Science Education in Europe

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University of Oslo, Norway

Plenary Address
83rd NARST International Conference
23 March 2010
Our journey

• Europe and the European Union

• Science Education in Europe

• Examples of European supported projects

• Discussion
kable map of Europe, showing one of the most commonly used geographical boundaries[18] (legend: **blue** = states in both Europe and Asia; **green** = sometimes included with European boundaries)
The European Union:
500 million people – 27 countries
Enlargement: from six to 27 countries
## The big enlargement: healing the division of Europe

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
</table>
| 1989 | Fall of Berlin Wall – end of Communism  
EU economic help begins: Phare programme |
| 1992 | Criteria set for a country to join the EU:  
• democracy and rule of law  
• functioning market economy  
• ability to implement EU laws |
| 1998 | Formal negotiations on enlargement begin |
| 2002 | Copenhagen summit agrees enlargement |
| 2004 | 10 new EU members: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia |
| 2007 | Bulgaria and Romania join the EU |

**Candidates**  
Croatia, Former Yugoslav Republic of Macedonia, Turkey
EU population in the world

Population in millions, 2009

- EU: 500
- China: 1339
- Japan: 128
- Russia: 142
- United States: 307
How many people live in the EU?

Population in millions, 2009
500 million total
The area of the EU compared to the rest of the world

Surface area, 1,000 km²

- EU: 4,234
- China: 9,327
- Japan: 365
- Russia: 16,889
- United States: 9,159
This entry gives the gross domestic product (GDP) or value of all final goods and services produced within a nation in a given year. A nation's GDP at purchasing power parity (PPP) exchange rates is the sum value of all goods and services produced in the country valued at prices prevailing in the United States. This is the measure most economists prefer when looking at per-capita welfare and when comparing living conditions or use of resources across countries. The measure is difficult to compute, as a US dollar value has to be assigned to all goods and services in the country regardless of whether these goods and services have a direct equivalent in the United States (for example, the value of an ox-cart or non-US military equipment), as a result, PPP estimates for some countries are based on a small and sometimes different set of goods and services. In addition, many countries do not formally participate in the World Bank's PPP project that calculates these measures, so the resulting GDP estimates for these countries may lack precision. For many developing countries, PPP-based GDP measures are multiples of the official exchange rate (OER) measure. The differences between the OER - and PPP-denominated GDP values for most of the wealthy industrialized countries are generally much smaller.

<table>
<thead>
<tr>
<th>RANK</th>
<th>COUNTRY</th>
<th>GDP (PURCHASING POWER PARITY)</th>
<th>DATE OF INFORMATION</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>European Union</td>
<td>$14,510,000,000,000</td>
<td>2009 est.</td>
</tr>
<tr>
<td>2</td>
<td>United States</td>
<td>$14,260,000,000,000</td>
<td>2009 est.</td>
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<tr>
<td>3</td>
<td>China</td>
<td>$8,791,000,000,000</td>
<td>2009 est.</td>
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<tr>
<td>4</td>
<td>Japan</td>
<td>$4,141,000,000,000</td>
<td>2009 est.</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>$3,561,000,000,000</td>
<td>2009 est.</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>$2,812,000,000,000</td>
<td>2009 est.</td>
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<tr>
<td>7</td>
<td>United Kingdom</td>
<td>$2,165,000,000,000</td>
<td>2009 est.</td>
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<tr>
<td>8</td>
<td>Russia</td>
<td>$2,117,000,000,000</td>
<td>2009 est.</td>
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<tr>
<td>9</td>
<td>France</td>
<td>$2,113,000,000,000</td>
<td>2009 est.</td>
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</table>
The Bologna Declaration

• Signed in the Italian city of Bologna on July 19, 1999 by 29 European countries.
• Today is united by 46 countries
• Committed to the goals of the European Higher Education Area
The Bologna Process –
Towards the European Higher Education Area

The European Higher Education Area will:

– Facilitate mobility of students, graduates and higher education staff
– Prepare students for their future careers and for life as active citizens in democratic societies
– Offer broad access to high-quality higher education, based on democratic principles and academic freedom.
• Adoption of a system of easily readable and comparable degrees;
• Based on two main cycles of 3+2 (undergraduate/graduate)
• Establishment of a system of credits (ECTS_{european} credit transfer and accumulation system);
• Mobility (for students and researchers)
• European co-operation in quality assurance
• Promotion of a European dimension in higher education (curriculum development, institutional cooperation, etc)
Key Competencies for Lifelong Learning
Key Competences for Lifelong Learning

