Science And Scientists: The SAS-study

Cross-cultural evidence and perspectives on pupils' interests, experiences and perceptions

Background, Development and Selected Results

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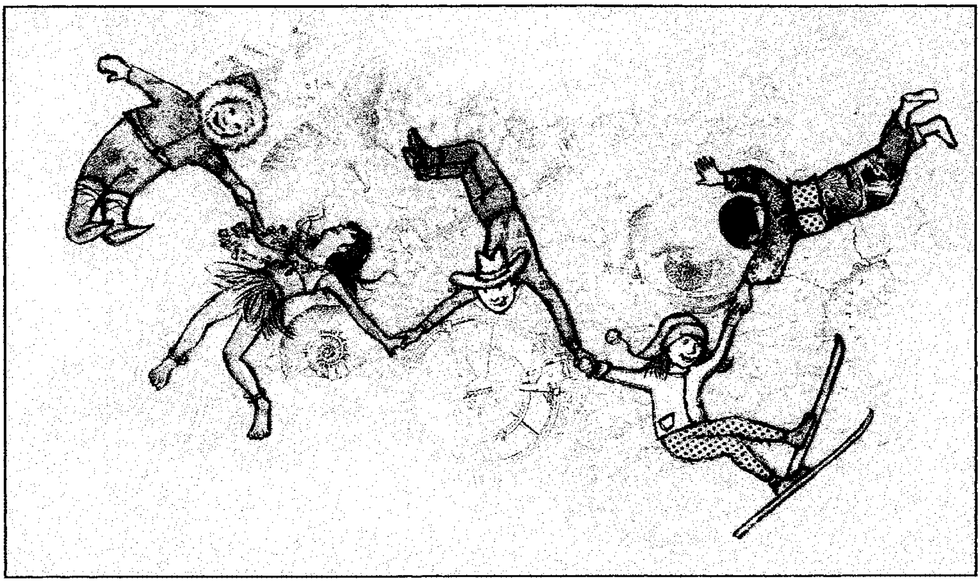

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Contents

Abstract

This publication is a documentation of the SAS- project: "Science And Scientists". This project is an investigation of interests, experiences and perceptions of children in many countries that might be of relevance for the learning of science. The project involves some 30 researchers from 21 countries. Some 9 300 children at the age of 13 have answered the questionnaire.

The SAS-study should be seen as an attempt to open up for a critical discussion on how one might approach teaching and learning in science in a way that takes into consideration cultural diversity within one country as well as differences between countries and cultures. The gender perspective is of particular importance in the SAS project. The aim is not to universalise or harmonise science curricula towards a given global "standard", but rather to open up for diversity.

The SAS-study builds on the rationale that science curricula should be meaningful and relevant for children in different cultures, and that the contents of school science needs to be adapted to culture and context. It is our hope that data from the project may form an empirical basis for local and national adaptations of the science curriculum.

The undertaking has been a cooperative effort, involving researchers from a wide variety of cultures in all continents[1] . Many researchers have written national reports or used the study in national efforts in teacher training as well as for critical deliberations about teaching, learning and the curriculum. The quality of the sample varies from country to country, and the results should be interpreted with care.

In this study the children in developing countries articulate a much more positive view towards science and technology than children in the richer countries do. Some children in the rich countries (mainly boys) portray the scientist as a cruel and crazy person, while most children in developing countries seem to consider scientists as idols, helpers and heroes. The low interest for learning science and technology expressed by Japanese children is remarkable. Gender differences in learning different topics of science vary among countries, but seem to be higher in the Nordic countries (and in Japan) than in other regions. The study also provides examples to illustrate how different contexts and applications appeal differently to girls and boys.

[1] *I would like to thank **Jayshree Mehta** from India and **Jane Mulemwa** from Uganda for the cooperation in framing the research design and for the joint development of the questionnaire. I will also thank all the researchers who have participated and collected data. The names are listed in Appendix A. There are plans for a follow-up study based on the experiences that we have drawn from the present study.*

Introduction

International comparisons put national situations, contexts and educational choices in a wider perspective – a perspective from which one may better be able to see one's own situation and priorities with new eyes and with a more open mind for alternatives. In this way, the comparisons may open up the potential for greater variety and for possible inspiration from outside. But international comparisons may also have the opposite effect. They may – often indirectly or unintentionally – have the effect of restricting choices and of providing a pressure to harmonize science teaching towards universal standards for content as well as teaching methods and assessment. This kind of criticism may be raised against the large-scale studies by IEA (International Association for the Evaluation of Educational Achievement.) The most recent IEA-study is TIMSS (Third International Mathematics and Science Study, reported in for instance TIMSS (1996, 1997 and 1998)). Such studies do, of course, also provide a wealth of information that may be used for critical reflection.

Smaller and less ambitious comparative studies may supplement the large-scale studies. Such studies may provide other sorts of information that may give clues and ideas for the improvement of science education. This report will present some results from a study of this kind, the SAS-study – "Science And Scientists".

The SAS-study: Science And Scientists

Rationale and aims

Science curricula and textbooks in different countries have striking similarities. Science teachers from very different backgrounds easily feel at home when they open textbooks from other countries in the world, in rich as well as poor countries, in the West as well as in the East. Even when the letters or the script is unknown, like in Russian, Japanese, Chinese or Thai, science educators can often recognize the contents, examples and the organization of the material presented.

This similarity may be interpreted in different ways. Some people take this to be an indication of the universality of science; for them it demonstrates that science in independent of culture, or even "culture-free". Others will interpret the observed similarities in a different way. They will argue that this demonstrates that science curricula reflect a western domination of the contents of education across the world. They will say that western science curricula are exported and imposed on pupils in other countries. They will argue that the observed similarity and homogeneity demonstrates a kind of educational and cultural imperialism.

The issue of the possible universality and culture-independence of science as an *academic* discipline per se is an important philosophical debate, and the views differ. However, there seems to be a much greater consensus in the debate about *school* science. Regardless of philosophical positions, most educators would agree that school science cannot be "deduced" from the science in research and universities (whether this is labelled "western", "modern", "academic" or "real" science). Among educators there is broad agreement that each society has to construct their own science curricula to fit their own needs and their own purposes for schooling. Academic science is only one of the possible inputs in this process of selection and construction.

There is also broad agreement that all teaching should "build on" the *interests* and *experiences* of the child. In particular, everybody who subscribes to (some version of) educational constructivism will take such a stance for granted. For the educational contents to be meaningful for the learner, it must have some sort of relevance, and it must fit into the personal or societal context of the child.

But the simple and obvious fact is that *children are different*. They do not have the same experiences when they meet school science, nor do they have the same interests. There are differences between pupils in the same class, in the same school or the same nation. And there may be systematic differences between girls and boys. And there are certainly large differences between children in different countries. Growing up in rural Africa is different from growing up in London. And growing up in Tokyo is different from growing up in New York.

Not only do experiences and interests among the learners vary. It is also evident that there are similar variations in what can be said to be "relevant" and useful knowledge for children coming from such different life situations. Learning to cope with the daily challenges and preparing for a meaningful life varies according to the different backgrounds of the children.

In the light of such obvious facts, the great similarity of science curricula becomes doubtful, whatever stance one may have on the more philosophical questions about the possible universality of scientific theories per se.

Other aspects of pupils' "mental luggage" may also be of importance for their learning of science, or for their overall approach to or attitude to science. Pupils always develop some sort of idea about what science is all about, how scientists are as persons, what they actually do and how this relates to society, the environment and the lives of themselves and other people.

Children's ideas about the nature of science, the personalities of scientists and the purpose and meaning of their activities may have different sources. They may emerge from the media and out-of-school influence, or they may arise from their encounter with school science and the science teachers. Some ideas may arise from their own culture and its prevailing world-views, ideologies, religious or other sorts of beliefs. These factors are of a more affective nature; they are related to feelings, ideals and values. They may influence the pupil's eagerness, motivation or interest to learn science. Maybe they are even more important than the "pure" cognitive factors.

Considerations like these are part of the rationale behind the study that is presented here. Debates over curricular contents and of curriculum emphasis (Roberts 1988) are important. However, they often take place on a general or theoretical level, based on generalisations and assumptions about different cultures. The discussion may be facilitated if one could refer to more concrete data and evidence. This is the basis for our research.

Background and context of the study

The intention of the SAS study is to shed light on some of the issues that may be important for an informed discussion of priorities in science education that is sensitive towards the background of children, with emphasis on culture and gender.

Another purpose of the study is *networking* and *capacity building*, with a special focus on engaging female researchers from developing countries in joint research. These aims emerge from the context of the development of the study. The three researchers, Jane Mulemwa from Uganda, Jayshree Mehta from India and Svein Sjøberg from Norway are jointly involved in international co-operation and development. The contexts are the following.

FEMSA (Female Education in Mathematics and Science in Africa), a project aiming at stimulating girls' access to and achievement in science and mathematics in African countries. The project is sponsored by NORAD (Norwegian Agency for Development Cooperation) and other donor agencies. It has the base in Nairobi. The first phase of FEMSA (1995-98) involved four countries (Ghana, Tanzania, Cameroon and Uganda), and resulted in the production of "country profiles" that describes factors relating to girls' access to and interest in science—and how to address these challenges. National action plans to address the challenges were also developed. At the end of 1998, the FEMSA project entered a second and more action-oriented phase, headed by a FEMSA centre that was established in each country. Eight new African countries have joined this second phase of FEMSA (Burkina Faso, Mali, Malawi, Mozambique, Senegal, Zambia, Kenya and Swaziland). (And Ghana has left the project.) The three SAS coordinators have been with the FEMSA project from its inception, where they produced the first project documents and plans. They are now members of the "FEMSA Consultative Group". The FEMSA project has enabled us to meet regularly in connection with FEMSA project meetings. (A rich variety FEMSA material is available from the regional FEMSA office: FEMSA at FAWE PO Box 53168, Nairobi, Kenya, e-mail: mail: femsa@fawe.org)

- **GASAT** (Gender And Science And Technology), an international association with a broad range of activities, among them bi- or triennial international conferences, starting in 1981. The second GASAT conference was arranged in Oslo, Norway in 1983. The two last ones have been held in developing countries, in Ahmadabad, India in 1996 and in Accra, Ghana in 1999. The next will be in Denmark in 2001(Information is available at http://www.ida.dk/gasat10). All the three project coordinators have a long-term involvement in GASAT, Jayshree Mehta as chair of the GASAT association.

