# The ROSE project
# An overview and key findings[1]

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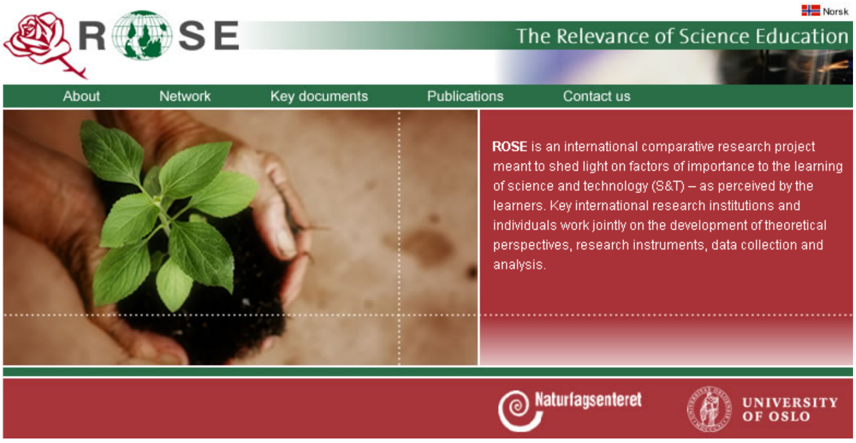




[1] This report is a slightly revised version of an invited expert input to the **Eurydice** http://eacea.ec.europa.eu/education/eurydice/ comparative study on Science and Mathematics education

## Introduction: Science[2] education, a field with many stakeholders

In addition to the formal national educational authorities, like Ministries of education, many groups are stakeholders and deal, in a more or less professional way, with issues of science education:

1. ***Science teachers*** in schools and elsewhere
2. ***Researchers*** in the academic field of science education (often working in teacher training)
3. ***Research Scientists***, having in an interest in how "their subject" fares well in the education system.
4. **National and International organizations** (UNESCO, EU, OECD etc.) support research and produce policy reports on science education.

More in detail about these groups.

1. ***Science teachers*** are organized in national associations for science teachers. These associations have an umbrella: International Council for Associations for Science Education (ICASE)[3] with a large number of national science teachers associations. ICASE as well as its member organizations have development projects, journals and conferences with large attendance. ASE[4], the association for Science Education in UK has some 25 000 members (from all over the world) and their annual conferences gather around 4 000 participants. These teacher organizations are often the driving force in the development of research, teaching material as well as policy recommendations.

2. ***Science education research*** has become a professionalized field over the last 50-60 years, with academic degrees and positions, research centers, professional association at the national, regional (ESERA[5] (European Science Education Research Association)in Europe, NARST in the US, ASERA in Australasia) and international level (IOSTE[6], the Organization for science and Technology Education) as well as a high number of international professional conferences for these organizations. These gather up to 1000 participants, members of the academic field of science (and technology) education. There are also several international academic journals of high standing (Journal of Science Education, International Journal for Science Education, Studies in Science Education, Science Education etc.) Some hundreds PhDs in science education are produced each year, probably thousands of academic articles.

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[2] In many countries, science and technology are taught as one subject, in other as two separate subjects. In this document I do not go in detail about similarities and differences between countries. Hence, I sometimes use S&T as an abbreviation, even SMT, since the challenges to mathematics education are interwoven with those of S&T education

[3] http://www.icaseonline.net/

[4] http://www.ase.org.uk/

[5] http://www.naturfagsenteret.no/esera/

[6] http://www.ioste.org/

3. The millions of ***research scientists*** also have an interest in science education in schools. Their professional institutions, like Academies (e.g. the Royal Society in England) have sub-groups dealing with school science and science in the public. Similarly, the professional bodies of scientists, at the national as well as international level (like IUPAP, IUPAC etc) have developed policy documents etc. related to school science. This year, ICSU[7], the International Council for Science, an umbrella organization for the professional academies and unions in science has taken an initiative to makes joint strategic plan for their member organizations, covering some 160 countries.

4. **International organizations** like UNESCO, OECD and the EU pay attention to education in general, but to SMT education in particular. This is, of course, in part due to the fact that these school subjects play key roles in modern society, certainly for the S&T driven economy, but also for cultural and democratic points of view. Explicitly stated, OECD's PISA-project is mainly justified by reference to the importance of science and mathematics in a knowledge-based and competitive, technologically oriented global economy. Reports and recommendations from these international organization have undoubtedly large political importance and are used also for national policies (but with large and interesting variations between countries, see e.g. Sjøberg, 2007.)

The point with the above overview is to remind ourselves that the area of science education is indeed well organized, there are many stakeholder, and that the resources for available research, policy statements, committee recommendations etc, are indeed rich – and should be used!

But this wilderness of thousands of articles, PhD's etc, make it impossible for any individual to get a scholarly and comprehensive review over the field. There are, however, already existing reviews that are published. In the ongoing IRIS[8] (Interest and Recruitment in Science) project there are (still preliminary) updated reviews of research (and research reviews) that may be useful. These are listed as references in this document. Journals like *Studies in Science Education*[9] have analytical review articles and meta-studies that provide useful scholarly synthesis and overviews.

One should also consider the more "official" reports and recommendations from reports from the EU and OECD, like *Europe needs more scientists* (EU, 2004) and *Science Education Now*, the so-called Rocard Report (EU, 2006). The OECD's Global science Forum has made a comprehensive report with policy recommendations, *Evolution of Student Interest in Science and Technology Studies: Policy Report* (OECD, 2006).

More useful and clear is, however, the recent report by the Nuffield foundation: *Science education in Europe: Critical reflections* (Osborne and Dillon, 2007). This report is made by a panel of European science educators and is, as the title indicates, a critical and constructive review of the current situation.

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[7] http://www.icsu.org

[8] http://iris.fp-7.org/about-iris/

[9] http://www.informaworld.com/smpp/title~content=t790627368~db=all

## Limitations and focus of this report

The focus in this paper is, since this is the focus of **Eurydice** study on science education, the age range up to 15 years, in other words in the obligatory school. Hence, this paper will not consider upper secondary schools or the tertiary level. For these higher levels, the educational considerations will actually be rather different from those of the obligatory school, since we are there talking about science as a optional, chosen subject for the rather few, often as part of their preparation for future work in science and technology oriented occupations.

We also limit the discussion to the *formal school system* ,leaving out the (very interesting) area of informal science education through science centres, environmental associations and a great variety of other institutions and interests groups.

We will also limit the discussion to present data and perspectives from research where we are personally involved, i.e. studies mainly regarding the affective dimensions of school science. We will therefore start with a rationale for the importance of this domain.

## The primacy of attitudes

The well known large-scale studies like TIMSS and PISA are mainly assessments of student learning and factors that explain (in a statistical sense) the resulting test scores. The focus of these large international tests is cognitive, while the affective factors are not central. There are, however, many reasons also to address the affective factors:

In the curricula and overall aims for schools in most countries, positive attitudes towards science and technology are important as *learning goals* in themselves. Part of the rationale for having science in the obligatory school is not just to convey the established science knowledge, but also to inculcate respect for and appreciation for science as part of our culture. Moreover, we know that values and interest are important *determinants for future educational choices* as well as other behaviors as citizens. When the contents (facts, concepts, laws and theories) of school science is forgotten, the 'ethos' or 'atmosphere' of the subject remains. Such impressions of the subject linger in the minds of the learners, long after school is over, and is likely to shape the behavior, interests and attitudes also in adult life. Bad experience with science (and mathematics, of course!) have lasting detrimental effect, while positive experiences are likely to have a lasting positive effect.

It is a worrying observation that in many countries where the students are on top of the international TIMSS and PISA score tables, they tend to score very low on interest for science and attitudes to science. These negative attitudes may be long-lasting and in effect rather harmful to how people later in life relate to S&T as citizens.

Hence, from a life-long educational and societal perspective, the affective dimensions of science education should be seen as just as important as the measured test scores at the end of compulsory school. In the following, we will present an international project, ROSE, and some its main results and possible implications.

## ROSE (the Relevance Of Science Education) in brief

ROSE is a cooperative research project with wide international participation, addressing mainly the affective dimensions of how young learners relate to S&T. The purpose of ROSE is to gather and analyse information from the learners about several factors that have a bearing on their attitudes to S&T and their motivation to learn S&T. Examples are: A variety of S&T-related out-of-school experiences, interests in learning different S&T topics in different contexts, prior experiences with and views on school science, views and attitudes to science and scientists in society, future hopes, priorities and aspirations as well at young peoples' feeling of empowerment with regards to environmental challenges, etc.

ROSE has, through international deliberations, workshops and piloting among many research partners, developed an instrument that aims to map out attitudinal or affective perspectives on S&T in education and in society as seen by 15 year old learners. The ROSE advisory group comprises key international science educators from all continents[10]. We have tried to make an instrument that can be used in widely different cultures. The aim is to stimulate research cooperation and networking across cultural barriers and to promote an informed discussion on how to make science education more relevant and meaningful for learners in ways that respect gender differences and cultural diversity. We also hope to shed light on how we can stimulate the students' interest in choosing S&T-related studies and careers – and to stimulate their life-long interest in and respect for S&T as part of our common culture.

About 40 countries have been taking part in ROSE, and many more have shown (and still show) an interest in the project. The ROSE instrument is used for many different educational purposes in these countries. ROSE partners have met at conferences like ESERA (European Science Education Research association) and IOSTE (International Organization for science and Technology Education), and special ROSE workshops have been hosted in several European countries and in Malaysia. The data from the following countries were found to meet the criteria for data quality, and are included in the comparative analysis: Austria, Bangladesh, Botswana, Czech Republic, Denmark, England, Estonia, Finland, Germany, Ghana, Greece, Iceland, India (Gujarat), India (Mumbai), Ireland, Japan, Latvia, Lesotho, Malaysia, N Ireland, Norway, Philippines, Poland, Portugal, Russia, Scotland, Slovenia, Spain, Swaziland, Sweden, Trinidad, Turkey, Uganda and Zimbabwe.

In most countries the target population is the whole national cohort (more precisely: those who are still attending school at the age of 15 years), but in some countries the ROSE target population is defined as the students in one *region* of the country (e.g. Karelia in Russia, Gujarat as well as Mumbai in India and the Central region in Ghana). In addition, many countries (e.g. Brazil, Taiwan, Italy, France and Israel) have published national reports, although their data have not been incorporated in the international data file.

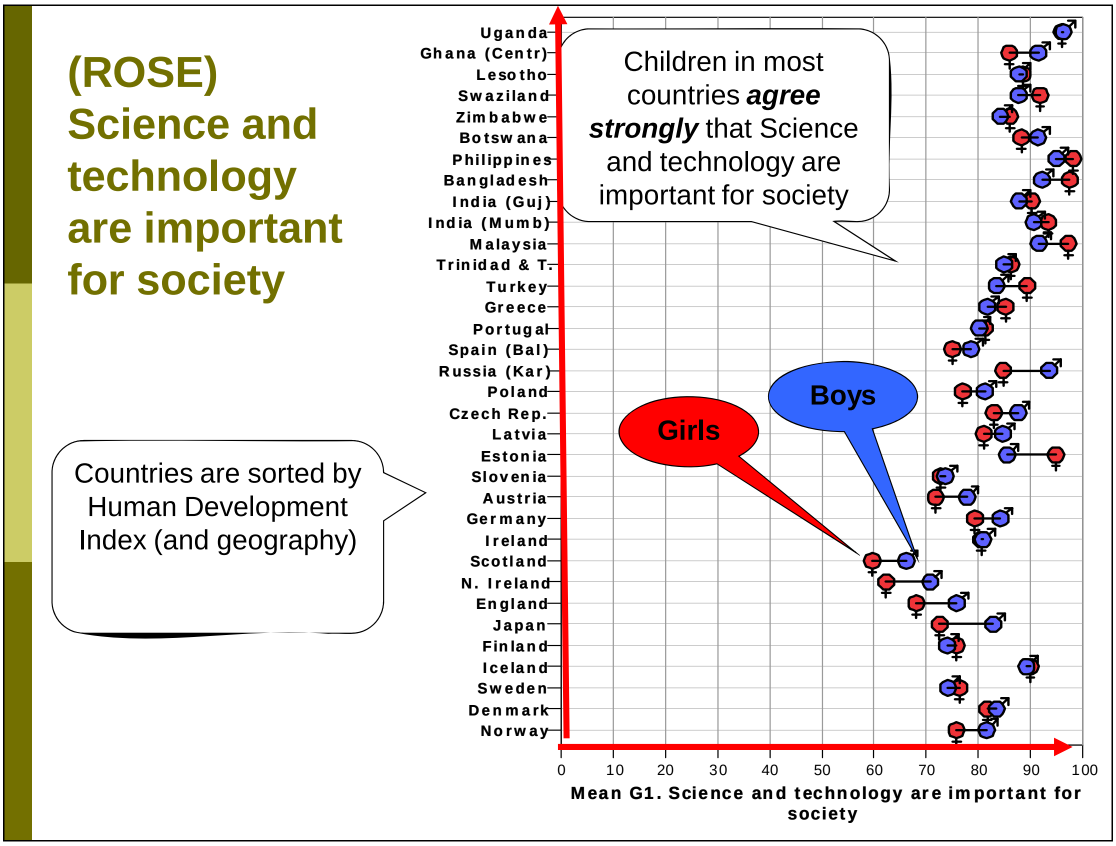
[10] The group had, in addition to the Norwegian team, the following members: Dir. Vivien M. Talisayon (The Philippines), Dr. Jane Mulemwa (Uganda), Dr. Debbie Corrigan (Australia), Dir. Jayshree Mehta (India), Professor Edgar Jenkins (England), Dir. Vasilis Koulaidis (Greece), Dr. Ved Goel (The Commonwealth, now India), professor Glen Aikenhead (Canada) and professor Masakata Ogawa (Japan).

