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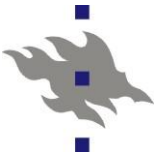
Science education, the science curriculum and PISA

Pisa 2006: Northern Lights III

Grand hotel, Reykjavík

August 17 - August 18, 2009

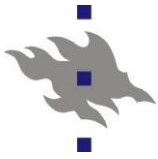
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The purpose of the chapter/presentation

An analysis of *science curricula for compulsory schools* in the Nordic countries/regions from the point of view of the PISA 2006 framework.

The analysis was done by one researcher in each Nordic country/region based on the guiding questions.

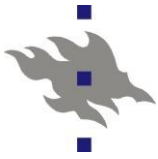


PISA competences according to PISA framework

PISA 2006 emphasises science competencies, defined in terms of an individual's scientific knowledge and use of that knowledge to...

- ... **identify scientific issues,**
- ... **explain scientific phenomena, and**
- ... **draw evidence-based conclusions about science-related issues**

≈ competences for future life



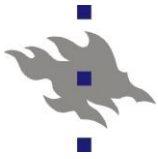
National level curricula in Nordic countries

Descriptions in general part of the curricula are rather similar:

- general goals and values for education like growth to ethically responsible membership in society
- knowledge and skills necessary in life and for life-long learning

Variation in guidelines for science education





National and local curricula & individual variation

Local municipalities (FI, DK) or
individual schools (DK, IS, NO, SE)
establish a local curriculum based on national guidelines.

Students have the option of choosing courses or school
subjects, especially during the last years of compulsory
schooling.

*For example in Iceland up to 30% of the school week is
allocated to optional subjects in grades 9 and 10.*



Integrated science – separate science subjects

In Finland

- science subjects are separated at grades 7 – 9;
- at grade 5 and 6, separate *physics and chemistry* and *biology and geography*

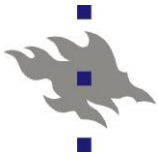
In Denmark and in Faroe Islands science subjects are partly separated at grades 7-9

- goals for combined *physics and chemistry*
- goals for separate *biology and geography*.

In Sweden a school can decide: separate or integrated (The majority teach science subject separately)

In Iceland science is divided into earth sciences, life sciences and physical sciences

In Norway, all schools teach integrated science.



PISA “contents” are taught in several subjects

There are a number of content areas, measured in PISA, which are part of

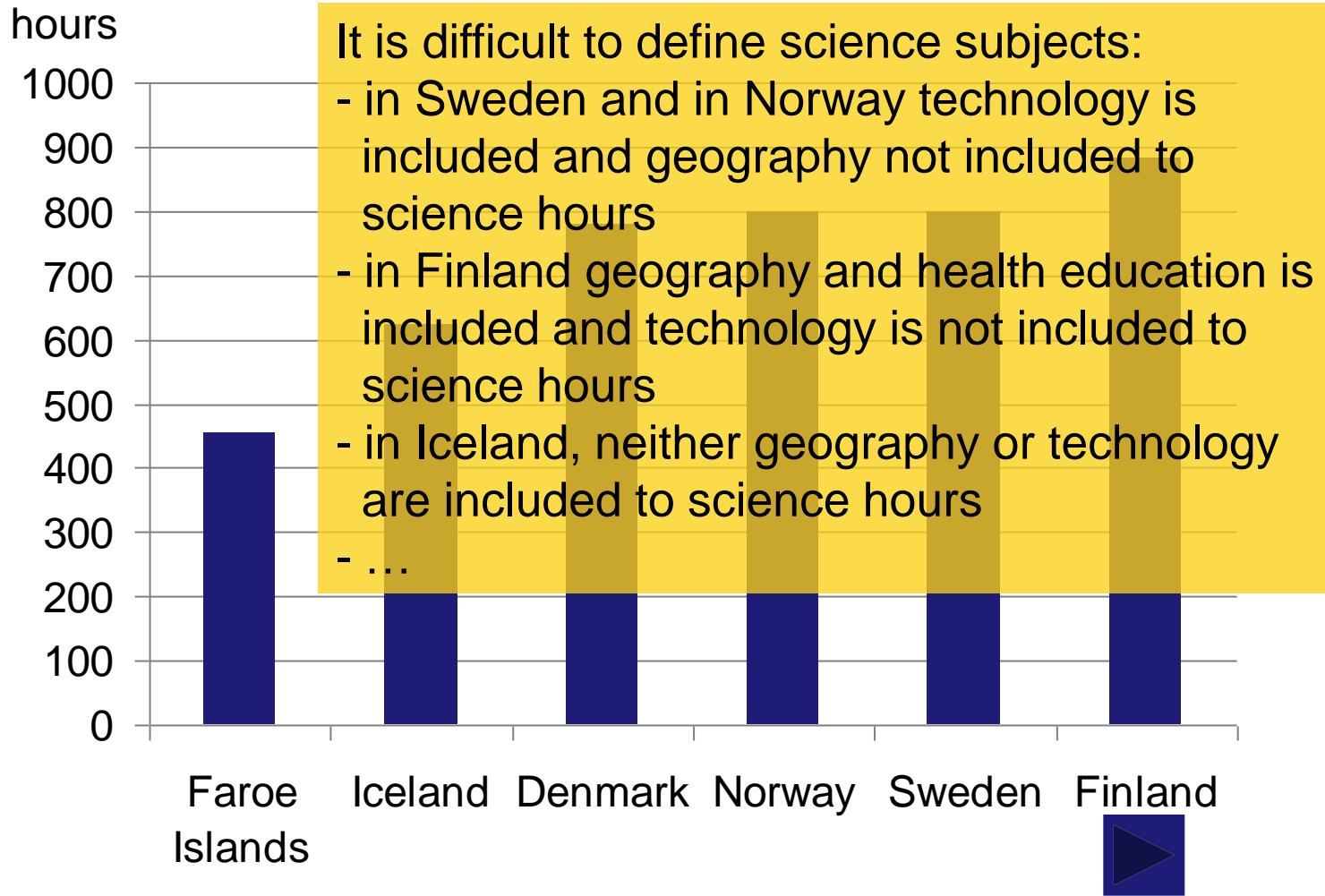
- geography in Finland,
- social science in Sweden,
- science and geography in Iceland
- in physical education and food and health in Norway,