- **IOSTE** (International Organization for Science and Technology Education) is an international organization that promotes science education, with an emphasis on "science for all". IOSTE hosts bi- or triennial international conferences. The 8th was held in Edmonton, Canada in 1996, the 9th in Durban, South Africa 1999. IOSTE has also a network of researchers and activists with a regular newsletter, special interests groups etc. (Information is available at http://www.ipn.uni-kiel.de/aktuelles/tagungen/ioste/ioste.htm) All three SAS project coordinators are or have been board members of IOSTE.

Activities related to these initiatives have brought the three researchers, coming from three continents, together with regular intervals. We decided to use these opportunities as a vehicle also for joint research and thereby also to promote the goals of the above-mentioned organisations. Support from NORAD (Norwegian Agency for Development Cooperation) provided a financial base for many of the meetings as well as for refunding some costs for participants from developing countries. NORAD grants have also made it possible for participants from developing countries to attend conferences and discuss the joint research. Some 20 SAS researchers from developing countries were funded by NORAD to attend the 8th GASAT conference in India in 1996, where they had the opportunity to discuss the development of the project. Oslo University has also in part funded the research.

The development of instruments

The research instrument is a questionnaire consisting of 7 items, meant to tap into aspects relating to the interests of children, their experiences, their perceptions of science, their hopes, priorities and visions for the future. The questions cover aspects of relevance for the science curriculum. A questionnaire to be filled in by the researcher was also developed, and a short guide for the administration and collection of data was developed.

The items in the pupils' questionnaire were based on research instruments used in research before, by this author and by others. Previously, these items have been used in only one country or in comparisons between similar countries in the North. We went through a long process of adapting the instruments to this new and wider cross-cultural context. We produced an "original" in English, and used translations in the different countries. Piloting of the instruments was done in the countries of the three researchers, hence translations of preliminary versions of the instruments was made into Norwegian and Gujarati (an Indian language with its own script). In Uganda the English version was used.

The pilot testing gave experiences from three different continents, and was the basis for the process of refining and finalizing the items. We had in mind to make an instrument that could in principle be used in all parts of the world. Therefore, in each culture, there will be words, phrases and even contexts in the final instrument that may seem strange for the kids. For instance, few kids in industrialized countries have experience with "making bricks" or "carrying water on the head". Similarly, few kids in developing countries are likely to have much experience with computer games and video recorders. Hence, the final instrument is a compromise, and it should be seen and understood in this light. We also tried to keep the wording of instructions simple (but yet precise enough) and provide few response alternatives (instead of exhausting all alternatives, like "I do not know", or "I do not understand the question".) In short, there were lengthy discussions behind most of the decisions behind the final instrument, and arguments pointing in different directions had to be balanced. The following is a brief description and discussion of the items, in the order they occur in the questionnaire.

The SAS questionnaire

The front page of the SAS instrument (also on the front page of this report) has a drawing of playing children from many parts of the world, and the term "scientist" is introduced like this:

> A scientist is a person who is curious and tries to find out about new things. Sometimes they also try to invent and make new things or find new ways of solving problems.

The setting of the investigation is then presented like this:

> This booklet contains questions about science and scientists.
> The questions are answered by children in many countries.
> (That is why some of the questions may seem strange to you!)
> The questions have no "right answers", but your views may help us to understand how children in different countries think, and in making science in schools better.

The following pages of the instrument contain the following 7 items. (The full version is given in Appendix C.)

1. Scientists as person.
This is an item meant to elicit what children think "real scientists" are like. Two opposite human traits are put up on each side of a 5-point Likert scale, and the response is given by indicating a position on this scale. The "direction" of the different traits is varied. Hence, what may be considered a "positive trait" may occur at both ends of the scale. We distinguish between a person working with physics or engineering (abbr.: "a physicist") and a person working with biology or medicine (abbr.: "a biologist"), since previous research has indicated that the perceptions of these two "types" of scientists may be quite different.

This item is close to the one used by this author in previous research, and it was included in the Norwegian version of the SISS-test (Second International Science Study). Results are reported in Sjøberg 1986. Some results are presented in English in Sjøberg and Imsen 1987. An English translation of the questionnaire was published (Sjøberg 1990) and later used in Korea and Singapore with strikingly different results (Kim 1994). This was one reason for including the item in this investigation.

2. Out of school experiences: What I have done.
This item is an inventory of 80 activities that may have bearing on the teaching and learning of science. This item has also been used in previous research in a slightly different form. (Lie and Sjøberg 1984, Whyte, Kelly and Smail 1987). The item was also included in the Norwegian version of SISS and is reported in Sjøberg 1986 and Sjøberg and Imsen 1987. Care was taken to sample a large variety of activities, and with a cultural diversity. There are three possible responses to each activity: "Often (Many times)", "Seldom (Once or twice)" and "Never".

3. Things to learn about.
This item is a similar list to the one above, and is used in some of the above-mentioned studies. It is an inventory of possible topics for inclusion in the science curriculum. 60 topics are listed. Care has been taken to put similar scientific contents into different contexts. The rationale behind this is to explore whether different contexts or different perspectives appeal differently to different groups of pupils or different cultures. The pupil's responses are simply to tick a Yes to each topic they like.

4. Important for a future job.
The rationale behind this item is that pupils have different hopes and priorities for their future, and that this may be an important element in their approach towards learning. Different preferences may also indicate that different curricular emphasises may appeal to different groups of pupils. (Like stressing the "other-oriented" or "person-oriented" aspects of science and technology versus stressing the "ego-centred" or "instrumental" aspects, or possibly the "intellectual" aspect of the subject.)

The item consists of a list of aspects that might be important for the choice of a future job (if such a choice exists!). The pupil is invited to judge the personal relevance of each of these factors. Previous research has indicated interesting differences between girls and boys on such factors. (E.g. Sjøberg and Imsen 1987). There may also be interesting cultural differences. The responses are given on a three-point scale: "Very important", "Of some importance" and "Not important"

5. Science in action.
"Science" may mean different things for different pupils, and the word may trigger different emotions, or give different associations. This item is a list of such possible word associations, and the pupil is invited to indicate the ones that they find suitable. This item is meant to elicit some attitudes to science and some perceptions about what science may or may not contribute to.

6. Scientists at work.
The "Draw-a-Scientist" task has been used in research for a long time in different formulations and with slight modifications. (Mead and Metraux 1957, Krajkovich and Smith 1982, Chambers 1983, Kahle 1987, Kjærnsli 1989, Matthews 1996) The purpose of this item is to elicit the image of scientists held by the learner. It may be argued that this item simply begs the stereotype to be presented; the respondents may concentrate on what distinguishes a "stereotype" of a researcher form other "normal" people. In the research, different approaches are used to counteract this. (Like drawing two scientists, or by sorting cards with drawings etc.) In our version, we ask the respondents to draw a scientist *at work*,

and to add something *in writing* on what they do and issues they work on. This may be a story or just a list of key words.

7. Writing: "Me as a scientist".

This last item may be seen as an extension of the previous one. Pupils are invited to put themselves in the position of being a scientist, being free to work and to do research on what they find important and interesting. Here, they may express their own interests, concerns and priorities. Previous research has indicated interesting differences between the priorities of girls and boys (Kjærnsli 1989).

Translations and adaptations

In many countries, translations were necessary. The national researchers were provided with a diskette with the original English version, and most of the translations were done by simply replacing text and keeping the formatting. The instructions given were these:

> "In countries where *translations* are necessary, please follow the same format and stick accurately to the order of items within each question! (Otherwise, common coding and comparisons will be difficult.) A project that intends to make comparisons across cultures from different continents, including the very rich and the very poor, has to make several compromises in the selection of items. We have tried hard to do so. This will, of course, mean that in each country, pupils may find some of the items somewhat strange. In spite of this, we kindly ask you to *include all elements of all items*, and to *keep the order etc. as in the original*" (SAS guide to the researcher)

Some instructions regarding translation were also given, like this one:

> "In translation, be aware of the different translations of key word like "science". (In our context, we of course mean what may be called "the natural sciences". For some activities, comparable activities are mentioned (like "Knitted, made baskets or mats"). In such cases, you may omit the alternatives that are unknown in your culture." (SAS guide to the researcher)

The SAS instrument now exists in the following languages: English, Portuguese, Spanish, Hungarian, Icelandic, Swedish, Norwegian, Gujarati (India), Japanese, Korean, Sudanese.

Participation and organisation of the study

The study was announced through different professional channels (The IOSTE and the GASAT newsletter, the NARST e-mail network, UNESCO's newsletter Connect etc.) The project was also publicized on meetings and conferences in Africa and Asia.) Interested researchers were offered a little booklet, the questionnaire and a diskette with the English version of the questionnaire (in different formats). At a later stage, this diskette also contained the codebook and empty data files for data entry in Excel or SPSS.

The booklet described the rationale of the project and gave practical details on procedures etc. Participation was open, and limited support was available for researchers from developing countries to cover actual expenses for collecting data. In some countries, translation had to be made of the questionnaire, as indicated before. For countries using the same language, the organisers helped in sharing translations.

Since the involvement of new researchers from developing countries was an important aim, the project group decided that it was unrealistic to be very strict on sampling, since this requires both the existence of reliable educational statistics plus resources for travel and other forms of communication. Hence, care should be taken in attempts to generalise to national populations. However, *interpreted with caution*, results may shed light on important aspects regarding differences and similarities based on culture as well as gender. Since none of the results involve pupil assessment, judgements of quality or ranking of countries in term of performance, the results do not run the risk of being misused.

In the initial phase, participants were asked to return the filled-in pupils' questionnaires and their own questionnaire to the project coordinator in Oslo. When participation increased, this procedure proved to be both costly and impractical. For the last part of data collection, the participants entered the data in either Excel or SPSS-format, using empty data files provided by the project. They did, however, send the last two items, drawings and free writings, since these had not been coded. These pages were provided with the identification number of the pupil to allow for later data entry.