• European citizens will need to meet new challenges
• Equality and access are driving forces for lifelong learning
• Identify and define KC necessary for personal fulfillment, active citizenship, social cohesion and employability in a knowledge society

European Reference Framework 2007
Key Competencies

• Communication in mother tongue
• *Communication in foreign languages*
• Science, Technology and Mathematical competence
• Digital competence
• Learning to learn
• Social and civic competencies
• Sense of initiative and entrepreneurship
• Cultural awareness and expression
Science Competence

• Competence in science refers to the ability and willingness to use the body of knowledge and methodology employed to explain the natural world, in order to identify questions and to draw evidence-based conclusions.
  – Knowledge
  – Skills
  – Attitude
## Resultater i Naturfag OECD-land

<table>
<thead>
<tr>
<th>Land</th>
<th>Gj.snitt</th>
<th>St. avvik</th>
<th>Naturfag</th>
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<tbody>
<tr>
<td>Finland</td>
<td>563 (2,0)</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>534 (2,0)</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>531 (3,4)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>530 (2,7)</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>527 (2,3)</td>
<td>100</td>
<td></td>
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<tr>
<td>Nederland</td>
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<td>96</td>
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<tr>
<td>Korea</td>
<td>522 (3,4)</td>
<td>90</td>
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<tr>
<td>Tyskland</td>
<td>516 (3,8)</td>
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<tr>
<td>Storbritannia</td>
<td>515 (2,3)</td>
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<tr>
<td>Tsjekkia</td>
<td>513 (3,5)</td>
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<td>Polen</td>
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<td>Danmark</td>
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<td>Frankrike</td>
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<td>Island</td>
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<td>Tyrkia</td>
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<tr>
<td>Mexico</td>
<td>410 (2,7)</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

( ) Standardfeil i parentes

| 300 | 400 | 500 | 600 | 700 |
-------------------------------------|-----|-----|-----|-----|

Resultater i Naturfag OECD-land
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.
More attempts at innovative curricula and ways of organizing the teaching of science that address the issue of low student motivation are required. 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 trialed 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.
ROSE is an international comparative research project meant to shed light on factors of importance to the learning of science and technology (S&T) – as perceived by the learners. Key international research institutions and individuals work jointly on the development of theoretical perspectives, research instruments, data collection and analysis.
I would like to become a scientist
I find important and meaningful.
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.
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.
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)
Recommendations

- Improvements in science education should be brought about through new forms of pedagogy. Promotion of inquiry-based approaches should be actively promoted and supported.

- Increased participation of girls in science

- La main à la pâte (France) and SINUS (Germany)

- Increased support through EU funding – 60 million euros
Recommendation 6

EU governments should invest significantly in research and development work on assessment in science education. The aims should be to develop items and methods should assess skills, knowledge and competencies expected of a scientifically literate citizen.
Recommendation 7

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.
Seventh Research Framework Programme (FP7)

Capacities

Home
- About Science in Society
- Newsroom
- Find a call
- Get support
- Find a project
- Find a partner
- Library
- Useful links

FP6
Science and Society

Our pages on Europa

Science in Society

Highlights

- Call for Papers for "Going Diverse: Innovative Answers to Future Challenges", the International Conference on Gender and Diversity in Science, Technology and Business

All interested experts are invited to contribute to this conference, which is organised by the RWTH Aachen University within the TANDEMplusIdea project. The conference will take place in Aachen on 29-30 October 2009. The deadline for submitting proposals is 20 February 2009.

Objective

News

First FP7 social sciences and science in society projects announced
[Date: 2008-01-07]
Science and space prioritised at Africa-EU summit
[Date: 2007-12-10]

Events

Conference on changing research landscapes and human potential, Prague, Czech Republic
The European Commission is organising a conference entitled "Changing research landscapes to make the most of human potential" in Prague, Czech Republic, on 14 and 15 May.