The participating researchers in different countries were requested to apply random sampling methods. For various reasons, e.g. due to limited financial resources, some countries have not been able to comply with the request. This means that not all of the 40 participating countries have samples that without reservation can be regarded as representative for 15 years old students in the country[11]. Details of the theoretical background and previous research, project development, logistics etc. are described in Schreiner and Sjøberg(2004).

The ROSE web site [12] contains several PhD's, articles, presentations and reports. A comprehensive ROSE report will be published on Springer Science , hopefully this year (Schreiner and Sjøberg 2010)

## ROSE: Key findings

In the following, several graphs illustrate the findings. They are taken from the ppt-presentation that was presented in the Brussels **Eurydice** seminar on Feb 25. 2010 and inserted as illustrations in the following text. The axes and the symbols are explained in the graph below. The percentages indicate the sum of 3+4 on the 4-point Likert agree-scale that is used in all ROSE items.




[11] National reports on how the survey was organized in each country are available from the ROSE website http://www.ils.uio.no/english/rose/

[12] http://www.ils.uio.no/english/rose/

## Positive attitudes to science – but also (growing?) doubt and skepticism

Some of the questions in ROSE are identical to those asked in the Eurobarometer[13] studies, where the target population is the adult population in 32 European countries (EU 2005a, 2005b). The results open for interesting comparisons between the young generation and the adults.

Some details are given as graphs in the following pages.

The overall picture is that...

- Attitudes to science and technology among adults and young people are mainly positive!
- In the richest countries (Northern Europe, Japan) young people are more ambivalent and skeptical than the adult population..
- There is growing gender difference, with girls, in particular in the richest countries, being more negative (or skeptical, ambivalent) than boys.

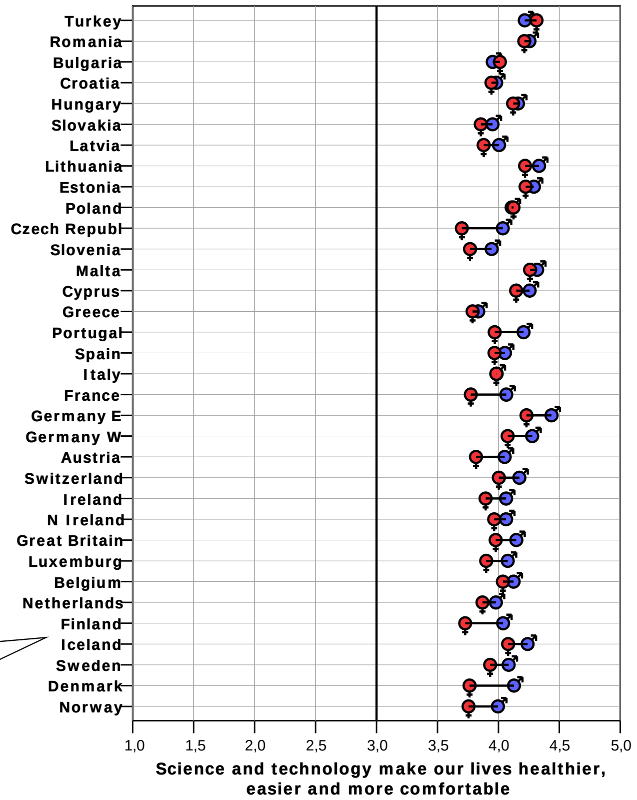
As we can see from the following graphs, although young people are rather positive to S&T, there are signs of a generation shift, where young people, more than the adults, also see the more problematic sides of S&T. These results emerge not just from single items shown here, but are consistent through a series of questions, and should be taken seriously by educators and policymakers.

Examples follow.

[13] For details on Eurobarometer. http://ec.europa.eu/public_opinion/index_en.htm

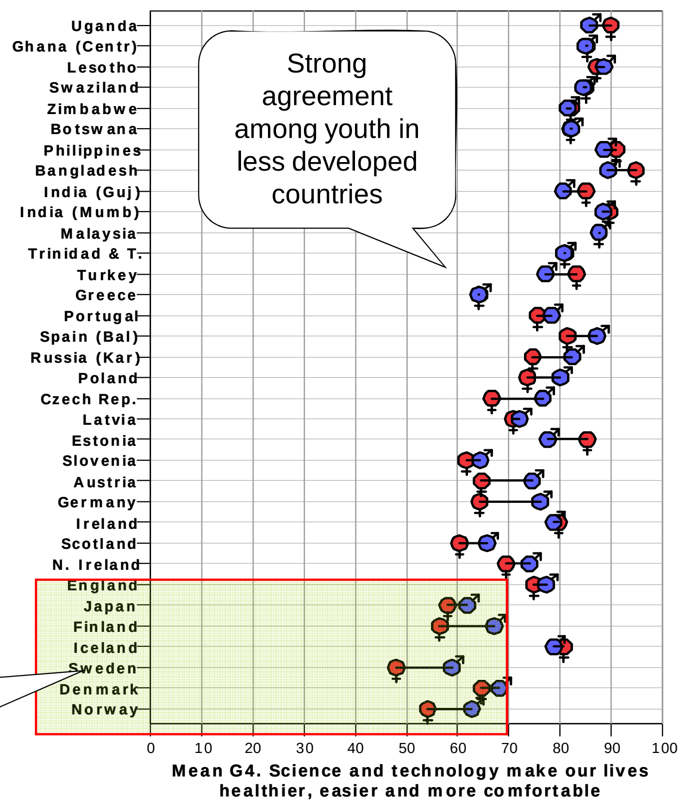
## (EB) Science and technology make our lives healthier, easier and more comfortable

Agreement in all European countries. Men are a little more positive than women.

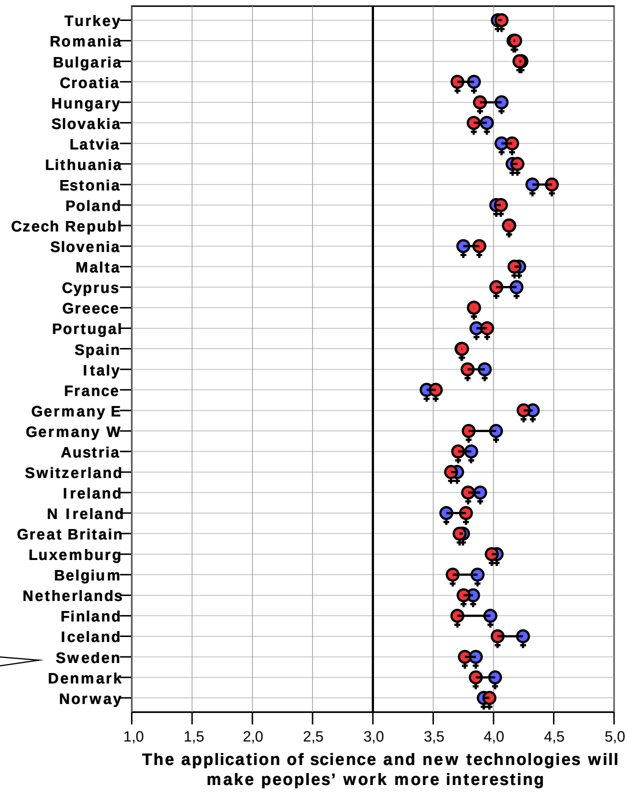



## (ROSE) Science and technology make our lives healthier, easier and more comfortable

Scepticism among youth in the Nordic countries and Japan, in particular among **girls**.