Target population, sampling and administration

It was decided that the test should be administered to the class level with the most 13-year-old children. In most countries, this is towards the end of the primary stage, which often means that a large proportion of the age cohort is still at school. In most countries it is also at an age before selection, curricular choices and streaming have taken place.

The intended target population is the whole age cohort. In industrialised countries nearly 100% of the age cohort is still in school at the age of 13, but in many developing countries, the proportion is much lower. Actual school enrolment is also lower for girls than boys in most developing countries. Actual enrolment data are given in e.g. the annual UNDP Human Development Reports (UNDP 1999). In interpreting the data, one should bear in mind that the school children in developing countries may not be representative of the national age cohort. For reasons already mentioned, we did not make a more refined statistical sampling a condition for participation.

The booklet with guidelines etc. contained some instructions on sampling and administration. The following is an excerpt from this:

> "The target *population* are **the 13 year olds**. *Sample* sizes should be at a *minimum* 300. We cannot expect you to use elaborate sampling techniques, especially in developing countries. It is, however, important not to draw unwarranted conclusions from the study. Therefore, we ask you to take care in describing the basis for sampling and the nature of the sample. If you are able to work with larger samples, please do so. Since the minimum sample is rather small, we suggest that the researcher in each country is present when the test is administered by the teacher, to ensure "standard" conditions, and to be able to write a brief description on the sampling and administration.
>
> The whole questionnaire is expected to last *two school lessons*. The more time-consuming drawing and writing exercises have deliberately been put at the end to avoid the possibility of some children being stuck in these items. We therefore hope to get complete data sets for most of the participating pupils.
>
> You are *not* supposed to send us the questionnaires, but rather to enter data yourselves in a format provided by us. On request we send you a "SAS-diskette" with empty data files, ready for data entry in either SPSS or Excel. A codebook with details for data entry is also included. Please also send the *notes from the researcher* to the project organiser in Oslo, preferably with the diskette.
>
> **Note**: The drawings and free writing items (items 6 and 7) have not been put in the codebook because of obvious complications in coding. *We ask you to send these pages to us* (and keep a copy if you like). Put the same *identification number* on these pages that you use in the coded data. That will make it possible for us to add data at a later stage, when these

qualitative data have been coded. We will come back to this at a later stage if funding is available.

Any *local* reporting (that is: of your own national or local data) must give reference to the project and the source of the material and with a copy sent to the project for information.

All *comparative* reporting (that is: including more than one country) should be done by the organisers, unless other arrangements are agreed. Participants will of course be paid credit with names etc. in such reporting, and will receive the publications. ."
(all quotes above from the SAS guide to the researcher)

Coding and data handling

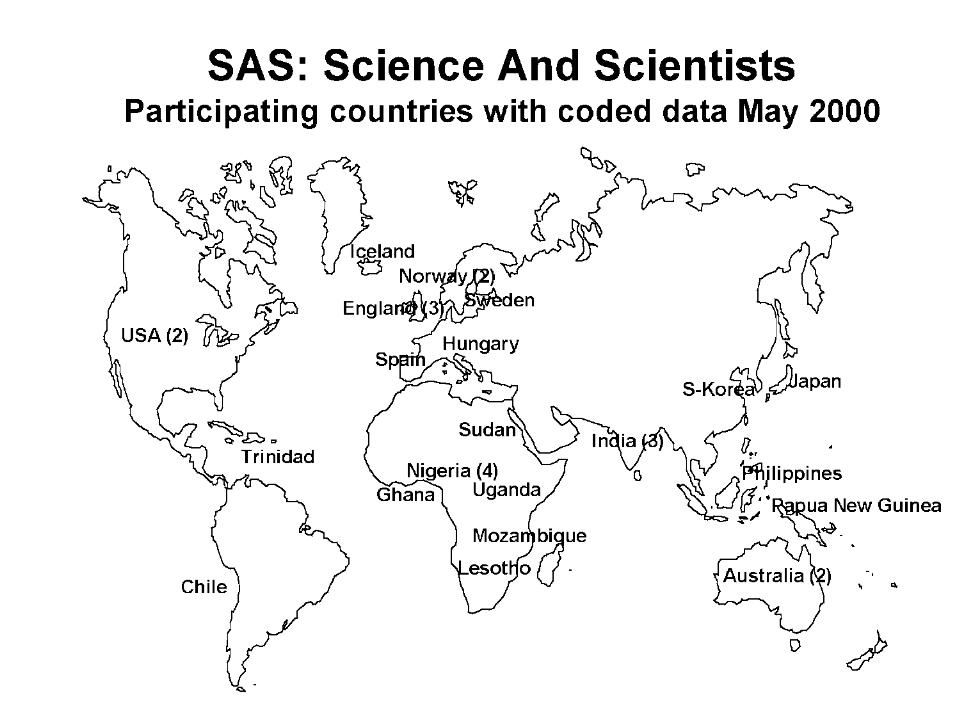
In the period 1996 to 1999, the project received data from the participants in various formats. Some sent the whole questionnaire for coding, others sent data files in Excel or SPSS as indicated above. For some countries, more than one researcher had asked to do the research, and all were accepted. This means that there is more than one sample from quite a few countries. (4 from Nigeria, 3 from India and England etc.) The names of the researchers are given in Appendix A.

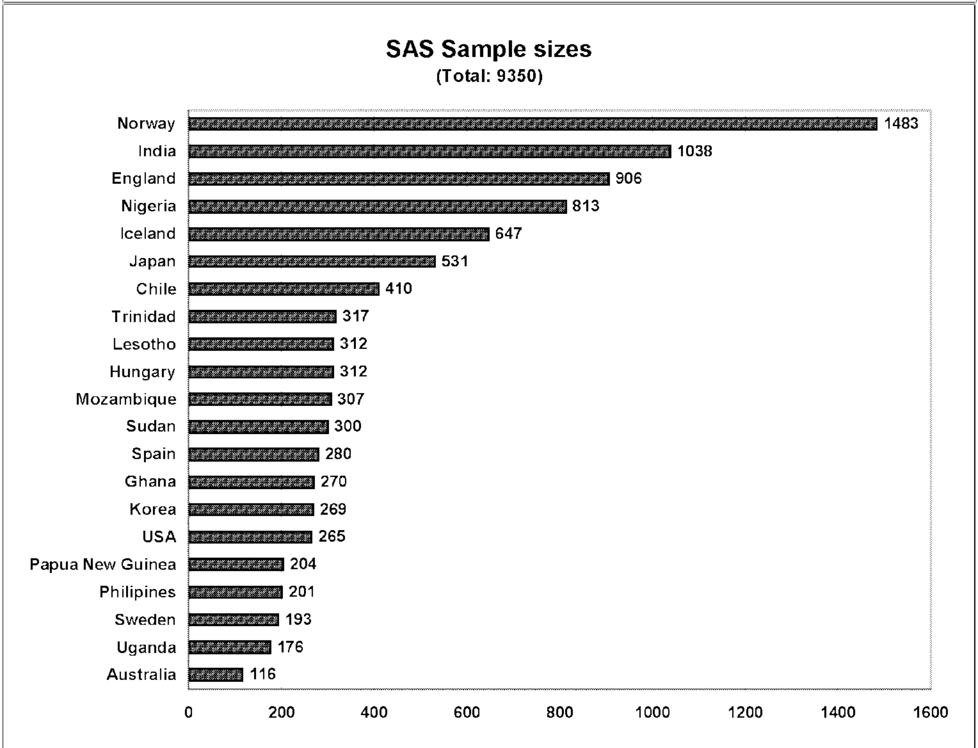
A considerable amount of time was necessary to "clean" the data files before they could be merged into one file for analysis. The initial coding was kept as simple as possible. The coding followed the position on the questionnaire: 1 for the first possibility, 2 for next etc. blank for missing data.

Data were later recoded for easier interpretation. The general rule was that responses were converted to be on a scale from 0 to 1 (or 100, to give percentages), or from -1 to 1 where negative responses around a "neutral point" have meaning. "Negative" items were converted to give the same "positive" direction.

Status and future plans

The project was from its beginning meant to be a rather modest and exploratory study, but it has grown. More than 60 researchers from nearly 30 countries have shown an interest in the study, and today (spring 2000) we have clean data files from 21 countries, collected by some 30 researchers. The total number of pupils in the data files is 9350. (53% girls, 47% boys). The map and the graph below show the geographical spread and the number of participants in each country, sorted by sample size.


SAS: Science And Scientists
Participating countries with coded data May 2000
Iceland
Norway (2)
England (3)
Sweden
USA (2)
Hungary
Spain
S-Korea
Japan
Sudan
India (3)
Trinidad
Nigeria (4)
Philippines
Ghana
Uganda
Papua New Guinea
Mozambique
Lesotho
Australia (2)
Chile


SAS Sample sizes
(Total: 9350)
Norway 1483
India 1038
England 906
Nigeria 813
Iceland 647
Japan 531
Chile 410
Trinidad 317
Lesotho 312
Hungary 312
Mozambique 307
Sudan 300
Spain 280
Ghana 270
Korea 269
USA 265
Papua New Guinea 204
Philipines 201
Sweden 193
Uganda 176
Australia 116
0
200
400
600
800
1000
1200
1400
1600

Many researchers from other countries have shown an interest in the study and have used the questionnaire to collect national data. Some researchers have written national studies in their own language (Chile, Spain, Nigeria, India, USA, Iceland, Sweden, and Norway). A list of publications based on the SAS project is given in Appendix B.

Some people have used the SAS instrument in teacher training for raising awareness about curricular issues etc. Students in science education in many countries have used the national studies as a basis for dissertations and degree work. Two Norwegian studies have been published as Master thesis in science education. One is an analysis of Norwegian data, contrasting the significance of social background and gender (Myrland 1997). The other study is a comparison of factors that operate against participation and achievement of girls in science in developing countries (exemplified by Uganda) and in developed countries (exemplified by Norway) (Sinnes 1998). Results from the SAS study have been utilised in national discussions about curricular reforms in several countries.

