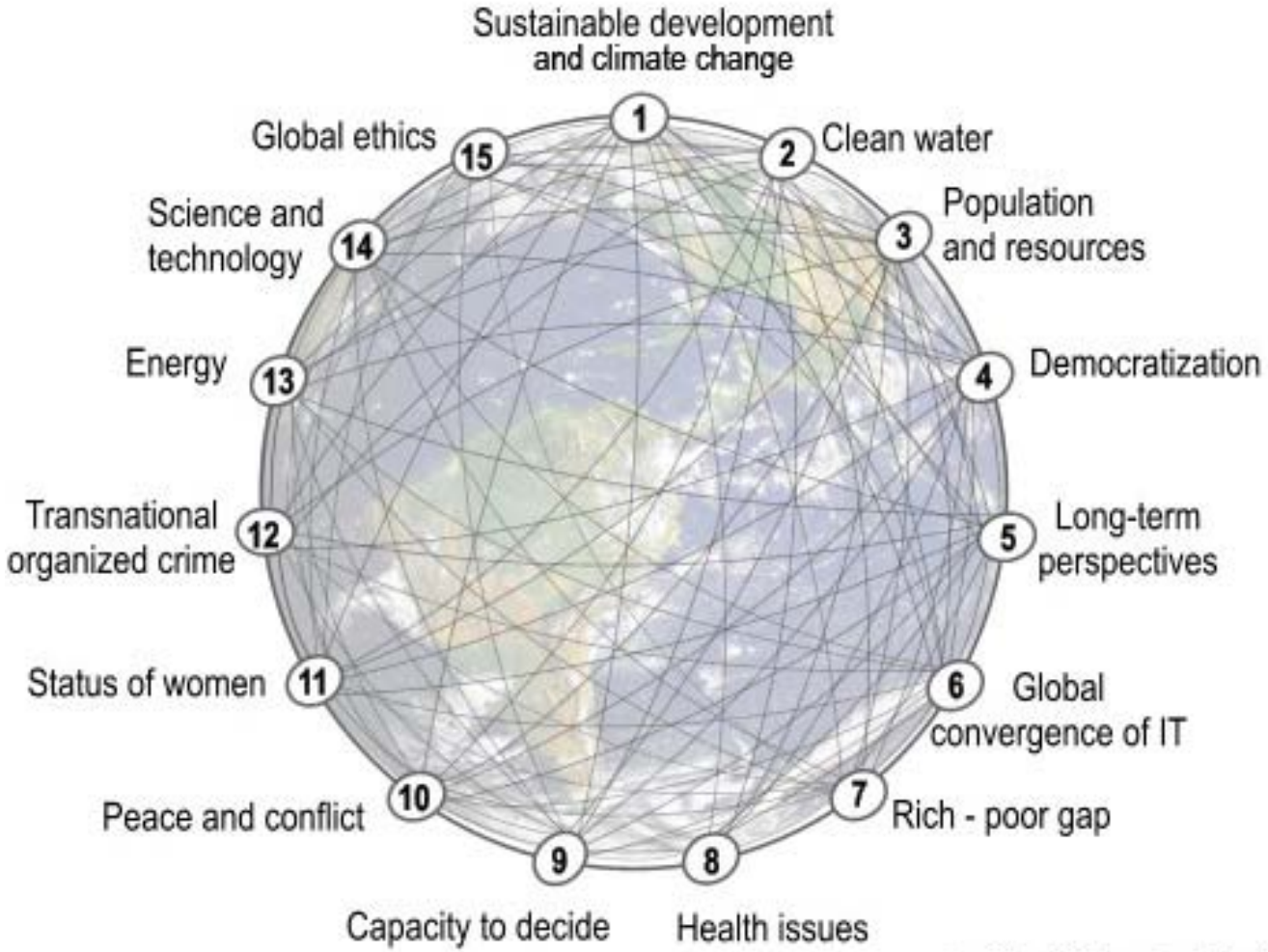
What is science?