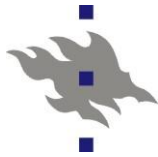
Examples:

- energy resources and energy,
- raw materials and trade,
- structures of the Earth’s systems (lithosphere, atmosphere, hydrosphere),
- changes in the Earth’s systems, and the Earth in space



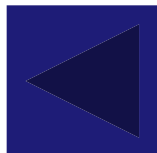
Hours (minimum) of science subjects in compulsory school (grades 1 – 9)

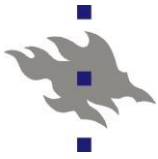




Allocation of science subjects to grades in comprehensive school in Finland

Grade	1	2	3	4	5	6	7	8	9
Students' age	7	8	9	10	11	12	13	14	15
Level	primary school						lower secondary school		
	Comprehensive school, Basic education								
Science subjects	<i>Integrated environmental and natural studies</i>			<i>Integrated Biology and geography 3 hours/ 3year</i>			<i>Separate: Biology & Geography Altogether 7 hours/3 year</i>		
	<i>Altogether 9 hours/4year</i>			<i>Integrated Physics and chemistry 2 hours/ 3year</i>			<i>Physics & Chemistry Altogether 7 hours/3 year</i>		
							<i>Health education 3 hours/ 3year</i>		





Teacher competences

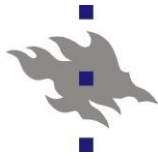
In Finland a teacher (grades 7 – 9) has completed undergraduate studies in two subjects (e.g. physics and mathematics) at subject departments and has a Master level degree.

In other Nordic countries, the student teachers take few courses in subjects they are teaching.

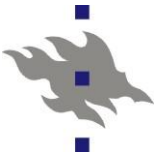
In Iceland fewer than 40% of the teachers teaching science have been trained as science teachers.

In Norway the teachers of science have little specific education within science.

➔ Teachers tend to spend little time on science subject matter in their instruction.



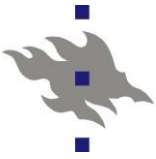
Goals for science subjects from the point of view of PISA



Goals for science

In Finland

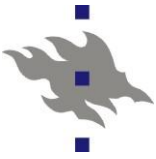
- goals for science subjects are structured in clusters of grades:
 - 1-4:** integrated *environmental and natural studies*;
 - 5-6:** *biology & geography* and *physics & chemistry*;
 - 7-9:** separate *physics, chemistry, biology, geography, health education*.
- descriptions of students' achievements (standards) at the end of the 4th, 6th and 9th grade.



Goals for science 2

The Swedish curriculum list two types of aims:

- the aims that guide school operations towards achieving the goals of compulsory education (“*goals to aim for*”)
- the aims that define the minimal expected outcomes of the compulsory school, expressed as the knowledge, skills, values and attitudes students are expected to have developed (“*goals to be attained*”).



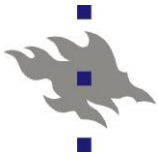
Goals for science 3

Danish, Faroese, Icelandic and Norwegian national level curricula give a summary description of science:

- the general goals
- common structural elements of science
- goals for individual educational cycles.