The SAS data have not yet been fully analysed, but some Norwegian students use them in their Master studies in science education. The future of the project is uncertain, largely depending on the availability of funding. New data are still coming in, and the project is in principle still open for new participants, although support cannot be expected. The full questionnaire is reproduced in Appendix C. Other language versions are also available from this author. A diskette with a codebook in Excel and SPSS format for data entry is also available. There are plans to use the SAS project as a platform for further cross-cultural studies of science education in the future.

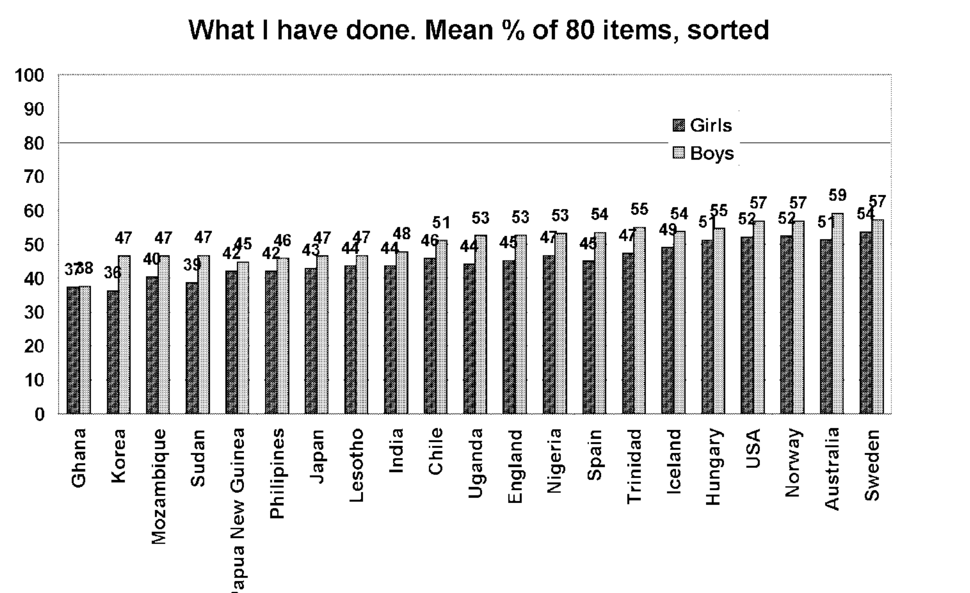
SAS: Some results and comments

Generalisability and uncertainty

As indicated before, the sampling could, for practical reasons, not follow strict rules. The quality of the sample varies from one country to another. In some countries, independent samples from different regions are pooled to make a national sample. The sample size from each country varies strongly, as can be seen in the graph above. These facts call for caution when one tries to draw conclusions. It also indicates that it is difficult to give measures of uncertainty and to judge the statistical significance of differences. In the following reporting, numbers are therefore reported without such statistical information. As a rule, only relatively large differences should be seen as educationally interesting. The observed similarity between countries with comparable cultural contexts lends credibility to the results. It will for instance become clear that there seems to be groupings of countries that come out as rather clustered on many items. (For instance the African countries and the Nordic countries.)

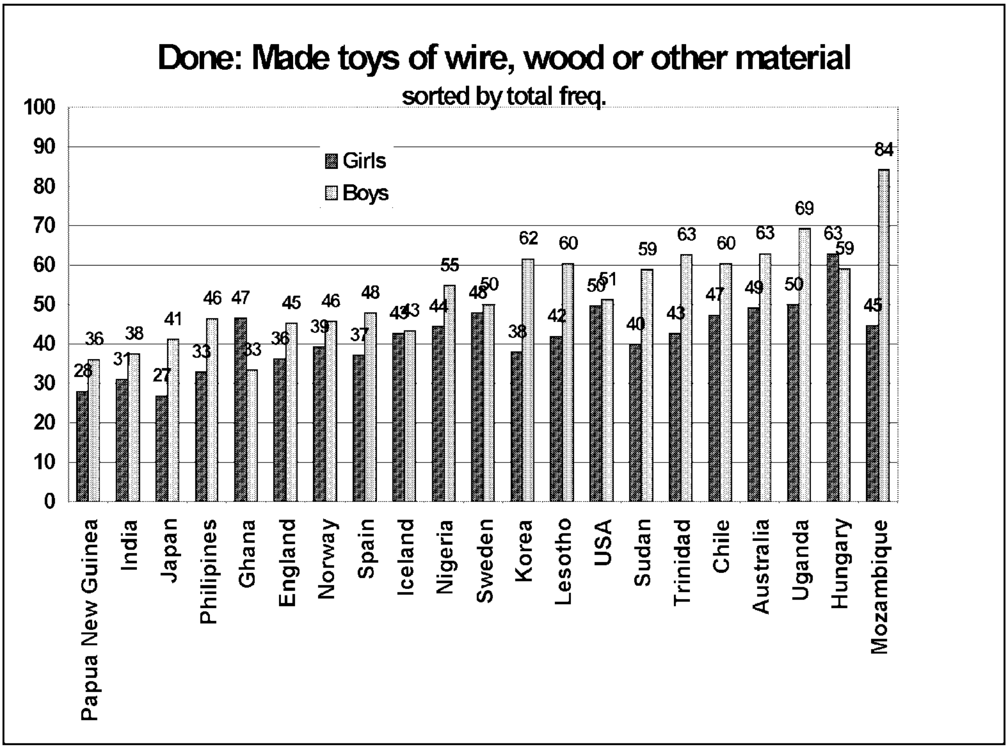
What I have done: Relevant experiences

For this item (Item 2) we tried to sample activities from a wide range of contexts that we found might be of value for learning science. We tried to balance relevant activities from different continents and cultures, and we tried to find activities that would be fair to girls as well as to boys. A test for the degree of success in this respect is to look the total picture that emerges from the data. We therefore made a composite score with the sum of all responses. The results are given in the graph below, country by country and separately for girls and boys.

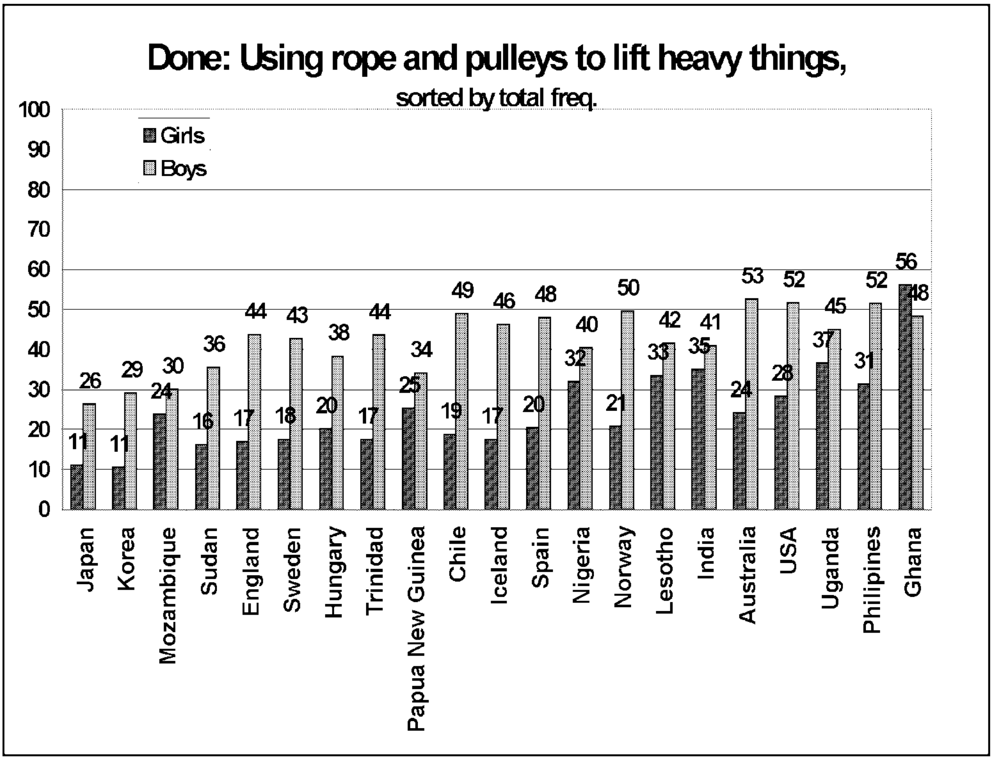


As we can see, all country means fall within a rather narrow range from 38% (Ghana) to 56 % (Sweden). Furthermore, there is no systematic difference between types of countries. Developing and developed countries come out with similar values and in a rather mixed order. For all countries, however, there is a difference in favour of the boys. The difference is, however, not very large, but may of course indicate that we have been better in sampling boys' activities. (Or possibly that boys' activities more often can be considered to have relevance for science learning.)

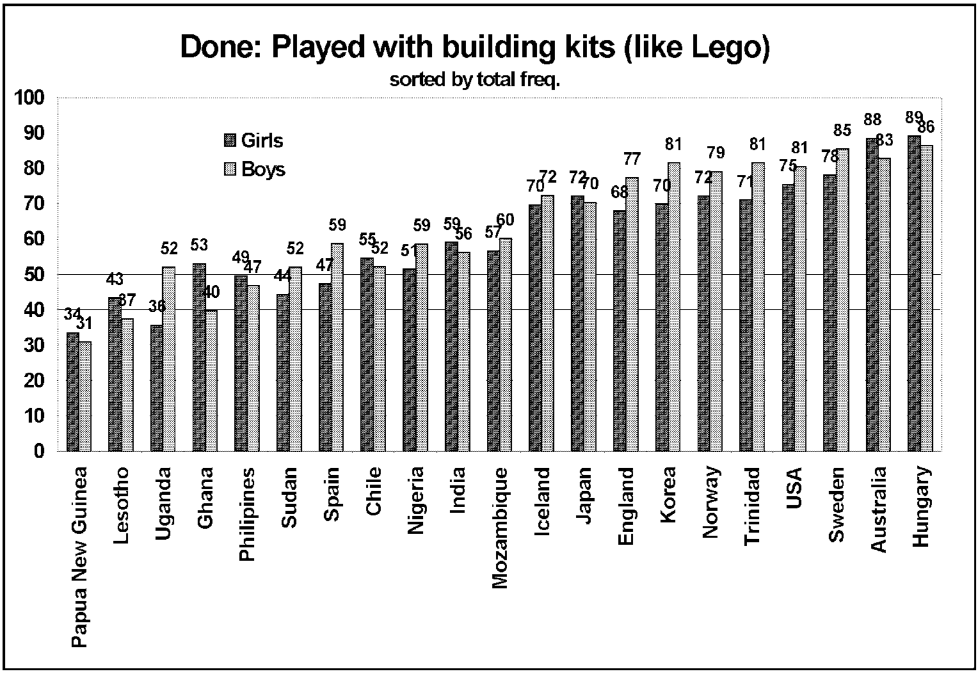
The background activities can be analysed separately or grouped in various ways. Here we present only some simple results. The data are given for girls and boys, and the countries are sorted according to the total frequency.