- Explanations of the material world
- Based on observation and testing of theories against nature (facts, hypotheses, laws, theories)

- Importance historically
- Importance in a modern society

Why Science?

15 Global Challenges
facing humanity



by The Millennium Project
www.millennium-project.org

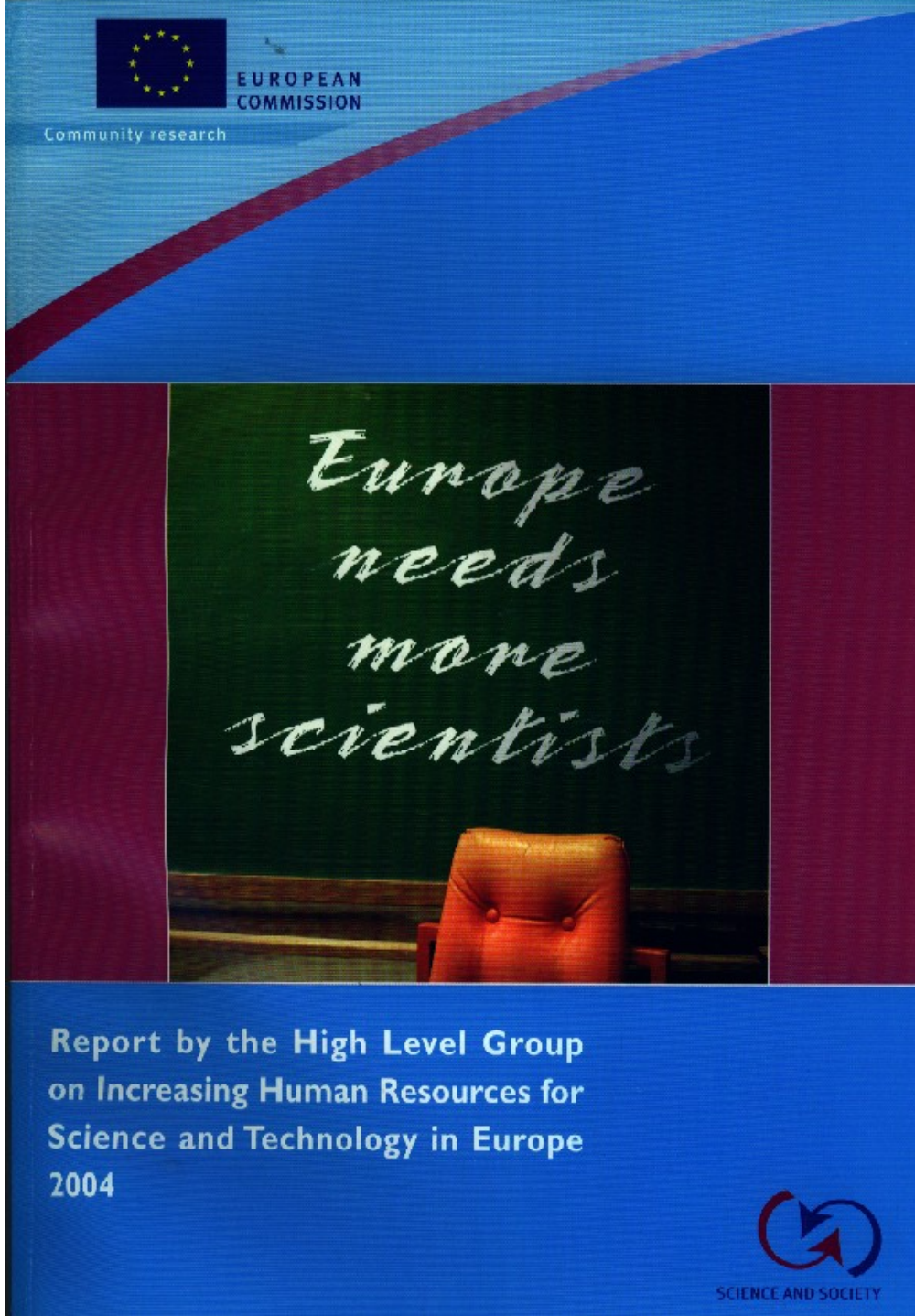
Why does science matter?