KNOWING Conference on "The politics of knowing: research, institutions and gender in the making"

more highlights
Science in Society

• **A more dynamic governance of the relationship between science and society**
  – Research on ethics in science and technology;
  – The reciprocal influence of science and culture;
  – Conditions for an informed debate on ethics and science;

• **Strengthening potential, broadening horizons**
  – Strengthening the role of women in scientific research;
  – Supporting formal and informal science education in schools as well as through science centers and museums and other relevant means;
  – Reinforcing links between science education and science careers;

• **Science and society communication**
  – Encouraging a European dimension at science events targeting the public;
  – Science prizes;
Improving the way school science is taught in European schools by bridging the gap between theory and practice using Inquiry-based Science Teaching (IBST)
• Norway, Denmark, Germany, Hungary, United Kingdom, Spain, and France

• Gather, exchange, develop and disseminate ideas of good practice in IBS around Europe
  – Argumentation
  – Scientific Literacy
  – ICT
  – Classroom video studies

• Teacher Professional Development (SINUS model)
SINUS
A Teacher Professional Development Model in Science and Mathematics Education
Problem areas of mathematics and science education in Germany

- Complex tasks requiring conceptual understanding
- Scientific thinking and reasoning
- Huge amounts of students with fundamental deficits
- Little gains in competence over the school years
- Decreasing interest - avoidance of science and mathematics subjects
Possible interventions

• Curricula
• Teacher education
• School development
• Organization of teaching and learning in classrooms
• Instructional patterns: Scripts
Conception of the program
Based on the assumption that it is the professional responsibility of teachers to improve the quality of instruction and school: Four principles

- Identification of problem-areas and creation of work packages (“modules“)
- Introduction of quality development at participating schools
- Cooperation between schools/teachers & researchers on learning/instruction
- Providing ideas, material, support, advice
From problem areas to modules

1. Further development of the task culture
2. Scientific work and experiments
3. Learning from mistakes
4. Securing basic knowledge
5. Cumulative learning: Experiencing increase in competencies
6. Integrative features of instruction
7. Promoting girls and boys
8. Developing tasks for cooperative learning
9. Strengthening students' responsibility for their learning
10. Assessment: Measuring & feedback of students' competencies
11. Quality development within and across schools
Module 1: Further development of the task culture

Moving away from mono-cultures (‘routine tasks’) - towards

- Variety!
- Tasks that allow for creative application of knowledge in authentic situations and meaningful contexts
- Tasks that allow for different ways to solve them
- A larger variety of teaching methods and strategies whenever a new concept, principle, phenomenon, etc. is introduced and elaborated,
  - the new knowledge is practiced by applying it to new cases or situations
Practicing addition of numbers

1.

2.

3.
Exploring number pyramids

What do you notice looking at the pyramids? Please talk to your neighbour for two minutes.
Working with schools

First steps:
- Selection of modules and setting
- Collaborative reflection, development, and evaluation of instruction
- Exchanging ideas, materials and experiences on the level of schools and networks of schools

Necessary: Support from the principle
Beneficial: Integration of the work in the school program
Conferences with training sessions and workshops
Internet server (information management)
Programme History


SINUS Pilot-Programme (98-03)

BLK-Pilot-Programme „Increasing the Efficiency ...“

1st Round (03-05)

BLK-Programme SINUS-Transfer

2nd Round (05-07)

„3rd Round“ (starting 2007)

Dissemination in Federal States

180 Schools

850 Schools

1.800 Schools

all Schools

850 Schools
Key factors of effective professional development

- School based
- Collaborative
- Long-term
- Linked to the curriculum
- Focused on student learning
Inquiry Based Science Teaching

- Student autonomy
- Emphasis on sequences
- Learning
- Self-regulated
- Authentic
- Problem-based
- Experiments
- Experimental procedures
- Hands-on
- Information search
- Communication with peers
- Argumentation with peers
- Activities
- 1 correct answer
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.
S-TEAM
Science-Teacher Education Advanced Methods

• 100 people/25 institutions/15 countries
• Involved in science teacher education
• Providing a tool kit for science teacher education, using inquiry based methods
S-TEAM Aims

• Improve scientific literacy and
• Increase popularity of MST careers
• Through....
• Improving science teacher professional development
• Through...
• Inquiry based science
The Pedagogy of Science Education in a national context

- Curriculum design
- Assessment frameworks
- Teacher knowledge base
- Teacher education
- Research influence and dissemination
- Resources
- Prevailing social policies and attitudes
IRIS - Interests & Recruitment in Science:
Factors influencing recruitment, retention and gender equity in science, technology and mathematics higher education

Proposal acronym: IRIS
Funding scheme:
Collaborative project
Small or medium-scale focused research project
Work programme:
FP7 SIS-2008-1
Part 5. Science in Society
Sub-part 5.2. Second Action Line - Strengthening potential, broadening horizons
Activity 5.2.1. Gender and research
Area 5.2.1.2. Gender dimension of research
2.1.2.1. Influence of the perception of science on study choices
Will I get a job?