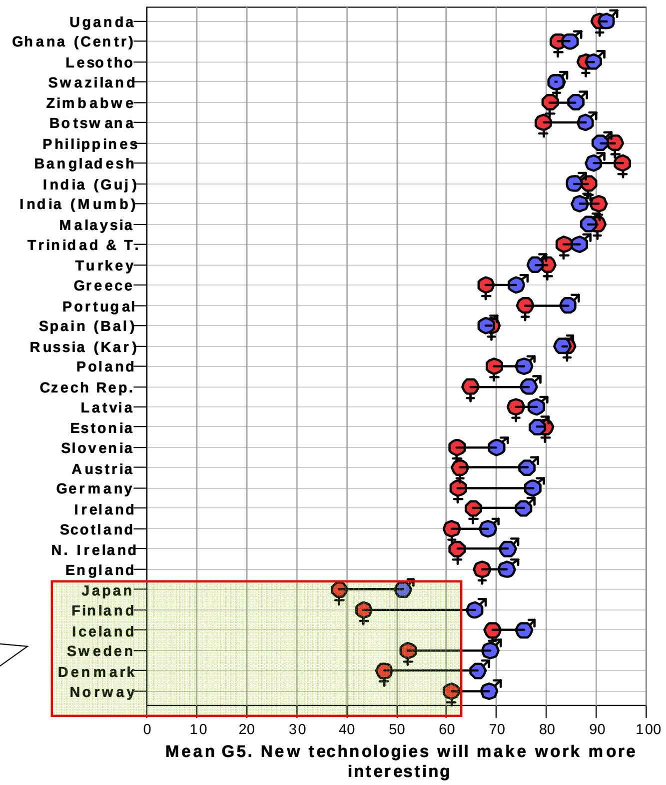


## (EB) The application of science and new technologies will make peoples' lives more interesting

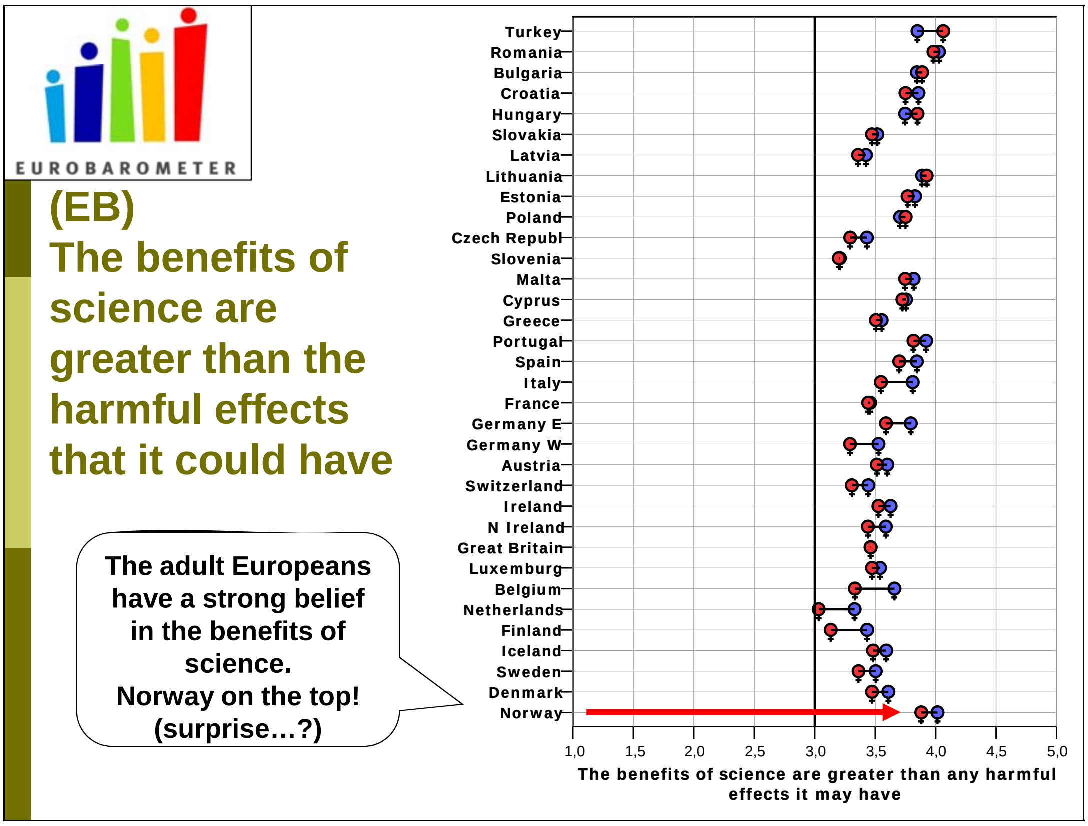


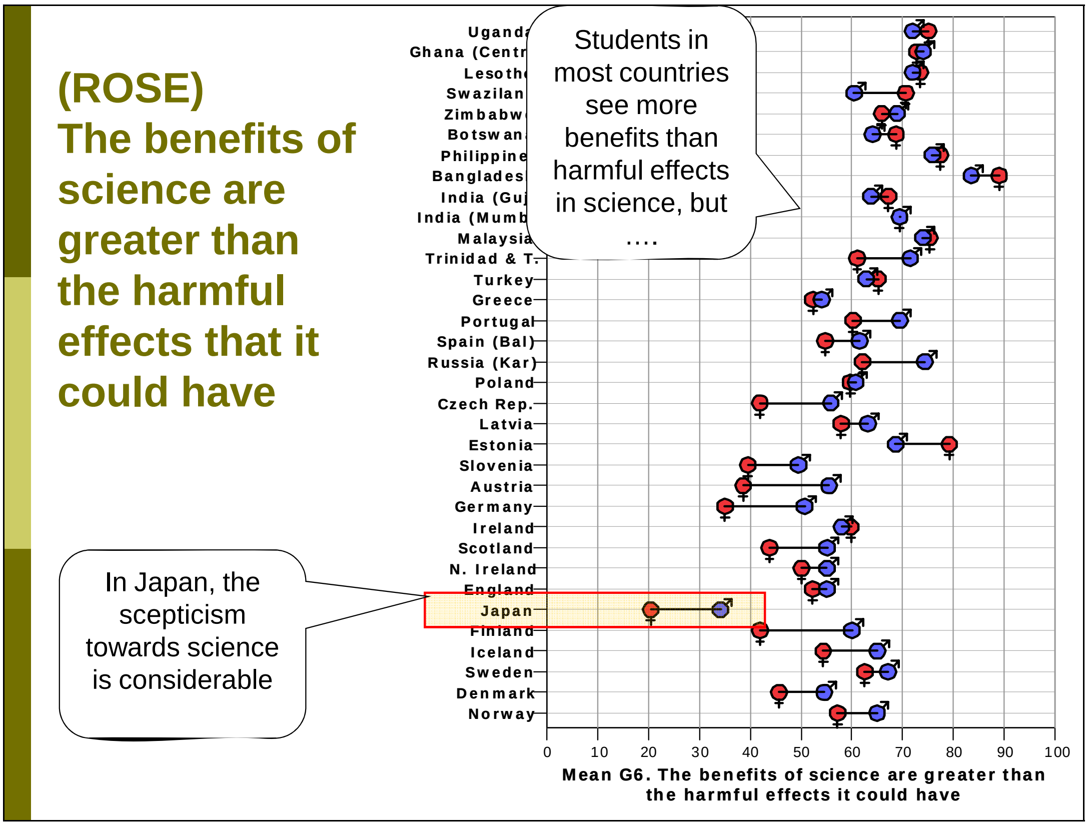

Adults in all Europe agree, small gender differences

## (ROSE) New technologies will make work more interesting




Scepticism and ambivalence among **young** people in the Nordic countries and Japan, in particular among **girls**.


EUROBAROMETER
(EB)
The benefits of science are greater than the harmful effects that it could have
The adult Europeans have a strong belief in the benefits of science.
Norway on the top!
(surprise…?)
Turkey
Romania
Bulgaria
Croatia
Hungary
Slovakia
Latvia
Lithuania
Estonia
Poland
Czech Republ
Slovenia
Malta
Cyprus
Greece
Portugal
Spain
Italy
France
Germany E
Germany W
Austria
Switzerland
Ireland
N Ireland
Great Britain
Luxemburg
Belgium
Netherlands
Finland
Iceland
Sweden
Denmark
Norway
1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0
The benefits of science are greater than any harmful effects it may have


(ROSE)
The benefits of science are greater than the harmful effects that it could have
Students in most countries see more benefits than harmful effects in science, but ….
In Japan, the scepticism towards science is considerable
Ugand
Ghana (Centr
Lesoth
Swazilan
Zimbabw
Botswan
Philippine
Banglades
India (Guj
India (Mumb
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
Mean G6. The benefits of science are greater than the harmful effects it could have

## Science in schools: Not a success story?

The ROSE project asks 16 questions about how the learners consider their experiences with school science. The heading is *"My science classes. To what extent do you agree with the following statements about the science that you may have had at school?"*

These students have had science for most of their years at school. Hence, the answers provide a kind of summative evaluation of those experiences. The results vary strongly between countries, but for European countries (and Japan), the answers indicate that school science fails in many ways. Some data and the exact wording of the questions are given in the following graphs, and the overall picture is the following. One should also note considerable differences between countries.

***"School Science** …*

- *is less interesting than other subjects."*
  There is a strong gender difference here, with girls less positive than boys, especially in the wealthier countries.

- *has not opened my eyes for new and exciting jobs."*
  The genders pattern is the same here, and the positive response is lowest in the richest countries.

- *has not increased my career chances."*
  There are interesting differences between countries here, with the young people in the 4 English-speaking countries are more positive than in other parts of Europe.

- *has not increased my appreciation for nature"*

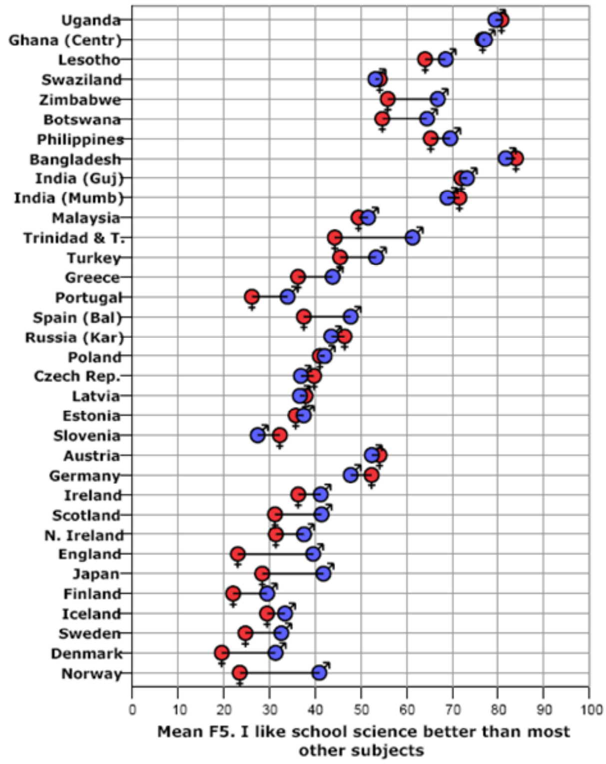
- *has not taught me how to take care of my health"*

- *has not increased my curiosity"*

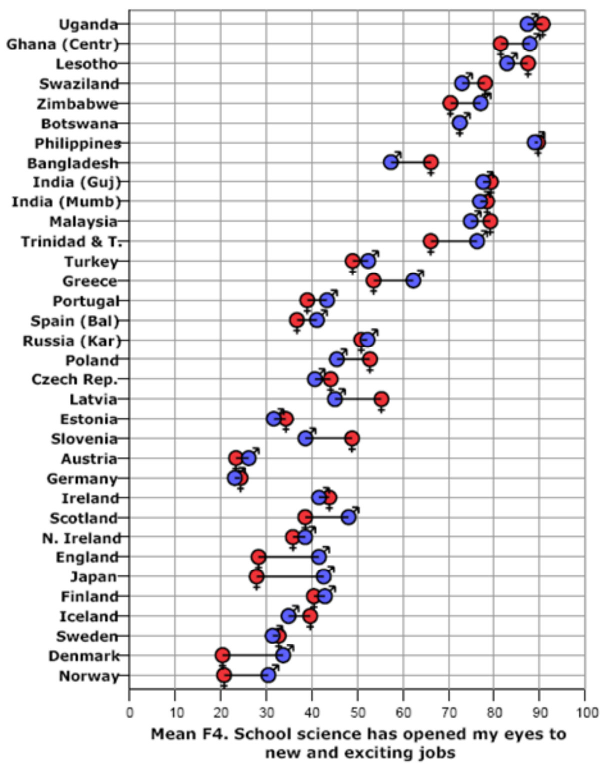
- *has not shown me the importance of S&T for our way of living."*
  In most European countries, less than 50% of the respondents agree with this statement. Gender differences are small.

Examples follow.

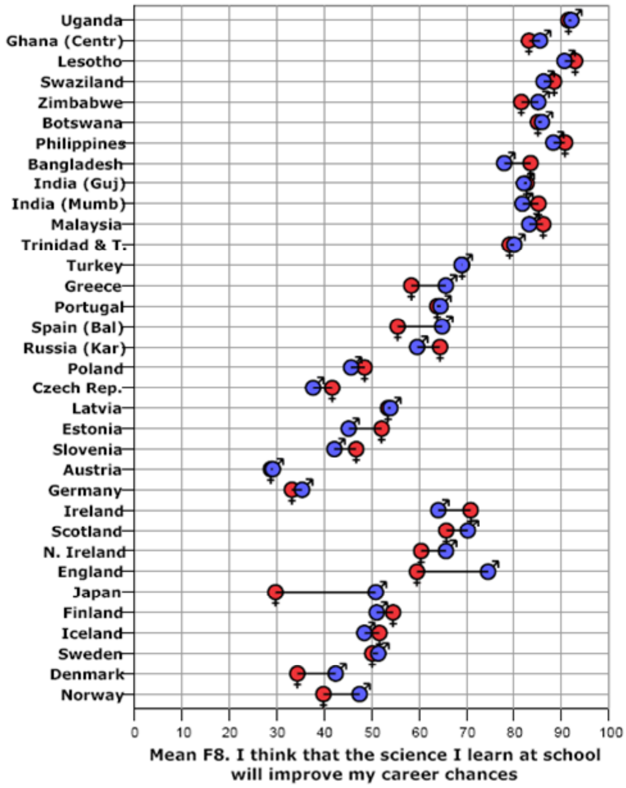
## I like school science better than most other subjects