- Science for all
  - Scientific literacy important in a democracy
- Science for future scientists
  - Important for EU – economic growth, competition, prosperity

Current studies

- Europe need more scientists - EU
- The Global Science Forum – OECD
- Science Education In Europe – Nuffield
- Science Education NOW – EU
- Mind the Gap

Recruitment and interest in S&T: A prime political concern for Europe and (most) OECD Countries…



It can be argued that science education in schools lives in a world of its own. It seems unsophisticated because it is unable to compete with advances within the scientific fields. It is abstract because it is trying to put forward fundamental ideas, most of which were developed in the 19th century……

…. It is heavily in danger of being excessively factual because of the explosion in scientific knowledge and the “adding-on” of topics to an already excessive content base.

Europe needs more scientists, 2004

Bridging the gap between science and society

- What should school science address in a knowledge society?
- What responsibility do schools, public institutions, business and industry share in connections between science and society?
- How do we go about making science careers more attractive?

Recommendations

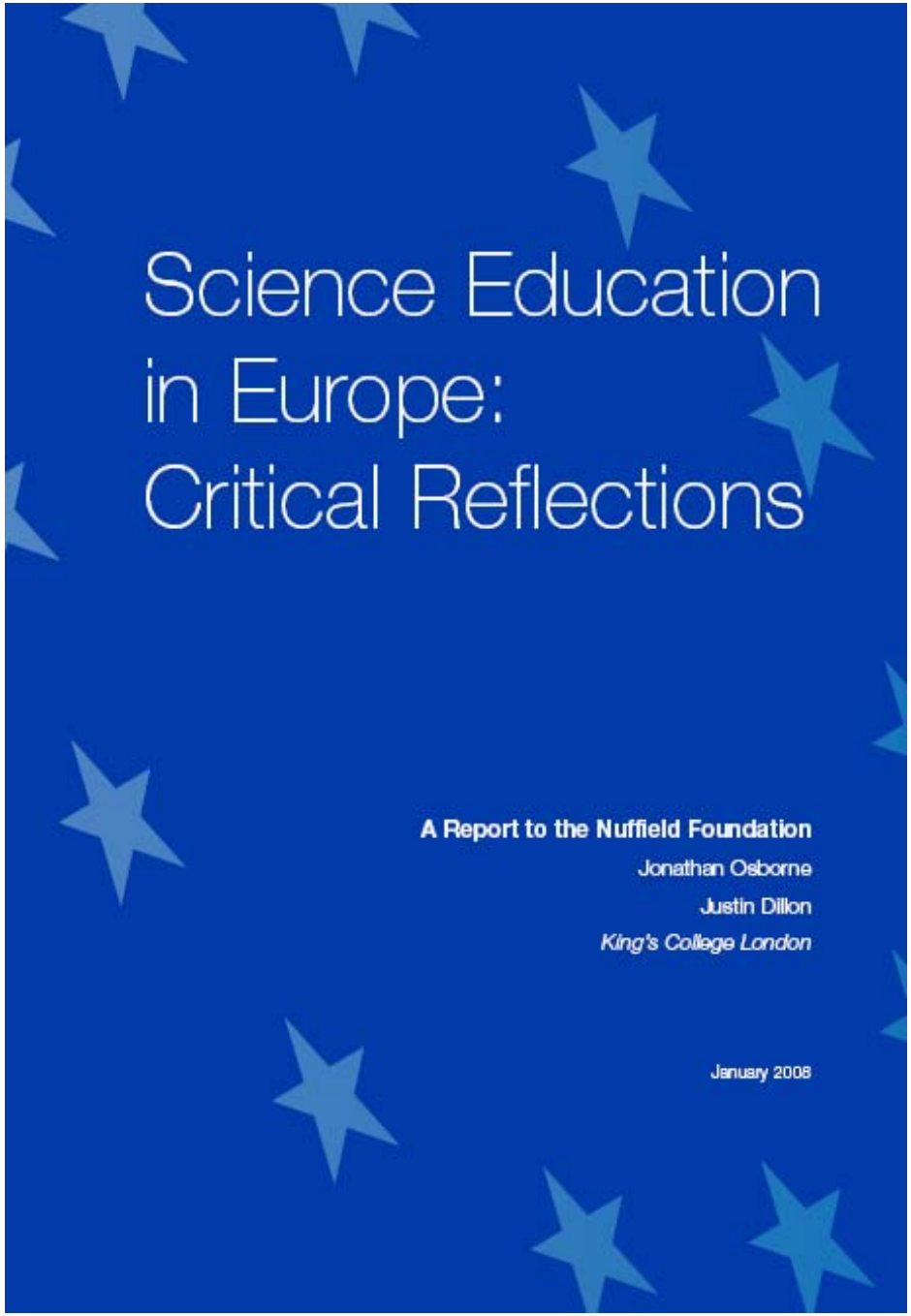
- Continue in-depth studies to show trends
- Long-term studies of student motivation
- Governments should actively promote equal opportunities for all (males and females) and take steps to eliminate negative stereotypes
- Governments should invest in teacher training, curriculum development, exchange of best practice, assessment