Norway and Iceland: goals are expressed in terms of outcomes at grades 1-4, 5-7, 8-10

Denmark: goals for outcomes are described after year six, and year nine.

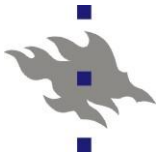


PISA competencies in science curricula 1

“Identify scientific issues” can be found in various forms:

- to recognise
- to observe
- to formulate a question
- to acquire knowledge
- to look for information



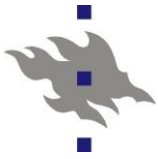


PISA competencies in science curricula 2

“*Explain scientific phenomena*” can be seen in the following expressions:

- to interpret
- to apply knowledge
- to test a hypothesis
- to use various graphs and algebraic models in explaining



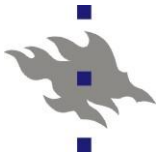


PISA competencies in science curricula 3

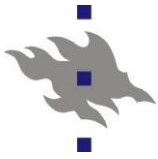
“*Draw evidence-based conclusions*” can be found in various forms:

- to make conclusions
- to formulate simple models
- to make generalisations
- to provide capabilities for making everyday choices





Contents for science subjects from the point of view of PISA



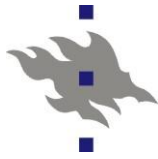
Differences with the level of detail in a syllabus

Finland: a syllabus for physics, chemistry, biology and geography for grades 5-6 and for grades 7-9.

Sweden and Norway: important concepts are listed

Iceland: efforts to develop the complexity of topics or concepts across the three phases

Denmark: a syllabus does not exist



Physical systems and living systems, in the national level curricula in Nordic countries

Similarities with *physical systems* and “syllabus” in Nordic countries:

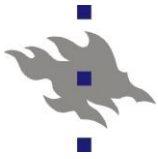
- structure and properties of matter – basics of astronomy,
- chemical reactions,
- waves and electricity,
- motion and forces,
- energy and its transformation.



Similarities with *living systems* and “syllabus” in Nordic countries:

- cells,
- the human being,
- animals and plants around us,
- populations and ecosystems





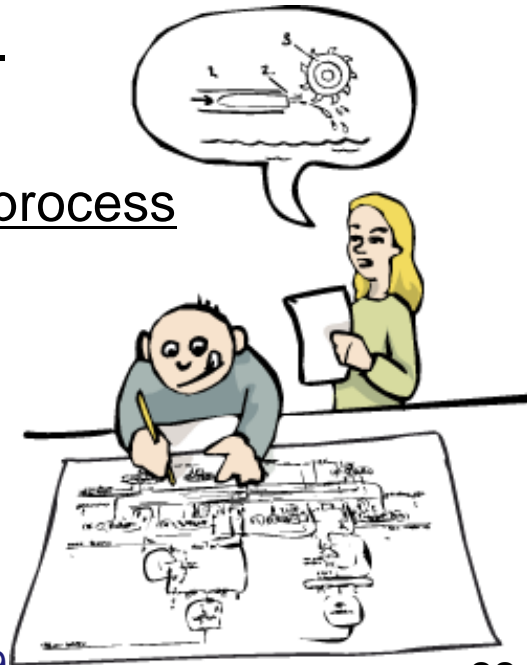
Technology systems in the national level curricula in Nordic countries

Denmark, Norway and Sweden: “technology” is part of the national curriculum and introduced with science

- Norway: *technology and design* as elements of the science attainment goals
- Sweden: longest tradition in technology education: goals for technology in the curriculum.

Iceland: technology is addressed as a process

In the *Finnish* curriculum, “technology” is an intercurricular subject and also part of science, handicraft and home economics curriculum.





Knowledge *about* science in PISA framework

The PISA framework identifies *two categories* of knowledge *about* science:

“*scientific inquiry*”

In Nordic countries:

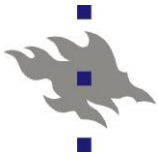
- asking of scientific questions
- models and modelling
- measurements, observations and investigations

“*scientific explanations*”

In Nordic countries:

- presentation of types of scientific explanations (hypothesis, scientific law, model, and theory),
- formation of knowledge and outcomes of research (new knowledge, new methods, new technologies, new investigations)





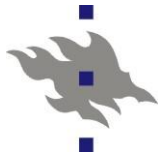
Conclusions

Descriptions in the curricula varies:

- integrated science – separate science subjects
- how the goals have been described
- syllabus (not exist ... concepts ... description)

There is good compatibility between *competencies described in the PISA 2006 framework* and *goals and contents described in the national level curriculum documents in Nordic countries*

➔ PISA evaluates partly the achievement of competences described in the national level curriculum in Nordic countries.



Thank you!