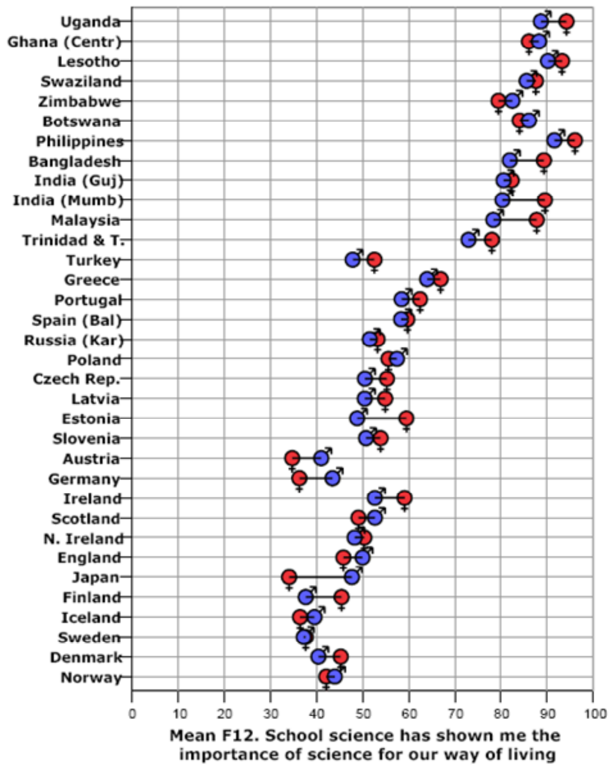

## School science has opened my eyes for new and exciting jobs

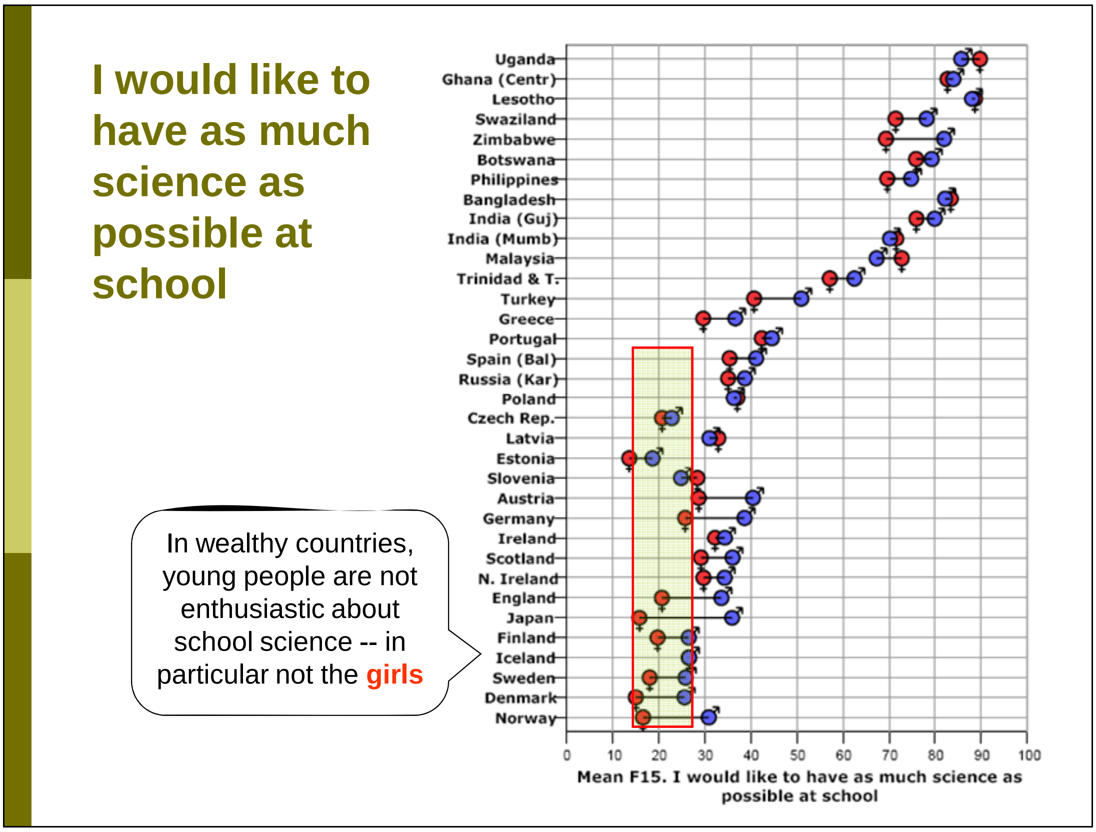


I think that the science I learn at shcool will improve my career chances




School science has shown me the importance of science for our way of living.




I would like to have as much science as possible at school
In wealthy countries, young people are not enthusiastic about school science -- in particular not the girls
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
Mean F15. I would like to have as much science as possible at school

## Interest in science: an inventory

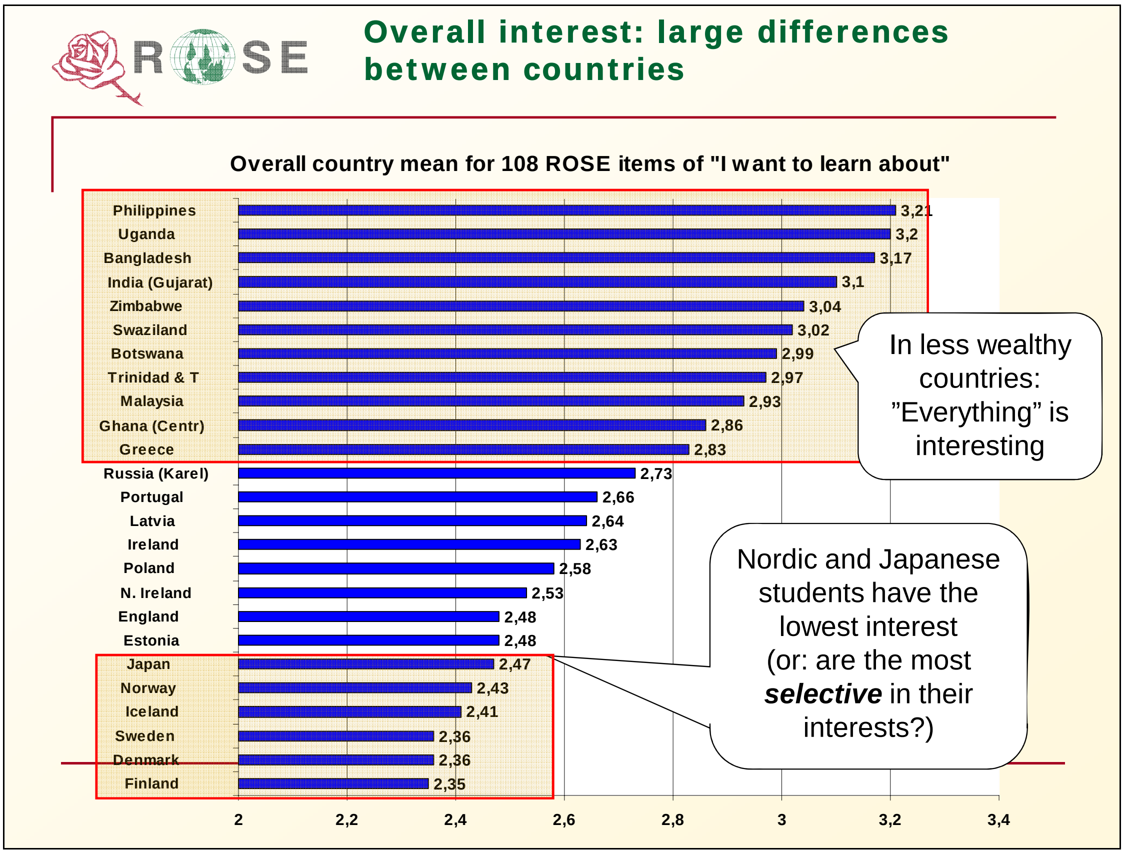
The ROSE instrument contains 106 items asking *for "What I want to learn about: How interested are you for learning about the following?"*

The items cover a wide variety of possible topics for science learning. The underlying structure in this pool of items is based on a kind of two-dimensional grid . The idea behind the selection of these topics is that different science **contents** (like electricity, heat, mechanics, botany, chemistry etc.) is placed in different **contexts** (social, technical, ethical, practical, theoretical etc.)

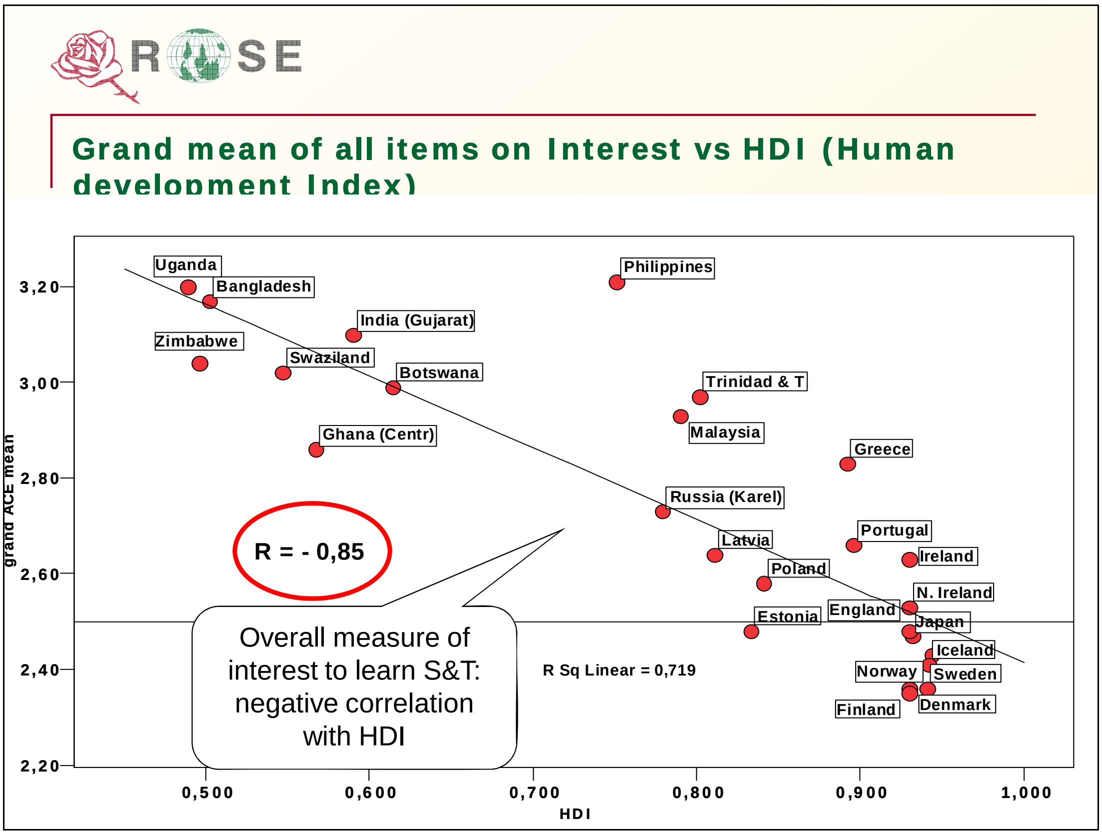
The underlying rationale is, of course, to explore to what degree the context determines the expressed interest in a particular content area. For details of the instrument and the underlying assuptions, see Schreiner and Sjøberg, 2004. Some of the striking results are summarized in the following sections.

## The more developed, the less overall interest

The overall pattern is that pupils in the less developed countries express an interest to learn about nearly all the topics that are listed. This point is illustrated at the graph below.



These data are presented in a different form on the graph below. One can notice a strong negative correlation between the average interest score (horizontal axis) and the level of development. If HDI (Human development Index) is used as the indicator for development, the correlation is **-0.85** between overall interest and HDI.




Care should be taken when interpreting this overall result. One should *not* assert that children become less interest in science the more developed the country is. A better explanation for these data is rather to suggest that for children in (mainly) developing country, going to school at the age of 15 is “luxury” or a “privilege”. Hence, they are, in principle, happy to learn about nearly everything the school may offer. Kids in rich countries (with low rates of unemployment) can “afford” to see school more as a duty and an obligation more than as a privilege. Many students also think that school should be fun and entertaining. Therefore, they are more likely to express what they like and what they dislike. One might say that they are more “selective” in their choices.

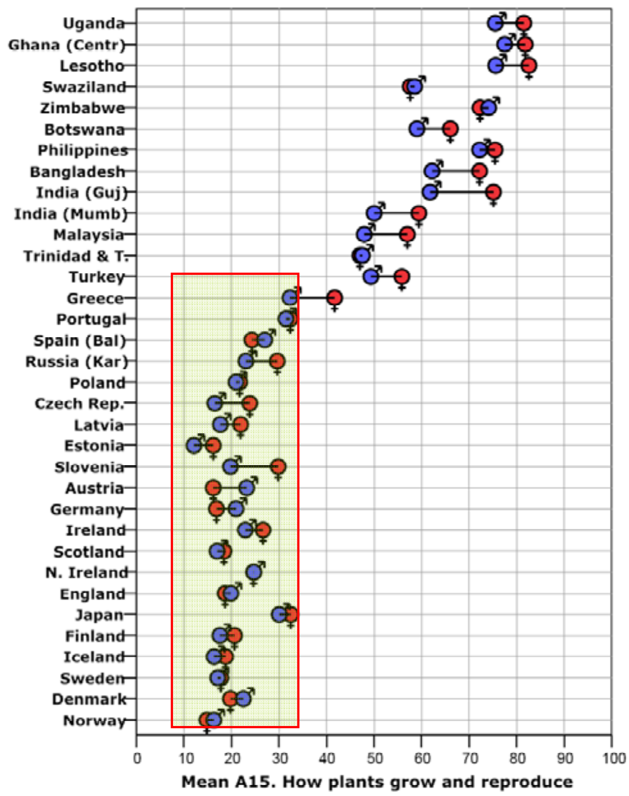
## The more developed, the less interest for “school science” – also practical, “relevant” and every-day S&T

A clear pattern is that topics that are close to what is often found in science curricula and textbooks have low scores on the rating of interest among young learners from Europe and other well developed countries.

Examples follow.