Science Education in Europe

A report to the Nuffield Foundation

Jonathan Osborne & Justin Dillon

http://www.nuffieldfoundation.org/fileLibrary/pdf/Sci_Ed_in_Europe_Report_Final.pdf



Questions asked:

- What are the major issues confronting formal secondary science education?
- What evidence is there?
- Is the situation common throughout Europe or is there variation?

The State of Science Education in Europe

- Relevance is lacking
- Reforms in Pedagogy needed
- Girls less interested than boys with fewer choosing careers in physical science and engineering
- Reforms in curriculum needed (more human content)

Recommendation 1

- The primary goal of science education across the EU should be to educate students both about the major explanations of the material world that science offers and about the way science works. Science courses whose basic aim is to provide a foundational education for future scientists and engineers should be optional.

Recommendation 2

More attempts at innovative curricula and ways of organizing the teaching of science that address the issue of low student motivation are required. These innovations need to be evaluated. In particular, a physical science curriculum that specifically focuses on developing an understanding of science in contexts that are known to interest girls should be developed and trialled within the EU.

Recommendation 3

- EU countries need to invest in improving the human and physical resources available to schools for informing students, both about careers *in* science – where the emphasis should be on why working in science is an important cultural and humanitarian activity – and careers *from* science where the emphasis should be on the extensive range of potential careers that the study of science affords.

Recommendation 4

EU countries should ensure that:

- Teachers of science of the highest quality are provided for students in primary and lower secondary school;
- Emphasis in science before 14 should be on engaging students with science and scientific phenomena. Evidence suggests that this is best achieved through opportunities for extended investigative work and “hands-on” experimentation and not through a stress on the acquisition of canonical concepts.

Recommendation 5

Developing and extending the ways in which science is taught is essential for improving student engagement. Transforming teacher practice across the EU is a long-term project and will require significant and sustained investment in teacher professional development.