On this item, we have developing countries at both extremes. On the low end of the spectrum are some Asian countries. A possible explanation may be that in Africa, children (mainly boys) are in some countries extremely skilful in making toys out of metal wire. These skills and experiences may be an untapped resource for education in science and technology. We note that boys in most countries have more experience in this area. Girls, on the other hand, have a corresponding (and much stronger) domination on activities relating to the use of textiles (weaving, knitting, making clothes etc.)



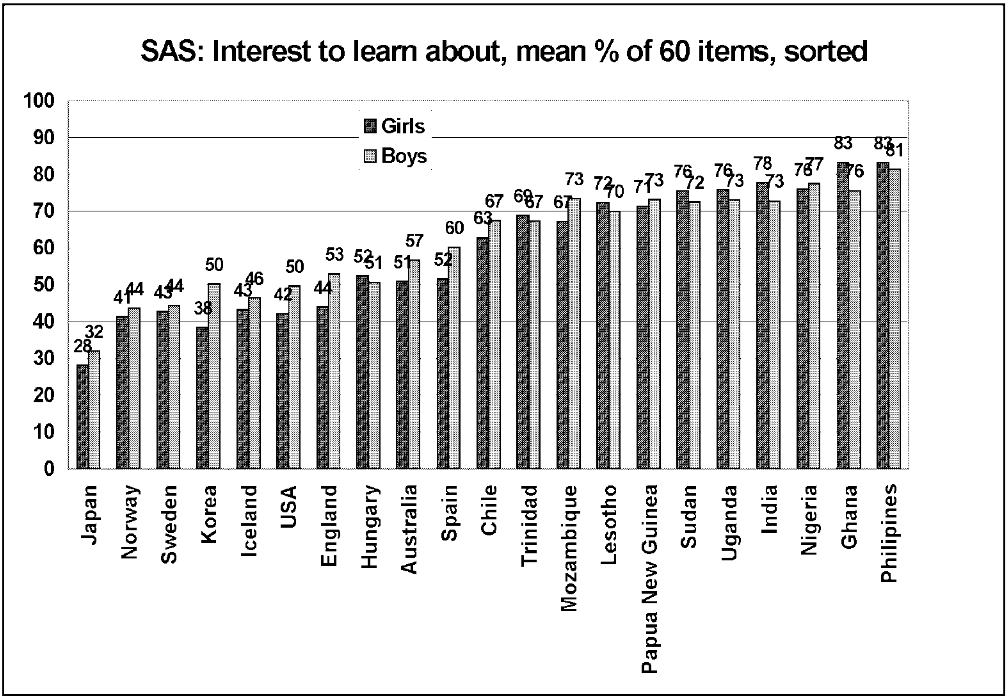
Activities like the one above (using ropes and pulleys to lift heavy things) are in effect very close to the curriculum contents in mechanics in most countries. It is to be expected that children with experiences like this have a great advantage in learning the principles of classical, simple mechanics. We note the extreme gender differences on this item in practically all countries. It also noteworthy to see that also this kind of experience is a kind of shared experience across countries (for boys). The same pattern is obvious in a range of similar activities. There is no doubt that boys have an experiential advantage in learning mechanics in most countries.



Several types of skills are involved in playing with different sorts of building kits. Development of manipulative skills is an obvious one, probably also the ability to follow detailed instructions with patience and concentration. Such skills are important in at least some practical laboratory situation in science. The percentages on this item vary from country, the mean ranging from less than 40% to nearly 90%. The highest averages are in general found in the more developed countries. This is in not surprising, since such kits are by definition sold in shops. We also note that countries like Korea and Japan come out rather high on this activity, a contrast to the very low response to the two previous topics. (Maybe because these are typical outdoor or rural activities?)
An interesting aspect with this topic is that it is rather gender neutral in practically all countries.

Things to learn about: The overall picture

Item 3 consists of a list of 60 possible topics to learn about. Pupils simply tick the ones they like to learn about. These items have been assembled to show different ways of approaching science content, keeping in mind different cultures as well as possible gender differences. These items may be presented one by one or grouped in a variety of ways. As a start, we may look at the overall picture. Also for this item, we made a composite score. The results are given below, sorted by the total frequency.



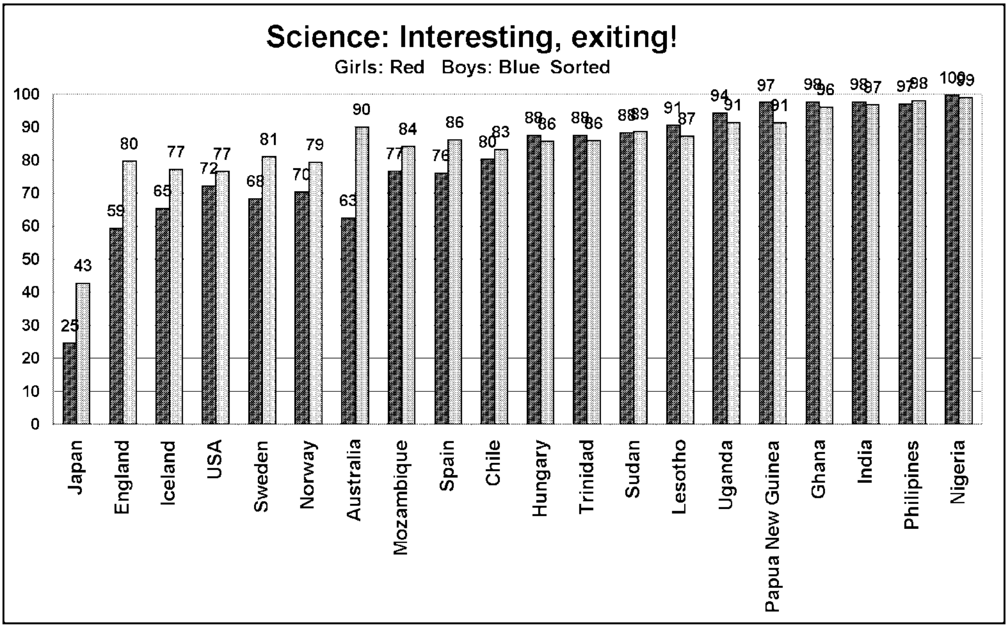
As can be seen, the variation on this sum is much larger than on the question about experiences. Country means range from only 30 % (Japan) to more than 80 % for several countries.

We note an interesting grouping of countries. Children in rather rich countries indicate a low or moderate interest in learning science topics, with the Nordic countries Norway, Sweden and Iceland among the lowest – but considerably higher than Japan! Children in developing countries, on the other hand, appear to be interested in a very high proportion of the science items on the list.

The gender differences on the total are not large in any country, with Korea as an exception. But there seems to be an interesting pattern: In most of the developed countries, the difference is "in favour" of boys, while the difference in most developing countries is in favour of girls.

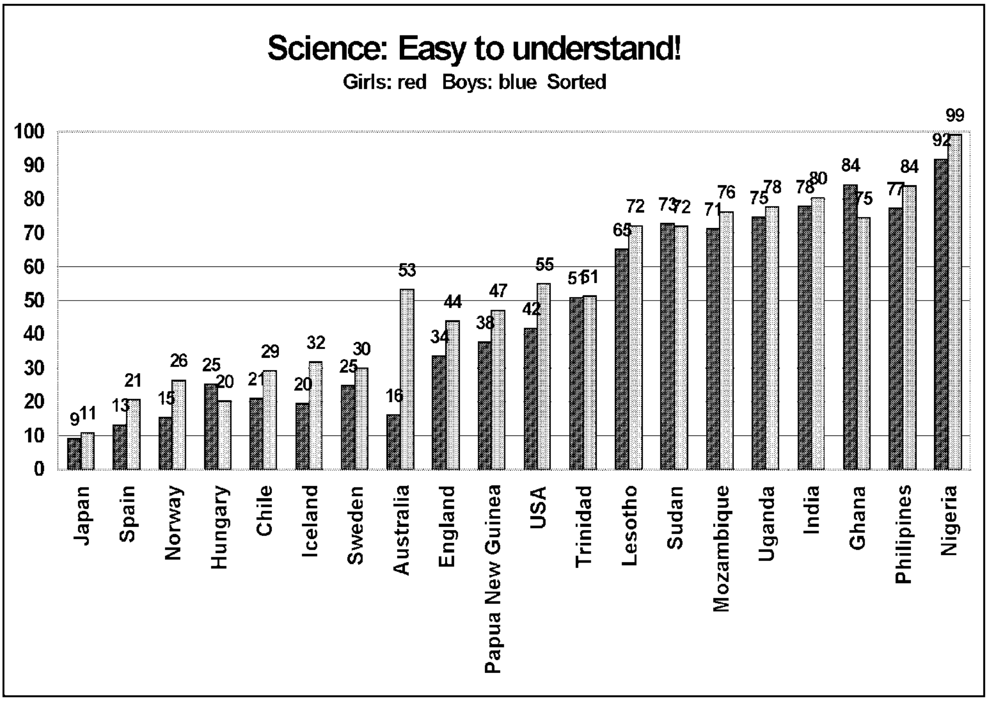
A tentative explanation for these observations may run like this: In developing countries, education is a "luxury" and a privilege, a resource that only a few children have access to. The motivation to learn and to study is high for both girls and boys. But, since the access to education is often denied the girls, for them education and learning may be perceived as being a luxury. Hence, they may indicate an eagerness to want to learn about most things on our list!