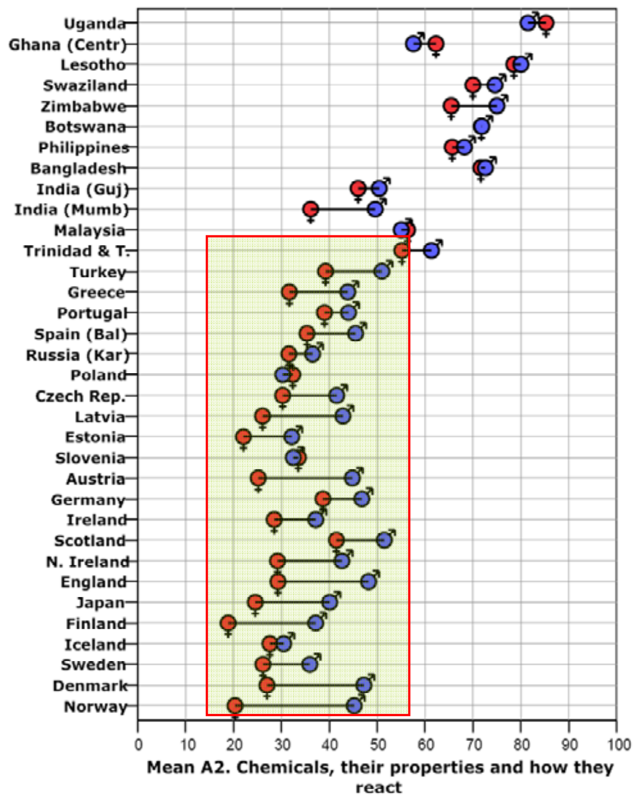
## How plants grow and reproduce

Very low interest, 20 % average



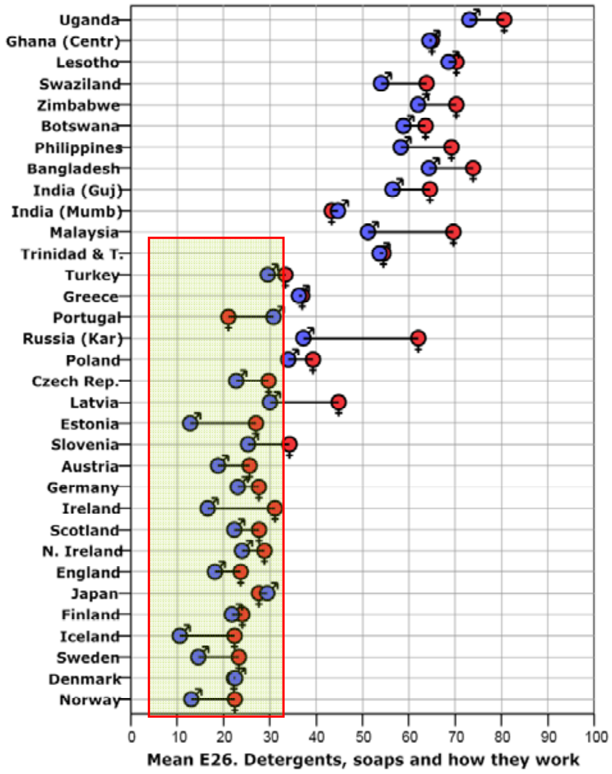

## Chemicals, their properties and how they react

”No context” or ”school context”
Low interest, in particular for **girls**



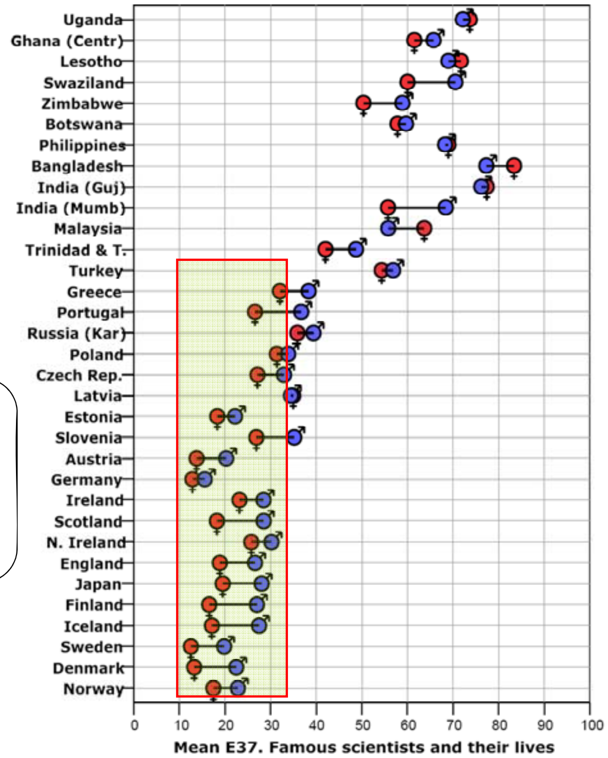
## Detergents, soaps and how they work

”Everyday context”
Low interest for all




## Famous scientist and their lives

Biographies of
(often male, old – and dead!)
scientists.
Low interest, in particular for
**girls**



## Girls' and boys' interest are *context-dependent* – and growing with level of development

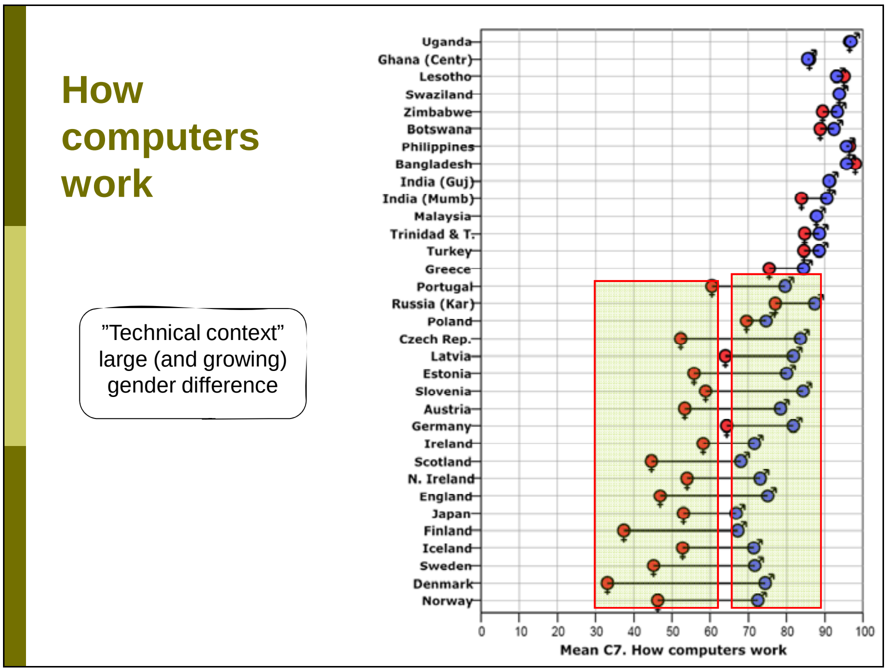
The graphs on the following pages illustrate that the ***Context*** is a key to understand the expressed interest. In sum:

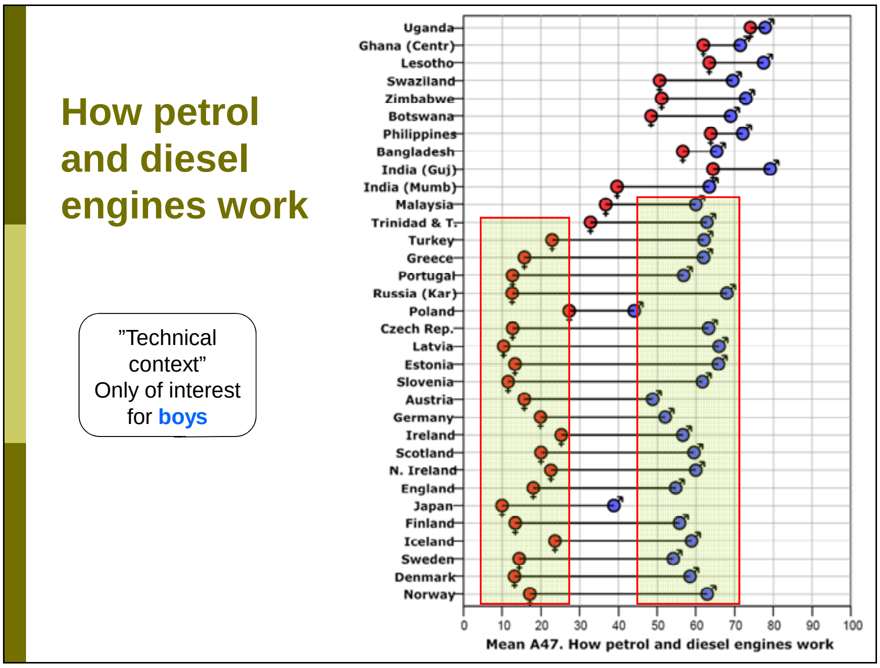
**Boys**' interests (and **NOT** the girls'):

The technical, mechanical, electrical, spectacular, violent, explosive…

**Girls'** interests (and NOT the boys')

Health and medicine, beauty and the human body, ethics, aesthetics, wonder, speculation (and the paranormal..)

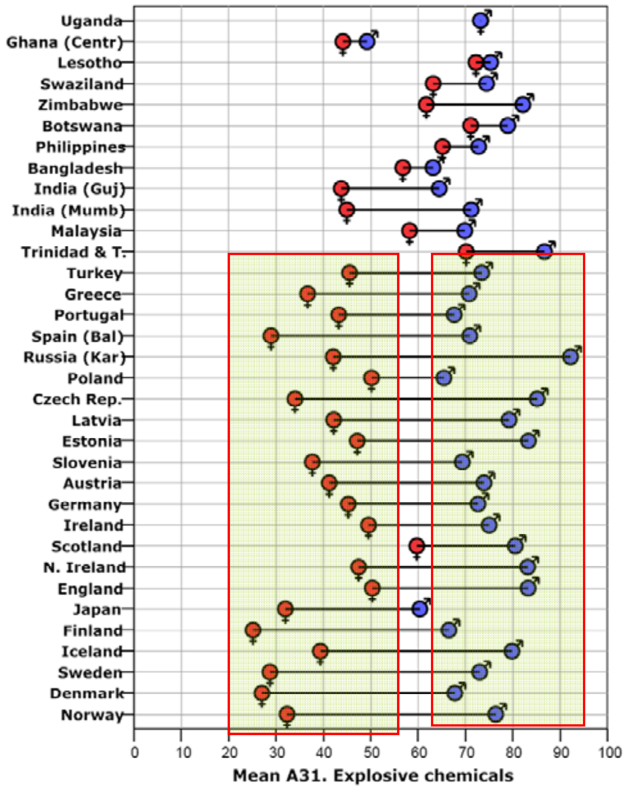


## Explosive chemicals

"Violent and spectacular context"

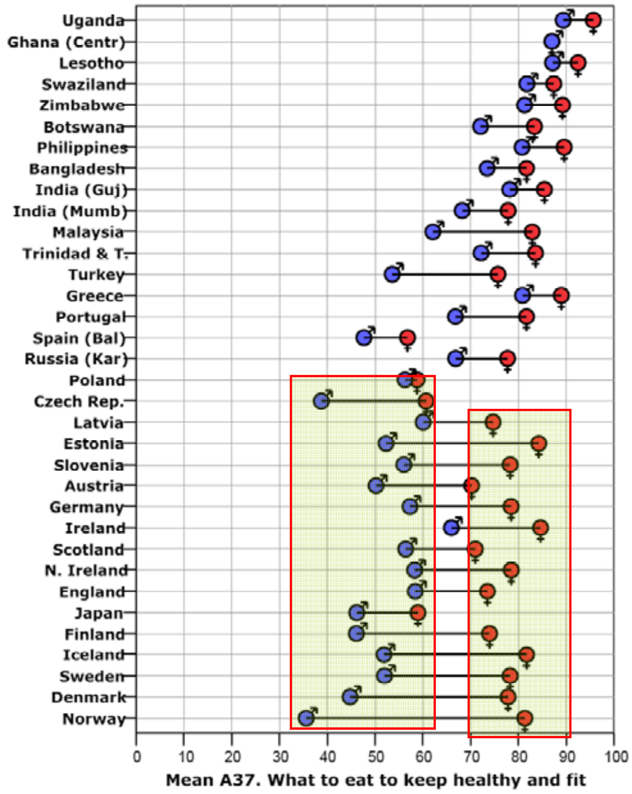
Only of interest for **boys**



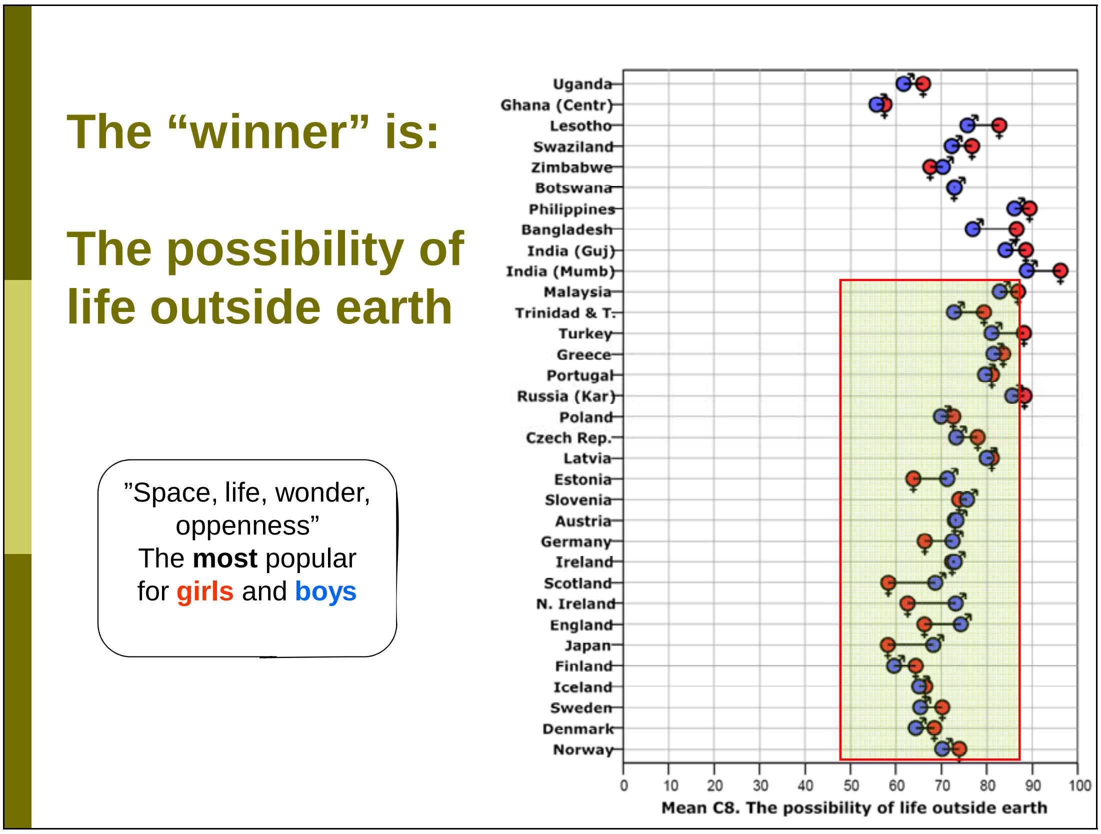

## What to eat to keep healthy and fit

"Body and health"