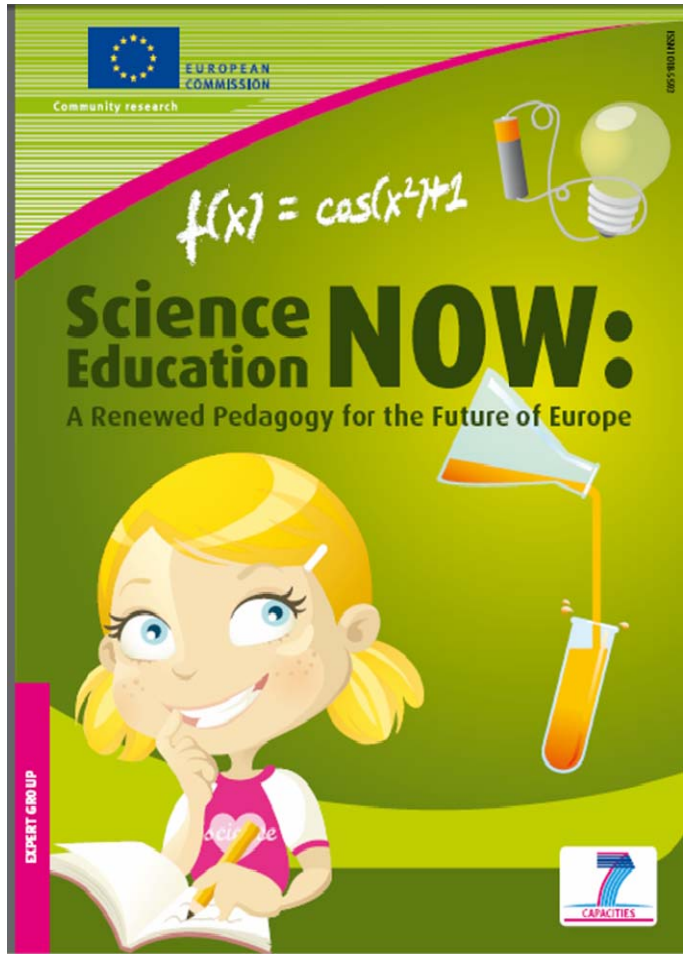
Recommendation 6

Good quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal science education. Systems to ensure the recruitment, retention and continuous professional training of such individuals must be a policy in Europe.

Science Education NOW

A Renewed Pedagogy for the Future of Europe

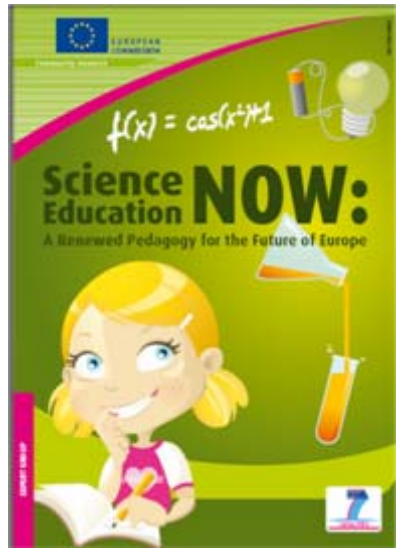
Michel Rochard (Chair)
Peter Csermely
Doris Jorde
Dieter Lenzen
Harriet Walberg-Henriksson
Valerie Hermmo (rapportur)



Background for the report

- Decline in student interest in science, math and technology in Europe
- Modest improvements in Europe despite numerous projects
- Future of SMT important in Europe

Recommendation 1

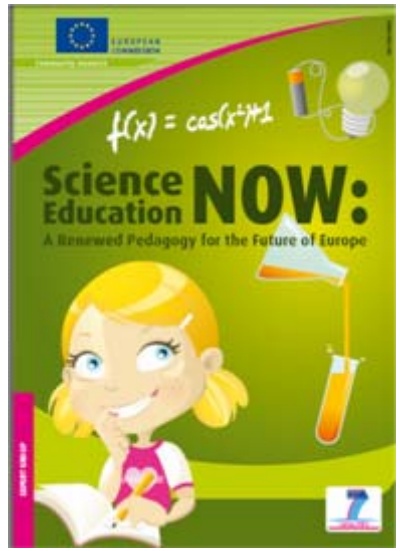


Because Europe's future is at stake decision makers must demand action on improving science education from the bodies responsible for implementing change at local, regional, national and European levels.

What can be done?