The overall picture given above may be supplemented by responses on item 5. For the questions "Science is: Interesting, exiting?" We get the following results:



This item reinforces the impression that Japanese pupils indicate a remarkable low interest in science, in particular the girls. In fact, the Japanese girls' response to this item (25 %) is much less than the half of any other group in the study! Similarly, the Japanese boys' response is also less than the boys' response in any other country.

It is interesting to note that also on this item, the average responses for children in most rich countries is considerably lower than the interest expressed by children in developing countries. We also note the same gender profile as above: In developed countries, the boys' responses are much higher than the girls', while the opposite pattern (to a weaker degree) is the case in developing countries. The explanation for these differences may be same as suggested above.

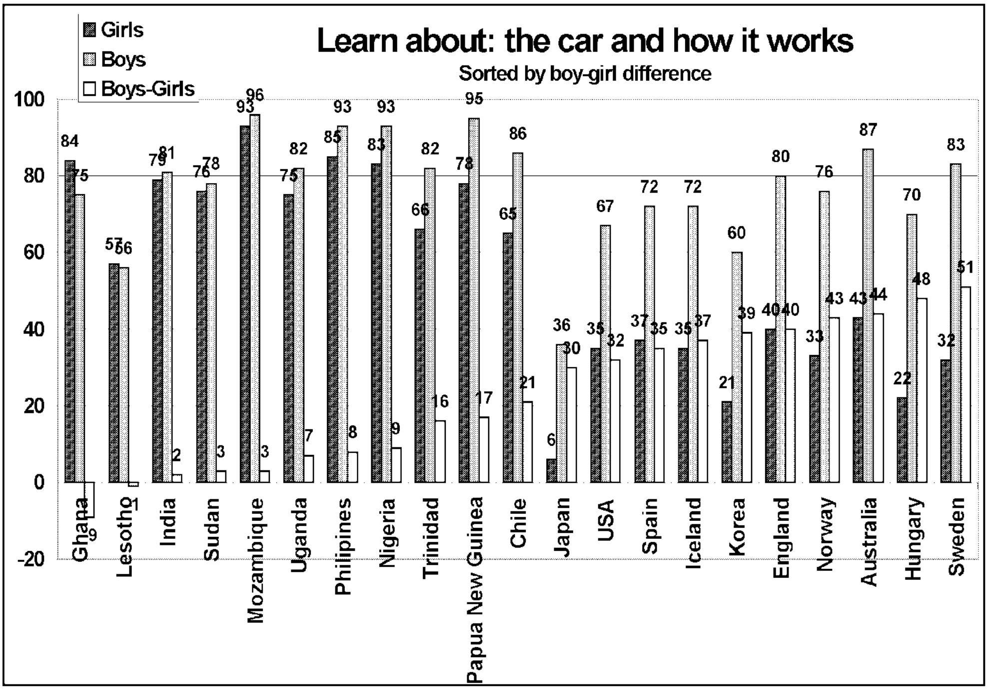


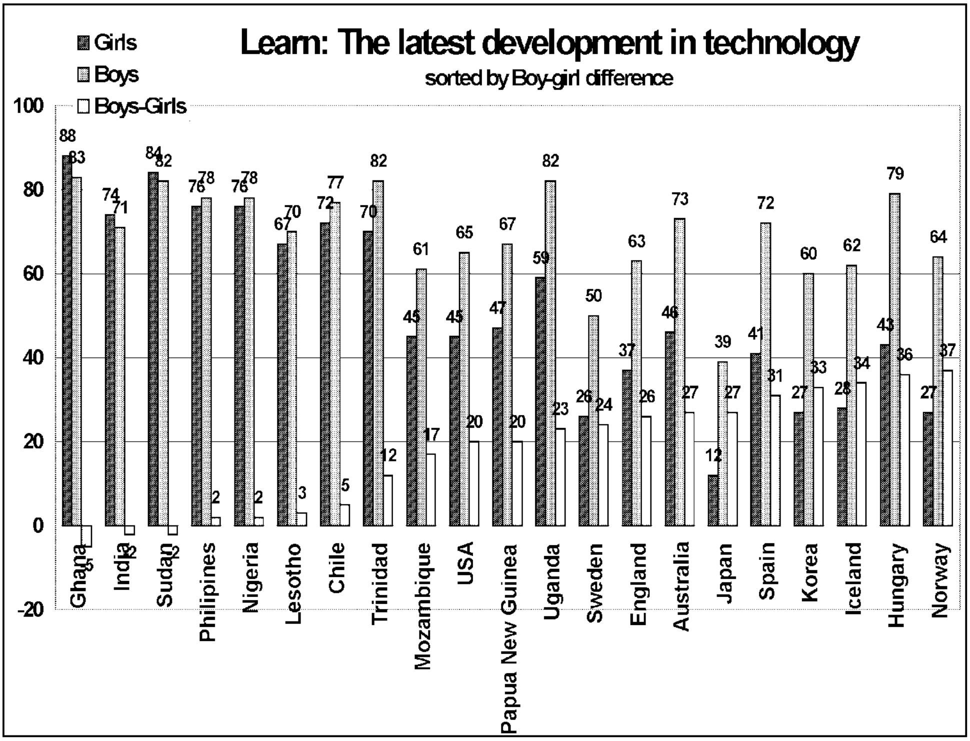
The response to this question (from item 5) shows that only 10 % of Japanese children find science easy to understand. This response is interesting in the light of the fact that Japanese children usually come out on the top in international comparisons on science achievement. A short discussion of the "Japanese paradox" is given later in the paper. We also note that in most rich countries, children do not find science to be very easy, and that girls in particular seem not to find it easy. Again we have rather high scores from most developing countries; the children indicate that they find science easy to learn. It is hard to judge whether this is a realistic assessment of their own learning, or whether it is a reflection of their positive attitude towards learning science.

Interesting topics – some examples

The simplest level of reporting is to provide data for girls and boys from each country. Below is a selection of graphs of such data. They are all sorted by the arithmetic difference between boys' and girls' score. It is important to keep in mind that we have chosen the *arithmetic* difference as our "criterion" for gender stereotyping. This means that countries with small numbers (like Japan) for both genders will produce low differences. If we had chosen the *ratio* between the responses of boys and girls as the criterion, the results would look very different: Japan and Korea would come out as the most gender stereotyped countries in the children's responses for most items. This should be kept in mind when looking at the data.

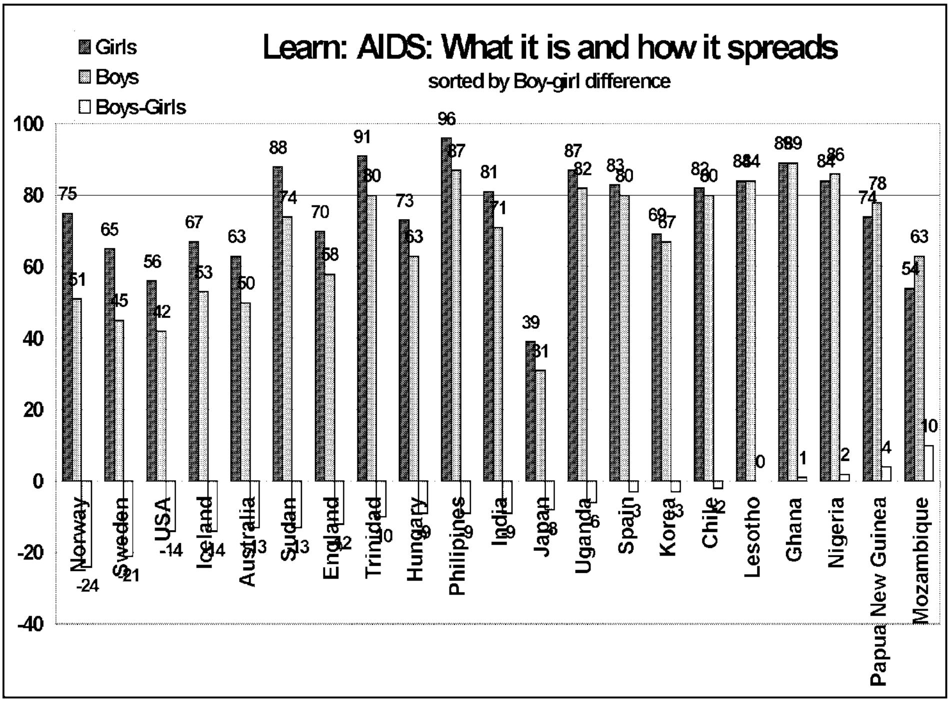
The first ones are topics we find to more popular with boys, then some more neutral and finally some topics that seem to be more popular among girls.

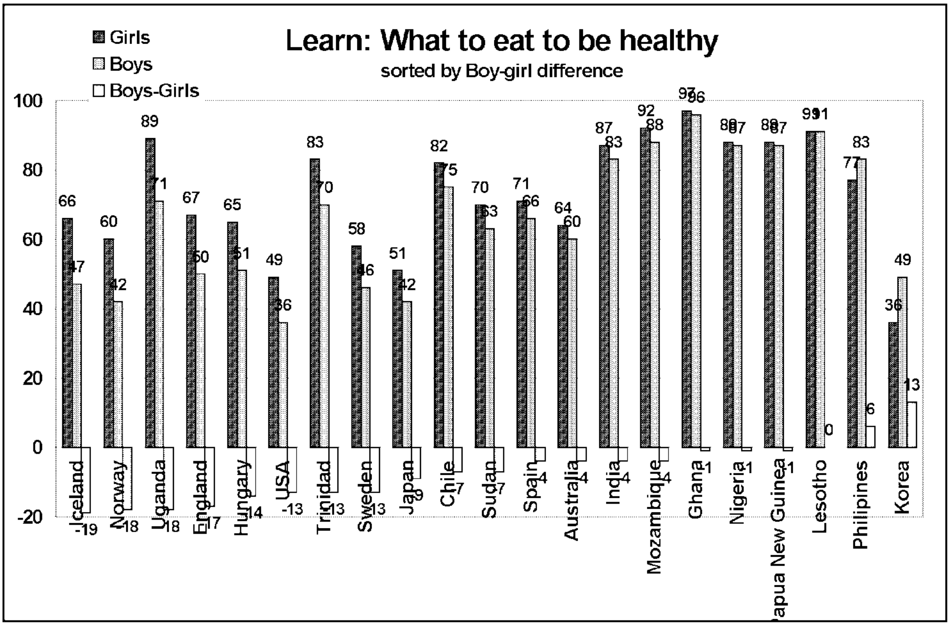




These topics are both related to modern technology. We note the extreme male dominance on both these topics. The same pattern is found on a series of similar topics. We also notice that the interest among Japanese children for such topics is extremely low, compared to all other countries. As mentioned, if the ratio had been chosen as the criterion, Japan would come out as the most extreme (for each girl wanting to learn about the car, there are 6 boys). We also note that the gender difference for these items is very high in the Nordic countries. (In this case Sweden, Norway and Iceland). We shall see that this is a general pattern, and will return to this towards the end of the paper.