Will an education help me with my ambitions?

With this type of work fit me?

What do my friends think about this?

Am I interested in the subject?

Am I good enough?

Will I think that my choice is meaningful?

What will mom and dad say?

Is this type of work OK for girls and boys?

What do people really do while they work in a profession?

What will this choice cost in terms of time and energy?
Because I want to develop my talents and abilities, I chose Chemistry.

Because I want to develop my talents and abilities, I chose Engineering.

Because I want to develop my talents and abilities, I chose teaching.

Because I want to develop my talents and abilities, I chose to be a designer.
Welcome to Pollen's Website!

Pollen was launched in January 2005 and took place over a three-and-a-half-year period. With inquiry-based science education as a primary objective, the project focused on the creation of 12 Seed Cities throughout the European Union. A Seed City is an educational territory that supports primary science education through the commitment of the whole community. The major goal of Pollen was to provide an empirical illustration of how science teaching can be reformed on a local level within schools whilst involving the whole community, in order to demonstrate the sustainability and efficiency of the Seed City approach to stakeholders and national education authorities, and to seek leverage leverage effects.

In each Seed City, Pollen provided material and methodological and pedagogical support compatible with the framework of the local curriculum.

All of the materials produced as part of Pollen, as well as further information about the project, can be accessed free of charge through the Pollen website.

"...Carried by bees, Pollen made of few-micron grains, will fertilize thousands of flowers. This evokes for me, the work of all these teachers who will spread knowledge among thousands of pupils. ..."

George Charpak
About the Xplora gateway

Xplora is the European gateway to science education. It is aimed at teachers, pupils, scientists, science communicators and science educators.

What can I do on this portal?

- Read science education news, pedagogical tips, ideas for teachers
- Search the database of websites and digital learning resources for science education
- Register to use our tools for creating online communities and join online discussions
- Get insight into innovative practical science approaches and projects
- Obtain guidance on freely available Open Source tools for science education
- Find out about the Pencil and Nucleus projects that support the Xplora portal

To learn more about Xplora you can download and read this article (pdf file - in English).

European Schoolnet – a network of 31 Ministries of Education across Europe - operates the Xplora portal. It is supported by the PENCIL project, a project funded by the European Commission's Directorate General for Research as part of Science and Society. The PENCIL project is part of the wider Nucleus framework, a cluster of science education projects including Europe's major research laboratories. Read more about the PENCIL project here.

Xplora Teachers Group
Emerging Learning Objects

Field data
Chem lab
Modeling tool
Report builder

Experiments
Data Sets
Model
Hypothesis

Repository

Report builder
Emerging Learning Objects (ELO)

• Created by Learners
• Exchanged in collaboration
• Representing knowledge of
  – Individual Learners
  – Groups of Collaborative Learners
  – Communities of Learners
ESERA
European Science Education Research Association

News

ESERA 2009 Proceedings 19/3

CONTEMPORARY SCIENCE EDUCATION RESEARCH: TEACHING

CONTEMPORARY SCIENCE EDUCATION RESEARCH: PRE-SERVICE AND IN-SERVICE TEACHER EDUCATION

CONTEMPORARY SCIENCE EDUCATION RESEARCH: INTERNATIONAL PERSPECTIVES

Book 1 (pdf)
Book 2 (pdf)
Book 3 (pdf)

Two more books are being prepared for the rest of the strands. They will be available from here as well. Please check back later.

Invitation to register for the Springer Forum on Cultural Studies of Science Education 13/3

Dear Colleagues

ESERA Google Map

We are building an ESERA Google map with information of research institutions in science education. Send an e-mail to Wenche Erlig and get a procedure for adding a placemark on the map.

View Larger Map
Cultural diversity in Science Education

- Multiple languages and cultures
- Degrees of freedom in the classroom
- Differentiation/streaming
- Tradition
- Mechanisms of change differ in each country
Why Science?

- Climate
- Water
- Health
- Food
- Energy
Questions for consideration across oceans

• The impact of standards and testing on the choices teachers make in their teaching
• Models for teacher education and links to practice
• Dealing with multiple language cultures in a time of globalization
• Science for citizenship/science for recruitment