- At national levels we can place science on the agenda – everywhere!
- Coordinate the MANY initiatives taking place and evaluate their impact
- National support for large scale curriculum development projects
  - Followed by exchange of ideas
- Allow for re-entry into science domains

Recommendation 2



Improvements in science education should be brought about through new forms of pedagogy.
The introduction of inquiry based approaches in schools and the development of teachers' networks should actively be promoted and supported.

Inquiry Based Science

- Inquiry is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debatng with peers and forming coherent arguments.

Linn, Davis and Bell, 2004

Inquiry Based Science is characterized by:

- Authentic and problem based learning activities where there may not be a correct answer
- A certain amount of experimental procedures, “hands-on” activities
- Self regulated learning sequences where student autonomy is emphasized
- Discursive argumentation and communication with peers (talking science)

Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and technologies to gather data, thinking critically and logically about relationships between evidence and explanation, constructing and analyzing alternative explanations, and communicating scientific arguments.

NRC 1996

Inquiry based science teaching

- From a goal of providing science education for scientists to providing science education for all
- From an image of science education as what we know to science education as teaching science as a way of knowing
- From an image of science education that emphasizes content and process goals to a science education that stresses goals examining the relation between evidence and explanations

- From and emphasis on individual science lessons that demonstrate concepts to science lesson sequences that promote reasoning with and about concepts
- From the study of science topics that examine current scientific thinking without regard for social context to the study of science topics in social contexts
- From a view of science that emphasizes observation and experimentation to a view that stresses theory and model building and revision

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What can be done?

- Importance of teacher education as a starting point for pedagogical change
- Importance of in-service courses for science teachers that combine network possibilities and take place over time

Key factors of effective professional development

- School based
- Collaborative
- Long-term
- Linked to the curriculum
- Focused on student learning

5E model

- Engaging
- Exploring
- Explaining
- Elaborating
- Evaluating

Engaging (Teacher)

- Creates interest
- Generates curiosity
- Raises questions
- Elicits responses uncovering what students are thinking
- Explains concepts
- Provides definitions and answers
- States conclusions
- Provides closure
- lectures

Engaging (Student)

- Asks questions such as, Why did this happen? What can I find out about this? What do I already know about this?
- Asks for the correct answer
- Seeks one solution

Explore (teacher)

- Students working together without direct instruction
- Observes and listens to student interaction
- Asks probing questions to help students
- Allows students time to think through problems
- Acts as a consultant

- Provides answers
- Tells or explains how to work on problems
- Provides closure
- Tells students they are wrong
- Provides facts to solve problems
- Leads step by step to solutions

Explore (student)

- Thinks freely but within limits of the activity
- Forms new predictions and hypotheses
- Tries alternatives and discusses them with others
- Records observations and ideas

- Lets others do the thinking (passive)
- Works quietly with no involvement
- Plays around with no goal in mind

Explain (teacher)

- Encourages students to explain in own words
- Asks for justification (evidence) and clarification
- Uses students' previous experiences as basis for explaining concepts
- Accepts explanations that have no justification
- Neglects to solicit students' explanations

Explain (student)

- Explains possible solutions or answers to others
- Listens critically to other explanations
- Refers to previous activities
- Uses recorded observations in explanations

- Proposes explanations from thin air with no relationship to previous experiences
- Beings up irrelevant experiences and examples
- Accepts explanations without justification

Hunting for letters and numbers in nature

Konkurransen for barnetrinnet og barnehager

Ta digitale bilder av former i naturen som ligner på bokstaver og tall. Minst 15 bilder av bokstaver og/eller tall. Motivet skal være hentet fra naturen og skal ikke være manipulert. Til hvert bilde må det oppgis hvilket tall eller bokstav det representerer og gjerne navn på motivet.

Lag en plakat eller presentasjon av bildene.