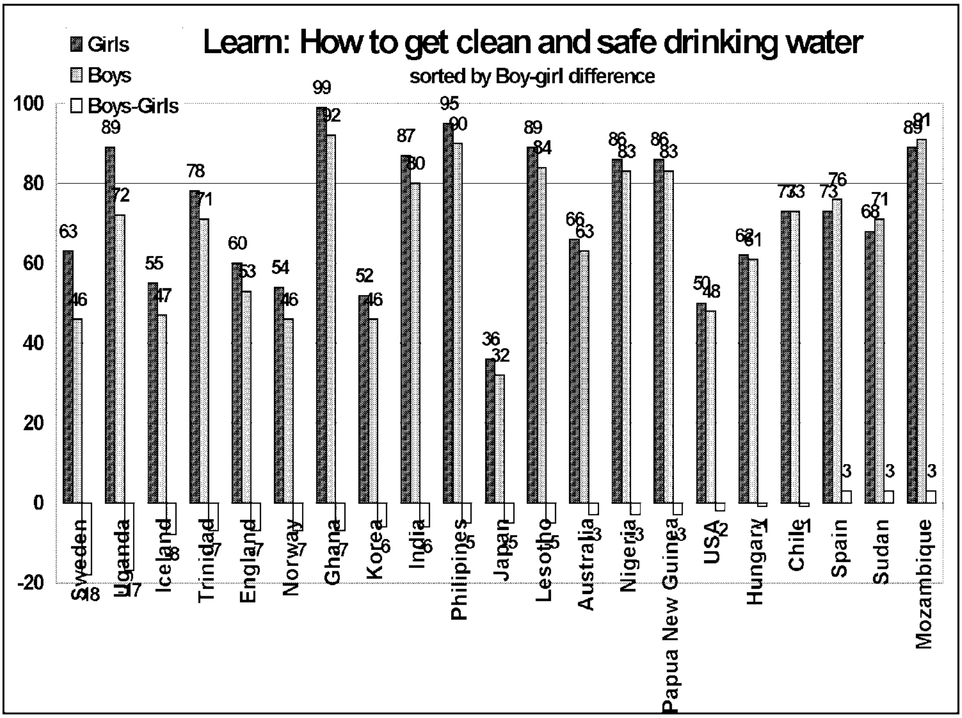
The following graphs are oriented towards human biology, and as we shall see, reveal a rather different pattern of responses.

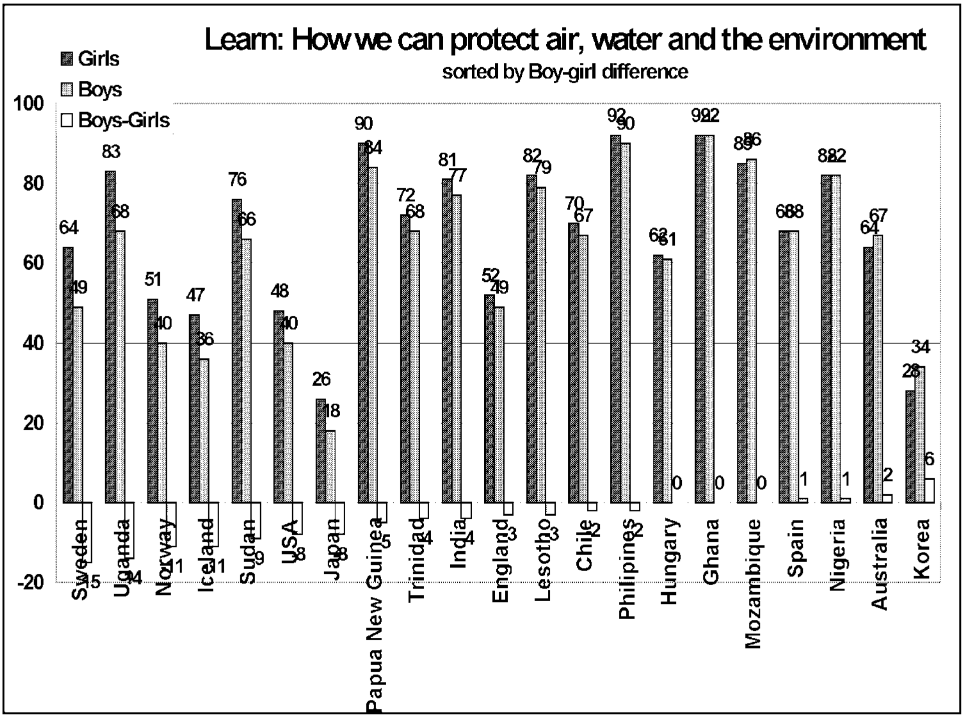




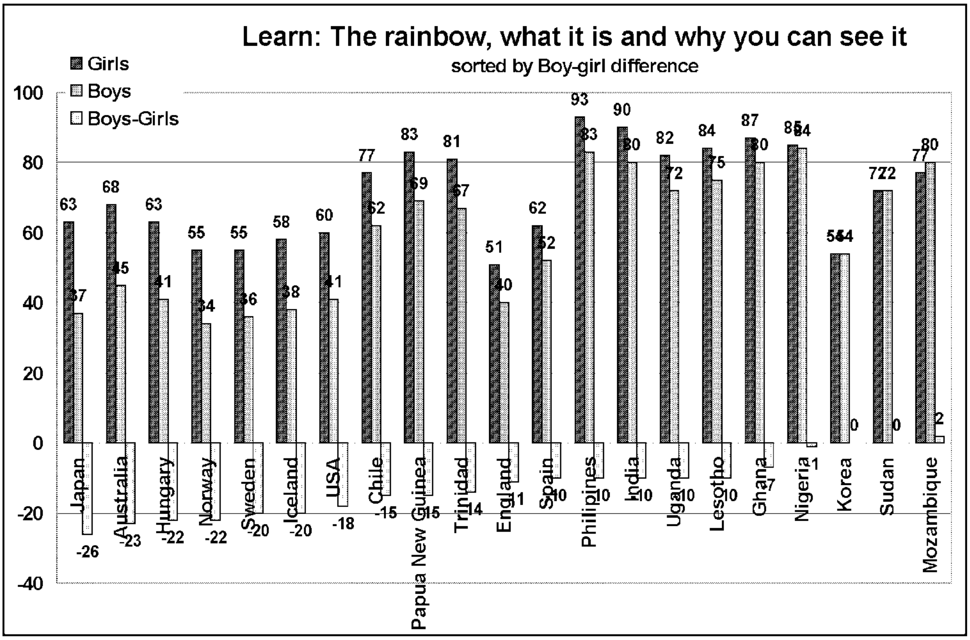
For both these items, the overall interest is (not unexpectedly) much higher in developing countries. These countries also have rather small gender differences. In most developed countries, these topics come out as girls' interests. Again, we find that Nordic countries are among the rather extreme concerning gender differences.

The next two graphs are related to the environment and its protection

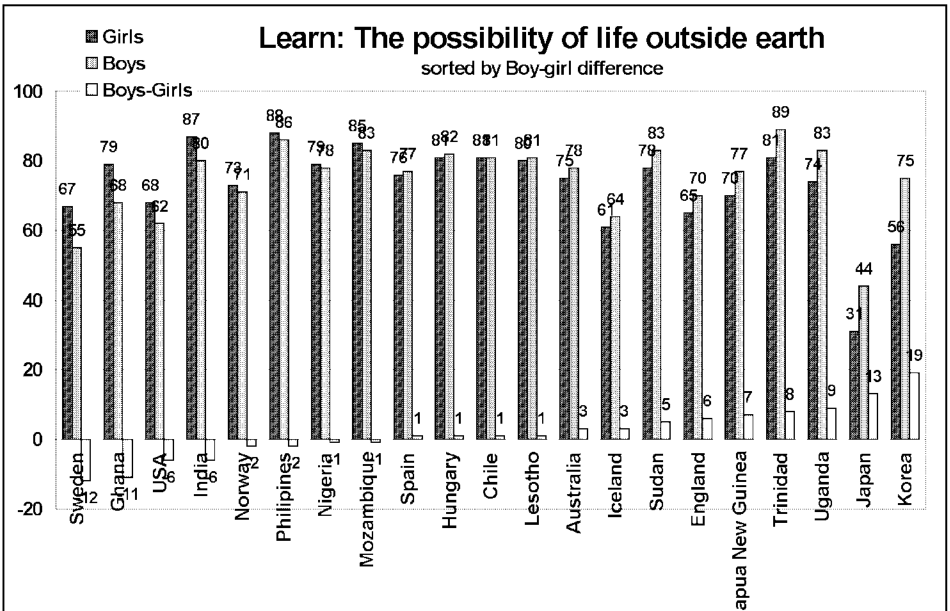




The pattern is similar to the above examples from human biology: High and rather gender-neutral responses from children in developing countries. The interest from children in developed countries is much lower, and with a clear gender profile. Again, the Nordic countries come out as rather extreme in terms of gender difference, somewhat disappointing both in terms of gender equity and environmental concerns, both being top priority areas in these countries, in politics as well as in education!