**Girls**' interest, growing gender difference



In spite of the strong gendering of interest, there are some items that seem to be interesting for both girls and boys. One example is given below.

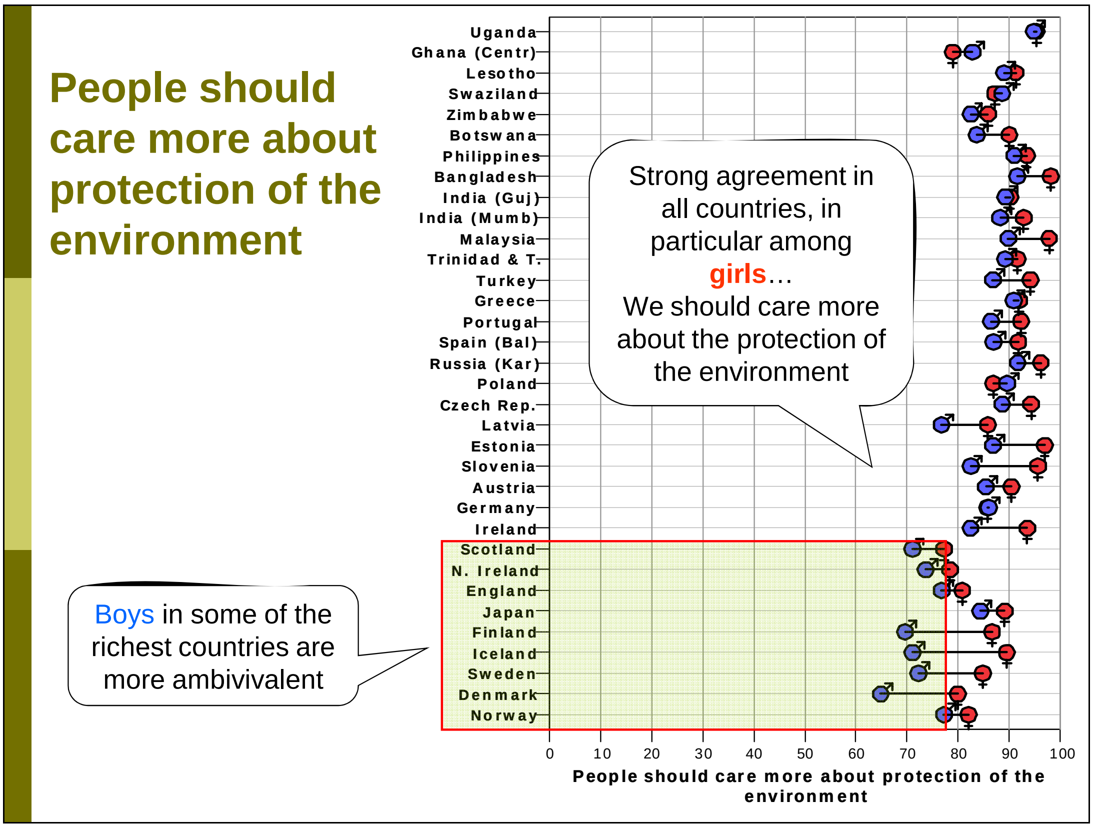


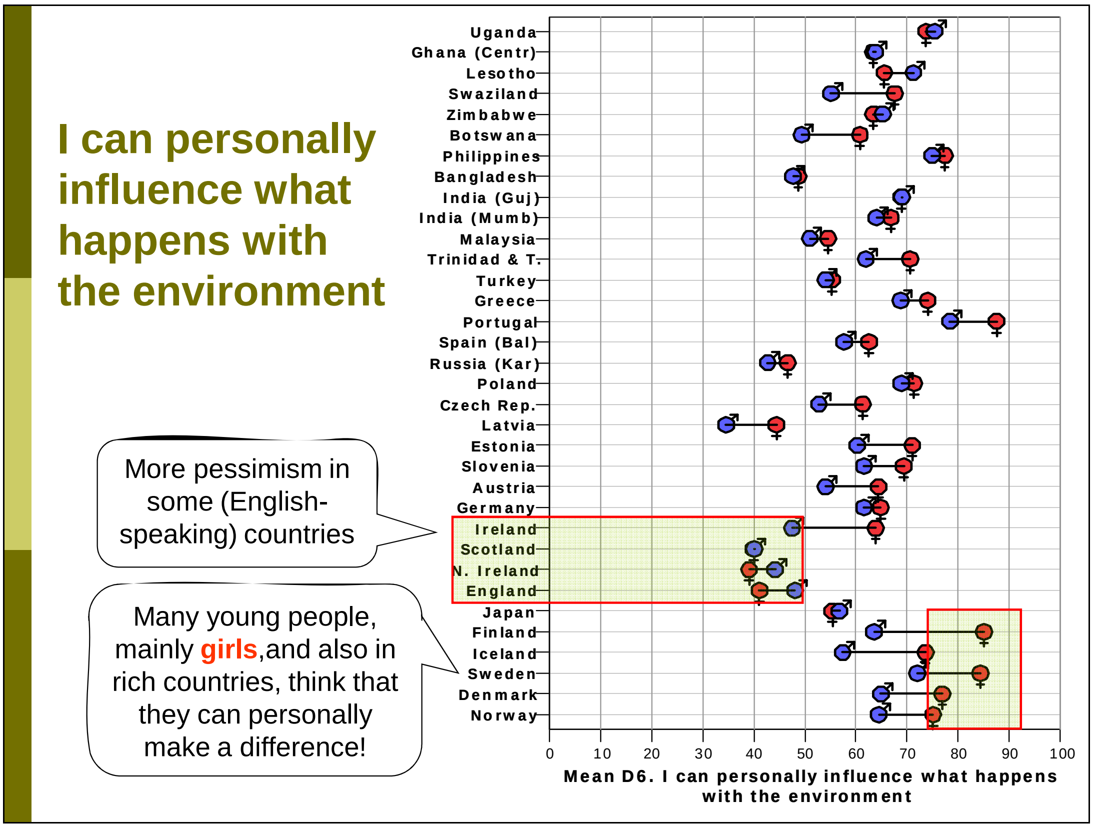

## Concern for the environment – mainly a concern for girls?

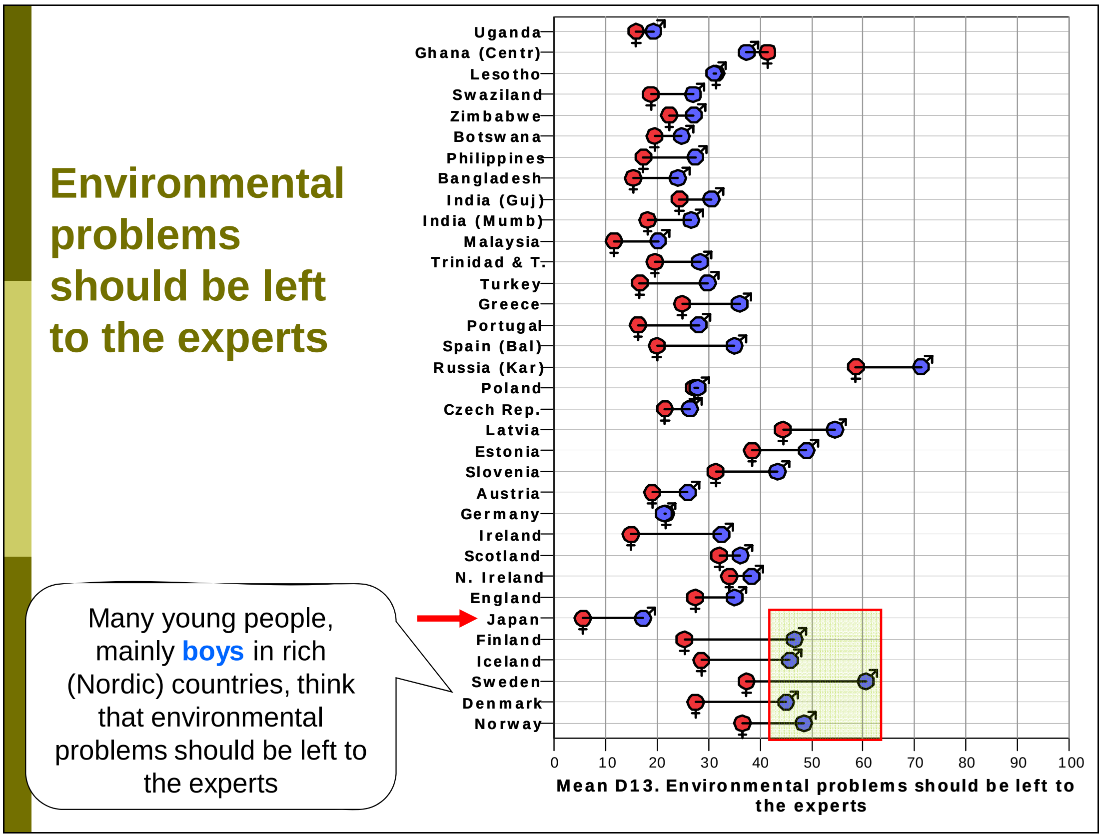
The ROSE instruments contains 18 items that probe how young people relate to environmental challenges. The overall impression is the following: Environmental issues are important for all, but mainly for **girls**

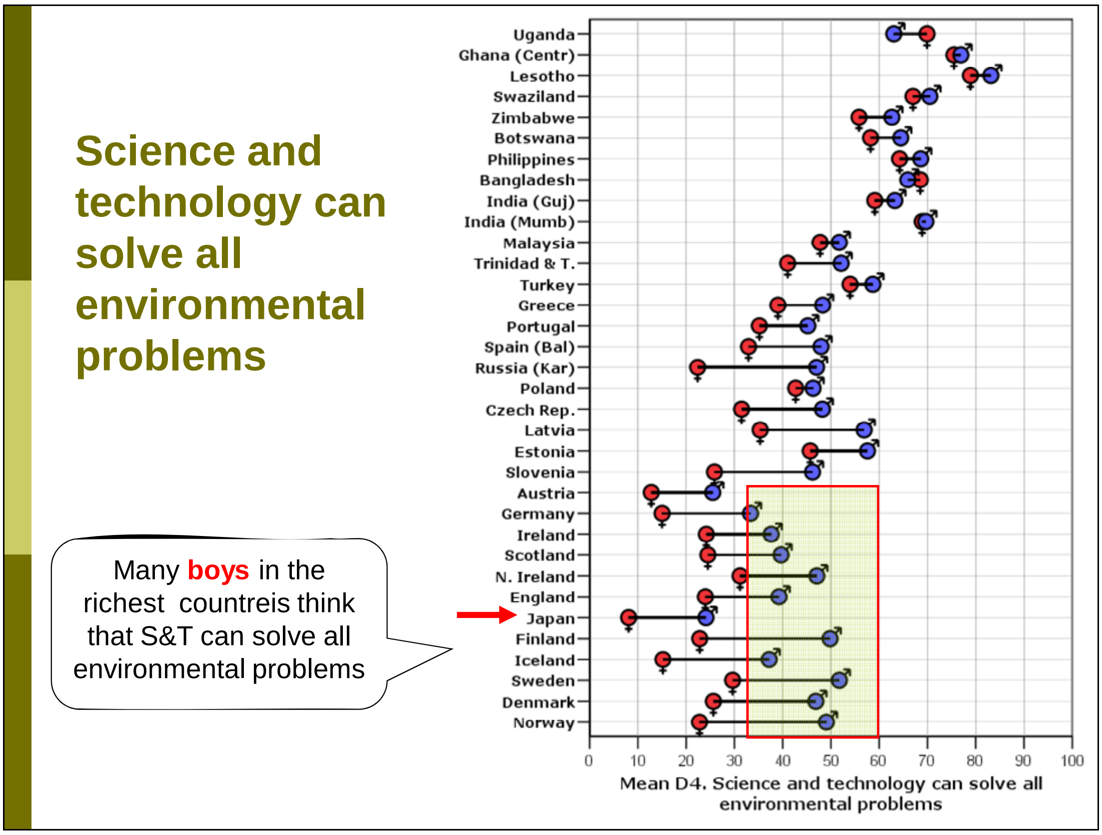
- **Girls**, more than boys, agree with statements like:
  *People should care more about protection of the environment, I can personally influence what happens with the environment*
- **Boys,** more than girls think problems are exaggerated and trust experts to sort out the problems
- **Boys**, more than girls think that science and technology can solve **all** environmental problems, (a considerable number of boys also agree with statement like Science and technology can solve nearly **all problems!)**
- **Girls** believe that each individual makes a difference
- **Girls** are willing to 'pay the price',
  **Boys** are more reluctant