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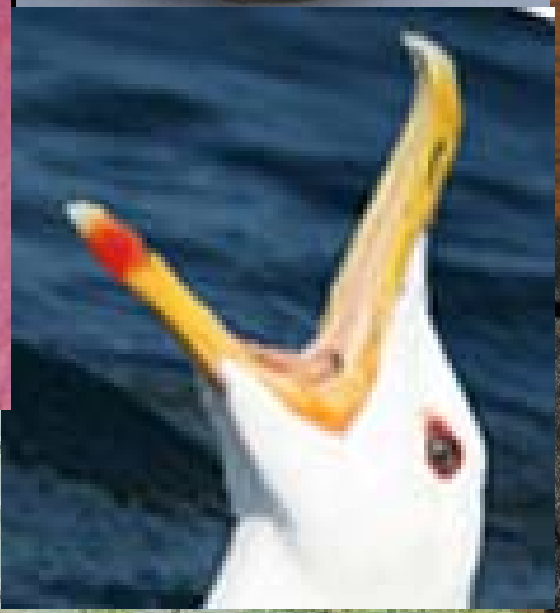

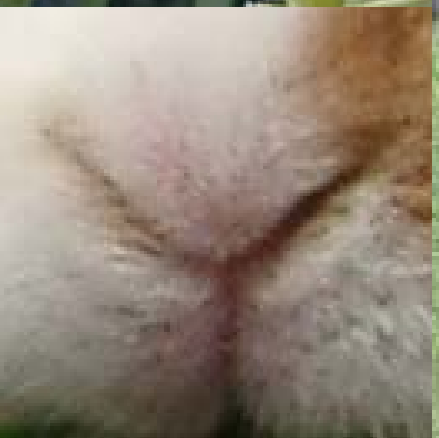
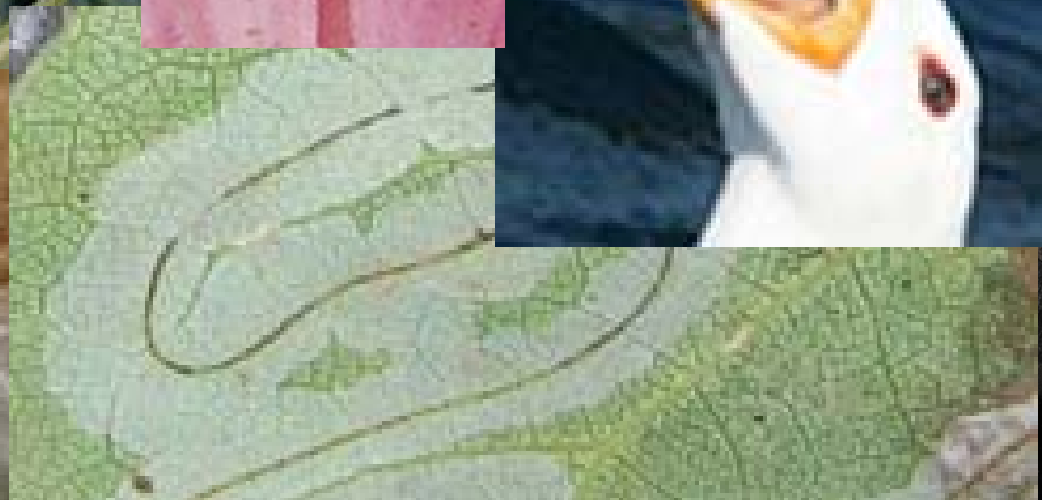