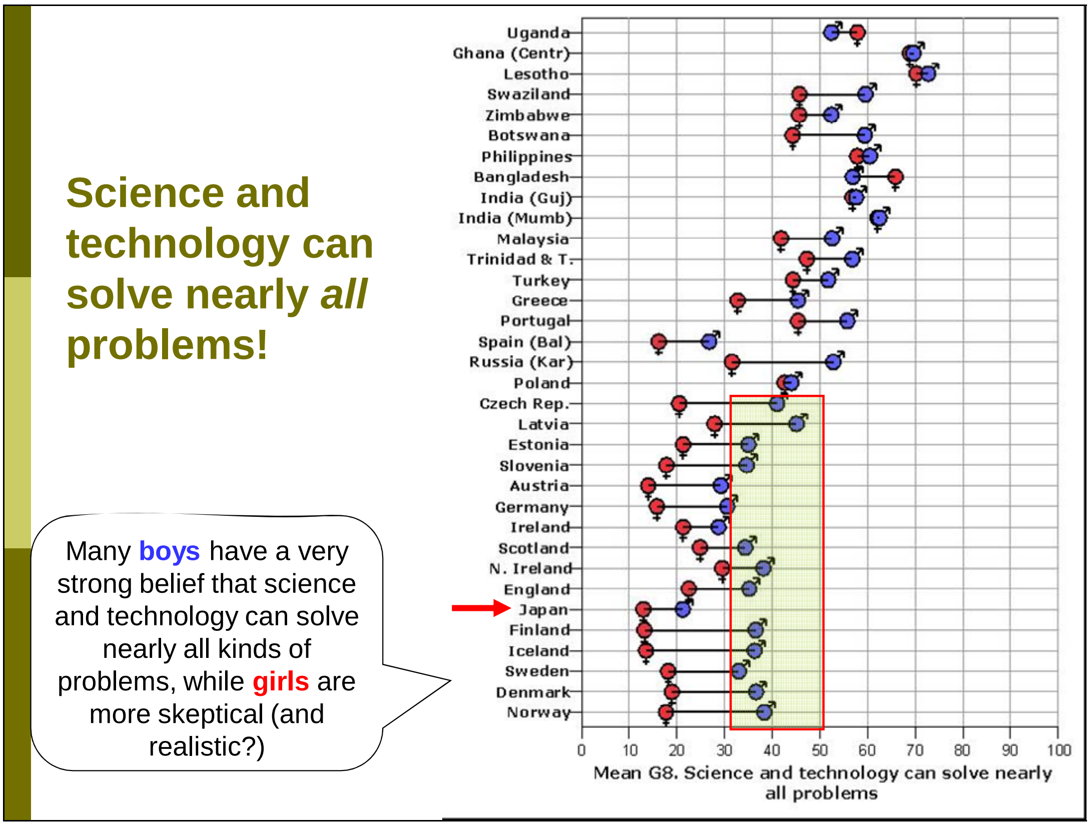
Examples follow.


People should care more about protection of the environment
Strong agreement in all countries, in particular among girls…
We should care more about the protection of the environment
Boys in some of the richest countries are more ambivalent
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
People should care more about protection of the environment


I can personally influence what happens with the environment
More pessimism in some (English-speaking) countries
Many young people, mainly girls,and also in rich countries, think that they can personally make a difference!
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
Mean D6. I can personally influence what happens with the environment


Environmental problems should be left to the experts
Many young people, mainly boys in rich (Nordic) countries, think that environmental problems should be left to the experts
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
Mean D13. Environmental problems should be left to the experts


Science and technology can solve all environmental problems
Many boys in the richest countreis think that S&T can solve all environmental problems
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
Mean D4. Science and technology can solve all environmental problems




## What is important for future work?

The ROSE instrument contains 26 questions that probe the plans and priorities for future work.

The wording is: ***My future job:*** *how important are the following issues for your potential future occupation or job?*

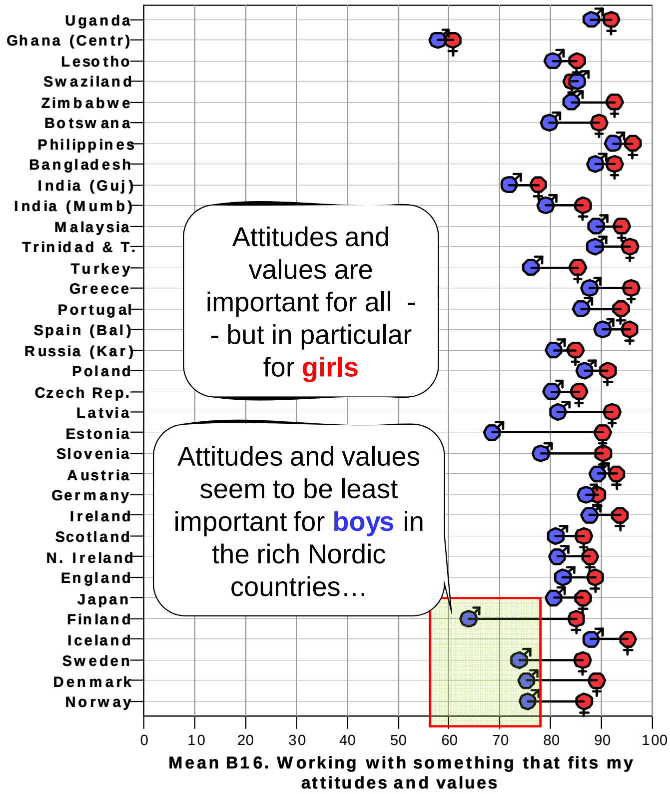
The results confirm our initial assumption about the prime importance of **values, attitudes and meaning**! But on all items probing this, we find that **girls**, in all cultures, seem to value these aspects even more than boys do.
In addition, we observe the following pattern.

- **Girls**' priority: Working with, and helping people
- **Boys**' priority: Working with their hands, with things, machines and tools
- Boys, more than the girls favour:
  Earning lots of money, becoming the boss at the job, becoming famous ---
  …. and *having an easy job*…)

Examples follow.

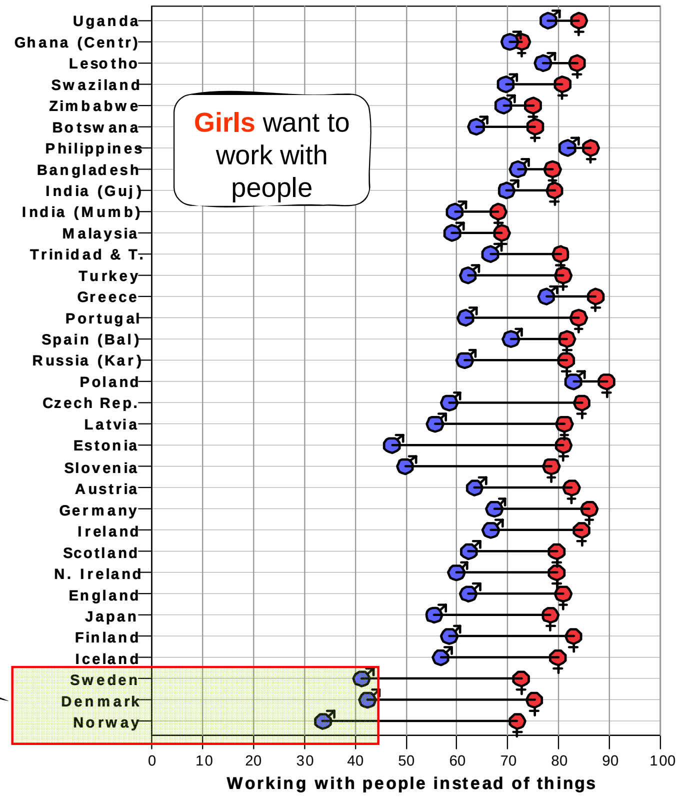
## Future work:

## “Working with something that fits my attitudes and values”

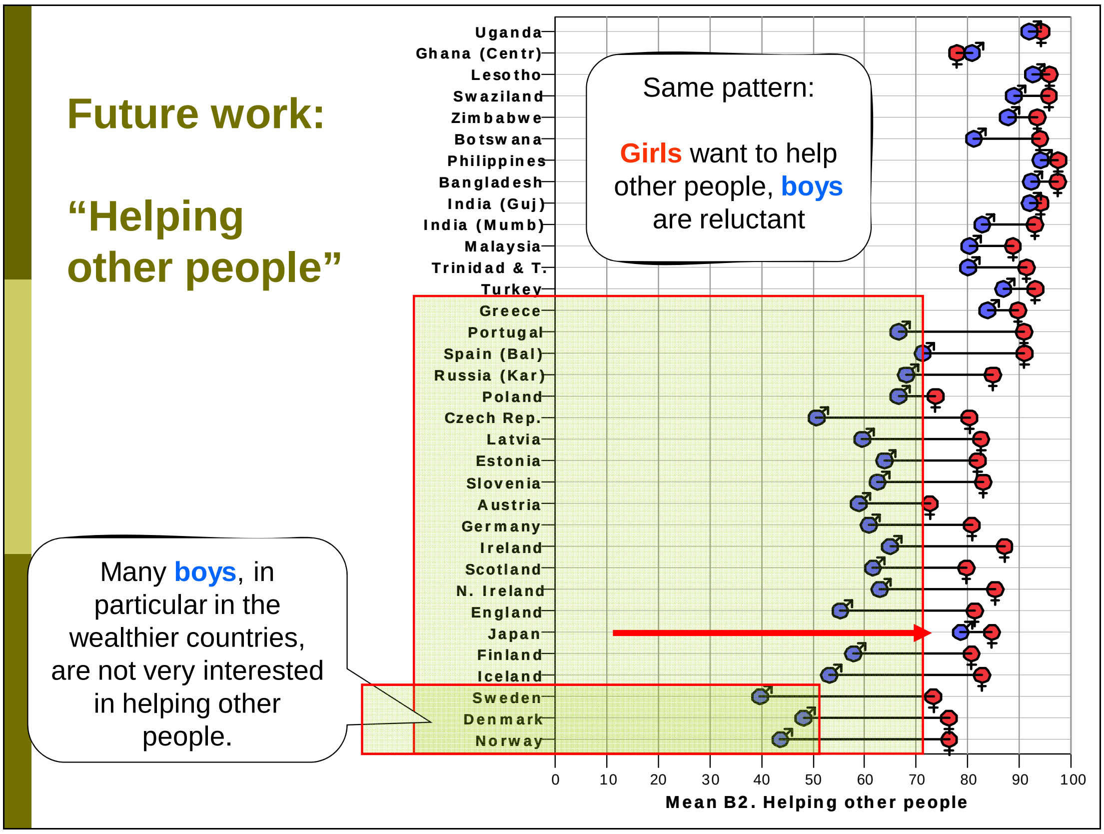



## Future work:

## “Working with people rather than things”




Many **boys**, in particular in Scandinavia, are not very interested in working with people.