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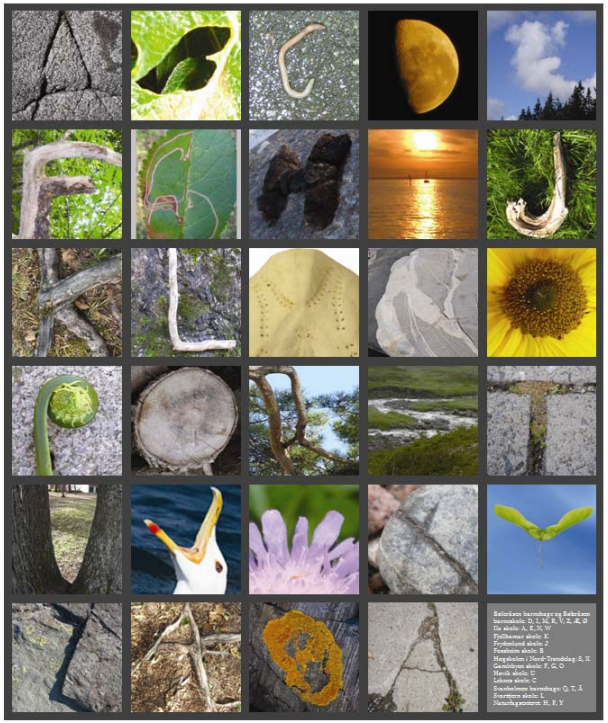

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Seeds of Science
Roots of Reading

- Connection between inquiry science and literacy
- Scientific literacy – familiarity with the natural world and key science concepts, principles and ways of thinking
- Scientific literacy – Connections among the language of science resulting in scientific knowledge

- P.David Pearson, U.C. Berkeley

Seeds of Science
Roots of Reading

Do it Talk it Read it Write it

Involving students in the whole range of practices of real scientists:

Observing, investigating, reading, writing, discussing, discovering and explaining

Northern lights

Global warming

Photosynthesis

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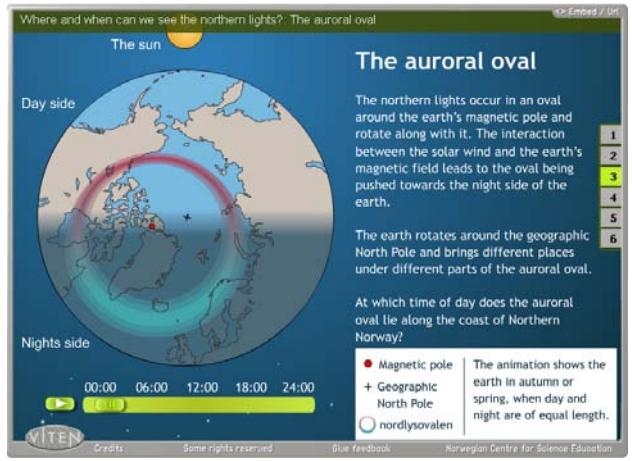

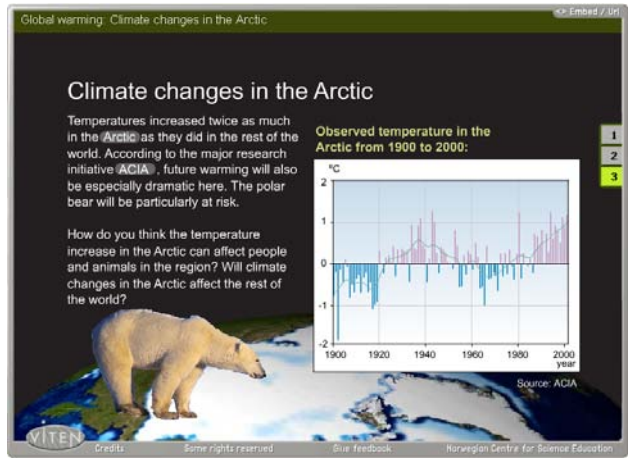

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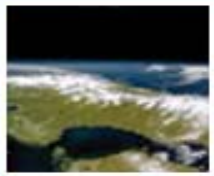

Global Warming

Run a climate model to see how the climate probably will change in 100 years! See how far a polar bear roams over the course of a year!

Northern Lights

Animations and interactive exercises give an introduction to how northern lights are formed, and how Norway and Norwegian researchers have been and are central to northern lights research.

Photosynthesis

Animations and interactive exercises about photosynthesis.

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