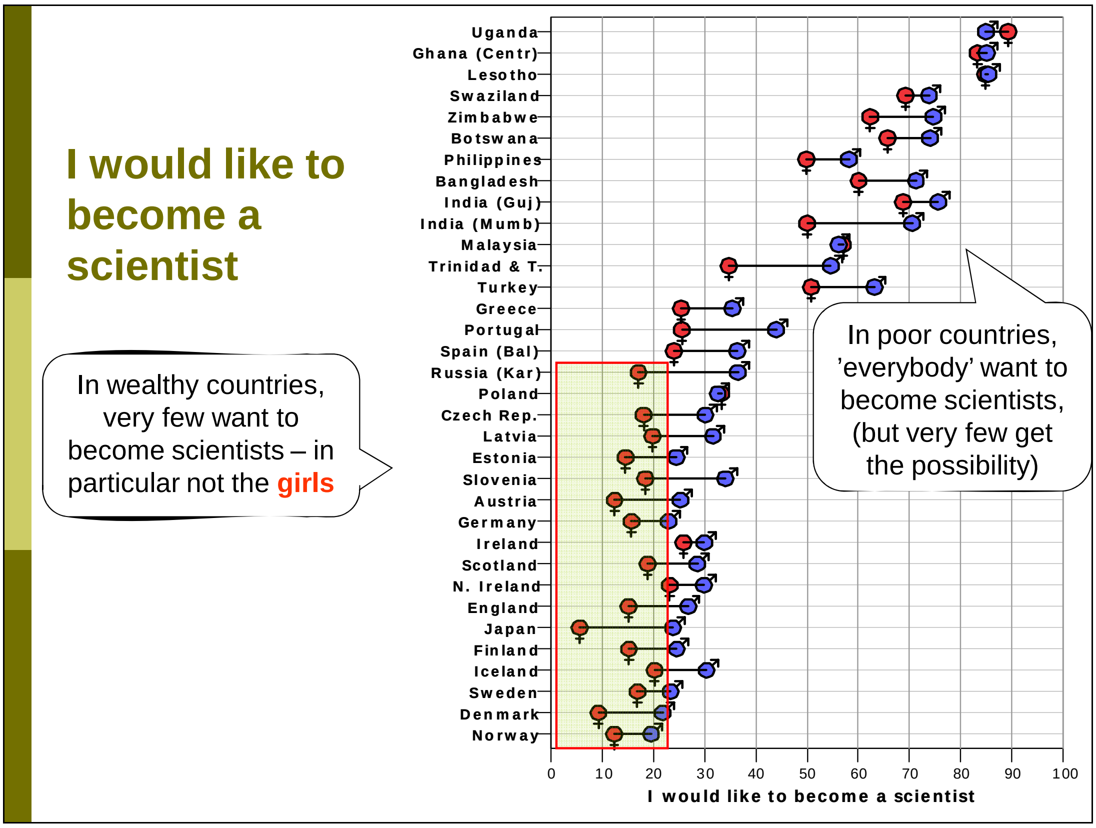

## Recruitment to science and technology?

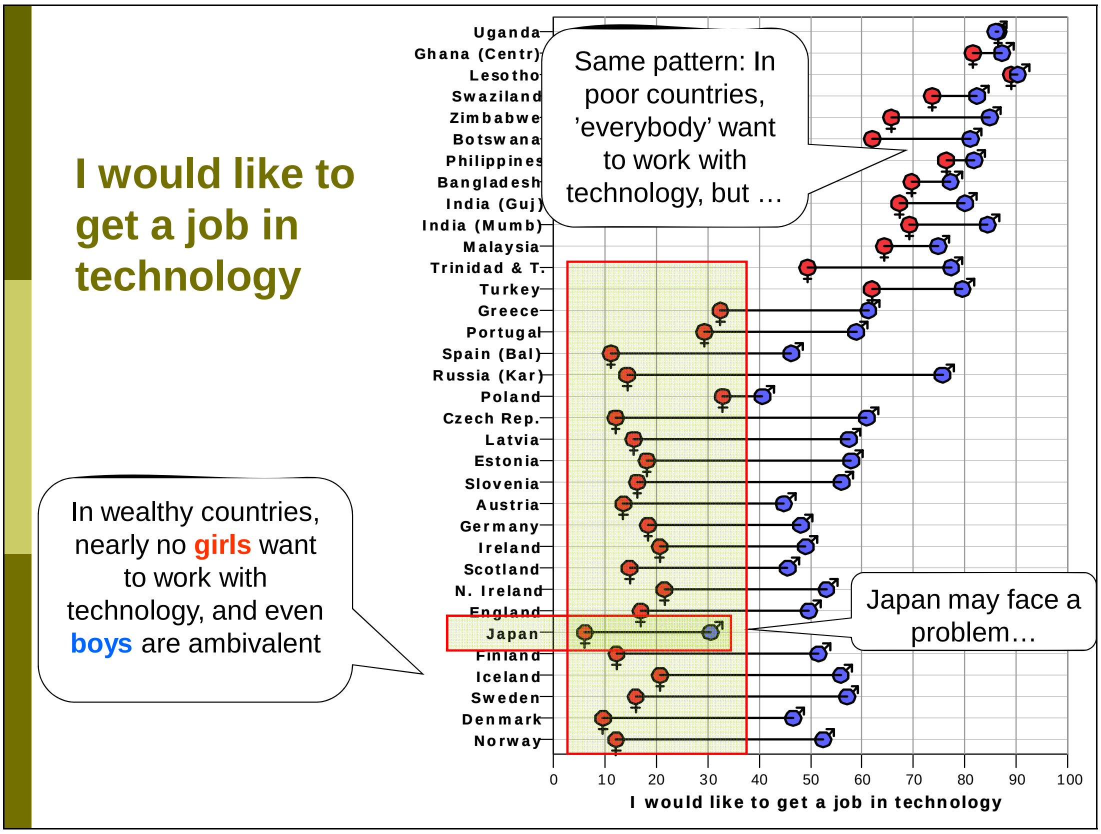
Since recruitment to S&T is a prime concern for the EU (as well as for most OECD countries), we have some questions that directly address this issue. The results are not very encouraging.

Very few young people agree with the statement *"I would like to become a scientist".* In particular, there are extremely few **girls** who want to become scientists, and even for the boys the percentage is very low. We also observe that the more developed the country is, the lower is the wish to become scientists.

Similar responses are given to the question. *"I would like to get a job in technology*". In Europe, around 50% of the boys give a positive response, but very few girls indicate that they want such a job. This gender difference is , indeed, dramatic, and there seems to be something about the perception of "technology" that puts off girls in a way that seems to exist in all well developed countries.

Data are given on the following page.


I would like to become a scientist
In wealthy countries, very few want to become scientists – in particular not the girls
In poor countries, 'everybody' want to become scientists, (but very few get the possibility)
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
I would like to become a scientist


I would like to get a job in technology
Same pattern: In poor countries, 'everybody' want to work with technology, but …
In wealthy countries, nearly no girls want to work with technology, and even boys are ambivalent
Japan may face a problem…
Uganda
Ghana (Centr)
Lesotho
Swaziland
Zimbabwe
Botswana
Philippines
Bangladesh
India (Guj)
India (Mumb)
Malaysia
Trinidad & T.
Turkey
Greece
Portugal
Spain (Bal)
Russia (Kar)
Poland
Czech Rep.
Latvia
Estonia
Slovenia
Austria
Germany
Ireland
Scotland
N. Ireland
England
Japan
Finland
Iceland
Sweden
Denmark
Norway
0 10 20 30 40 50 60 70 80 90 100
I would like to get a job in technology

## Next step: IRIS (Interest and recruitment in Science)

From the data provided above, as well as from recent educational statistics and the reports referred to in previous sections, it is obvious that the S&T sector in Europe (and other OECD countries) is facing a serious problem, the recruitment to the S&T sector.

Although this is not the focus of the planned **Eurydice** project, we find it important to end by drawing attention to the emerging EU FP7 project IRIS, also because it will involve many of the research partners from the ROSE project.

**IRIS (Interest and Recruitment in Science)**[14]
**Factors influencing recruitment, retention and gender equity in SMT higher education**

The target population are first-year students at the tertiary level. The illustration below indicate the questions to be addressed. A Norwegian study[15] is a kind of pilot for this European study, and has already collected data (qualitative as well as quantitative) from 12 000 first-year student in Norway.


[14] The international web site is http://iris.fp-7.org/about-iris

[15] http://www.naturfagsenteret.no/vilje-con-valg/

## Raising interest and motivation: Possible implications from ROSE

It is always problematic to draw clear implications from empirical findings. One simply cannot unproblematically move from the descriptive to the normative! Recommendations for possible actions must also involve statements of values. The following recommendations therefore rest on some assumptions about the aims and purposes of school science. Some of these value statements are embedded in the ROSE project rationale, as indicated earlier.

We understand that the criteria for "success" for the current **Eurydice** initiative is politically framed in terms of higher scores on international tests, mainly PISA. More specifically, to decrease the fraction of students in the lower end of the score spectrum, since these are considered "to be at risk" for functioning well in the future society. This assumes that PISA measures what it intends to measure, i.e. literacies and competences for real life situations. Sjøberg (2007) and many other science educators have elsewhere argued that these aims are important, but that PISA (by necessity) fails to live up to these expectations One should therefore at least problematize this criterion for "success" of a given educational initiative.

To us, it seems that more valid criteria for success will be closely linked with more lasting, even life-long, results. These are related to attitudinal aspects like higher interest in SMT, positive (as well as critical!) attitudes to SMT, willingness to engage in SMT related issues, understanding the significance of SMT for our well-being and culture etc. For some, but not for all, this may lead to a motivation to choose SMT as subjects in schools, even to go into SMT studies and occupations.

With such criteria for success, we will suggest some implications of the research findings.

Students experiences as well as their interest should be attended to in the construction of curricula, in the production of textbooks and other teaching material as well as in the classroom activities. In doing this, one should keep the larger gender differences in interests and values in mind. "listening to the students" does, of course, not imply that they should be taught "what they want to have". But the teaching has (in particular in the more wealthy countries) to be motivating, meaningful and engaging. It has, in some way, to link up to the values and interest that the learner bring to the classroom. If not, no other "learning" than rote memory based on duty is likely to occur. If this is the situation, the learner is likely to develop negative attitudes, and will turn their backs to SMT when they make their decisions about future life, be it as students or as citizens.

There is to-day an international recognition that SMT (and other subjects) should be "contextualized", should have meaning in the **context of the learners**. (Some countries use the term "localizing the curriculum".) Current theoretical concepts like "constructivism", "situated learning" and "socio-cultural theory" point in the same direction. The implication of these current perspectives is also that students' own attitudes, values and interest should be given high priority in the selection and presentation of the science curriculum contents. Teaching material and teaching practices that do not engage students in meaningful learning is not likely to give lasting positive results. An implication of this is also that since the contexts of the learners vary widely from one country to another, science curricula (at this age) cannot and should not strive to be common and universal. (This is also a critique of testing like TIMSS and PISA, where items *by definition* are identical for learners in all countries. In these tests, the context has to be "neutral", in practice: no context.

Current science curricula, also in the early ages, are to a large extent based on the assumption that school science is the first step in the process to educate the future scientist. Curricula follow the logic and the structure of well established academic science. Although “logical” from a scientific point of view, this is not likely to be engaging for the great majority of children. These ideas are well developed in the recent Nuffield report (Osborne and Dillon, 2007) and are not further elaborated here.

**In particular, there seems a need to “humanize” school science**, to show that science is part of human history and culture, and that it is a corner-stone in our present, modern world-view. The learners should also learn to see that S&T form the basis of our current way of life as well as a basic element of many jobs and occupation, also for those who do not choose to work in what is perceived to be the S&T sector.

The purpose of ROSE is to provide empirical data of the views, interests and attitudes of young people for an informed discussion on such issues. As one can see, there are remarkable differences between countries, but the most striking difference is that between girls and boys.

The low proportion of girls who choose studies and occupations in SMT is an important concern in most countries. The ROSE data may provide insights into how to increase girls’ interest and motivation for SMT studies and careers. Girls are, more than boys, orientated towards values. One may say they are more idealistic, more people-oriented as well as more oriented to care for the environment. If SMT school curricula, teaching (and testing!) open up for such aspects of the subjects, one may hope for a better gender balance in the future. It is important to stress that such a turn in priorities does not imply a “watered- down” version of real science. On the contrary, one may well argue that the needs of our future society will be better served if potential scientists, engineers and science teachers see the relevance of SMT to meet the pressing demands of our societies.

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**The IRIS project** http://iris.fp-7.org/about-iris/ contains some useful reviews of literature, published at http://iris.fp-7.org/reports-publications/ :

*Review on young people's (particularly girls') educational choice with focus on reasons for choosing (or not choosing) STEM*

*Gender and feminist perspectives- empirical findings on scientific careers*

*Review on theoretical perspectives for understanding young people's educational choices*

*Recruitment initiatives and choice of STEM higher education: Review of theoretical perspectives and empirical findings regarding recruitment initiatives inside and outside school*