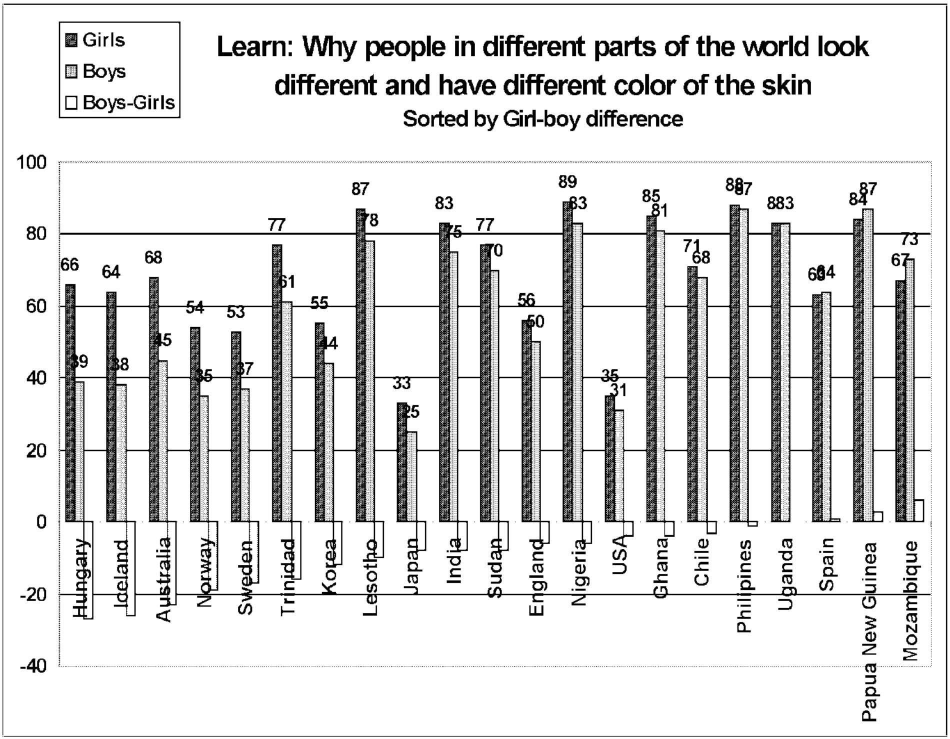


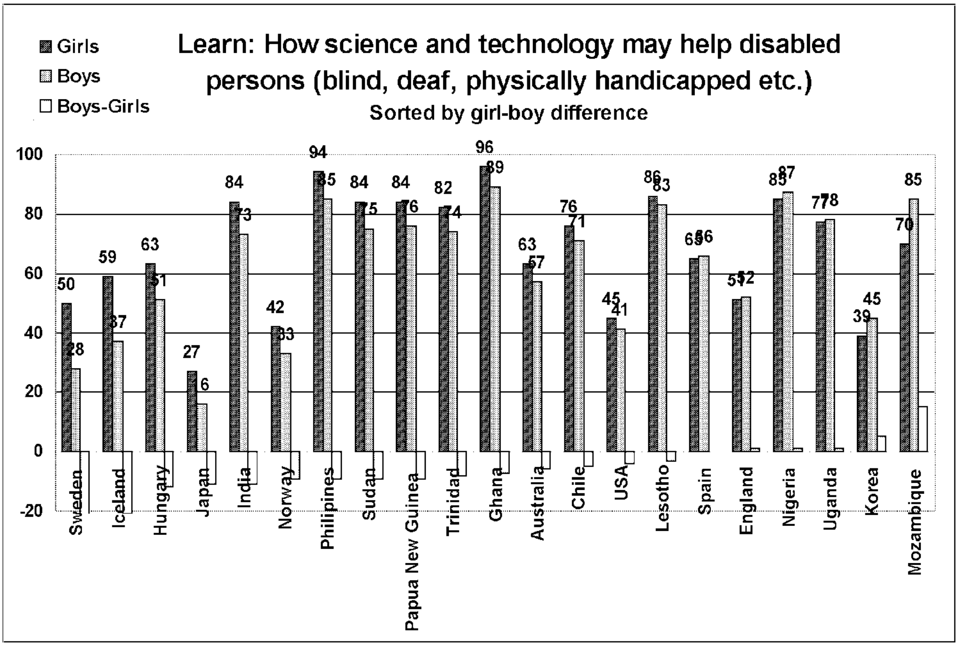
This item can be seen as an example of optics, but it also has an element of aesthetics, possibly also fantasy and wonder. We see that the responses are very gendered: This is a prime example of "girls' interest", although the score is also rather high for boys! The response is noteworthy high (but gendered) for Japan, at least when compared to the Japanese responses to most items relating to "pure" science, and in particular to modern technology.



This item can be seen as belonging to "proper science", but it also has an element of speculation, uncertainty and science fiction that is seldom found in science curricula. In fact, this particular topic seems to be the most popular of all the 60 topics in this study. It is also noteworthy to see that it is popular among girls as well as boys in all nations. The response from Japan is not overwhelmingly high –but actually much higher than on most other topics.

The next two topics put science in two different social and cultural contexts. The first may be an approach to use science to promote respect for other races, the other may show how science and technology may be put in the service of groups of people who are in need. In most countries, these contexts seem to appeal more to girls than to boys – a pattern that is not unexpected in the light of other data from this study.





Things to learn about: further analysis

The wealth of information in the SAS-material may be used in many different ways. Here is an indication of how one may go a little beyond the mere data. The examples show how we have used the data in the national context of Norway.

Two aspects of equity: social class and gender

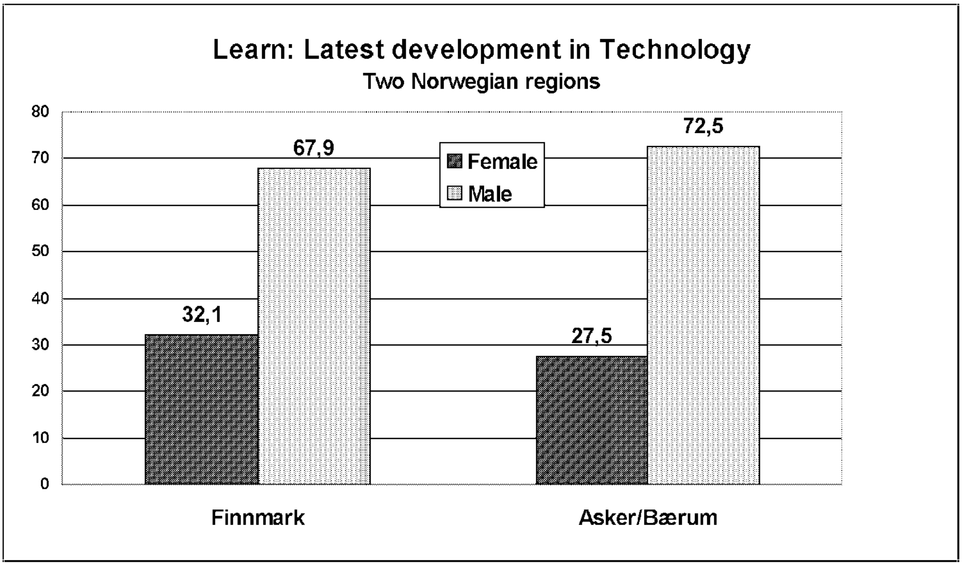
A dominating political and educational concern in Norway, as in other Scandinavian countries, is *gender* equity. Another key concern is equity based on geographical background or *social class*, two concerns that often coincide. (The concern about *cultural* equity has only recently become a concern, since Norway until recently has been a country with a rather small proportion of the population coming from other cultures. This picture is, however, rapidly changing.)

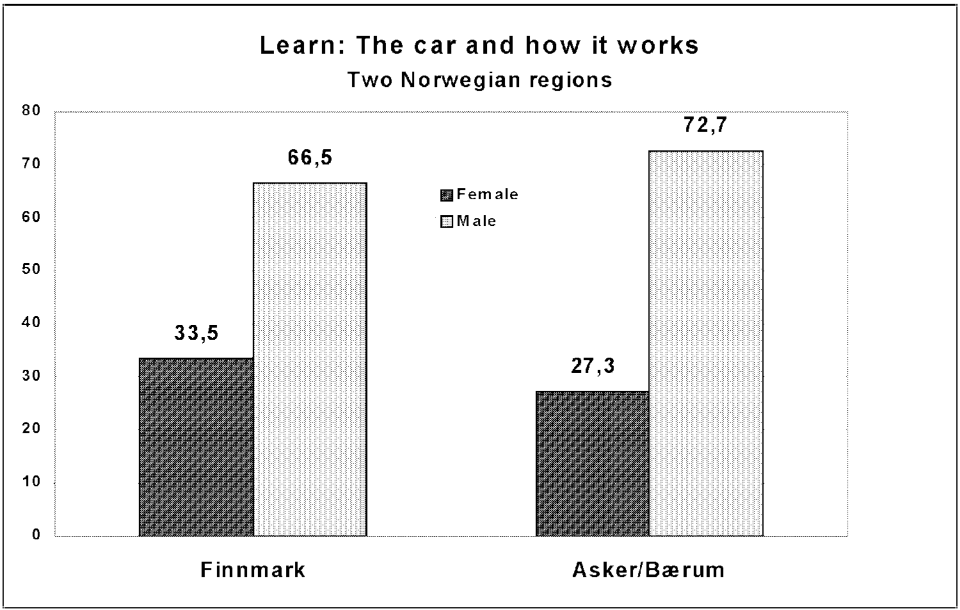
There is a national concern to make curricula that are fair to the various concerns mentioned above. In particular, there is a strong concern for a *local* curriculum, and for a *gender fair* curriculum. (In science this means for a curriculum that does not favour boys). Concerns about class and gender equity may in practice be in conflict with each other, and they also have different interest groups promoting them. We can use the Norwegian SAS-data to shed light on at least some aspects of this issue.

In the Norwegian study, we therefore sampled pupils from two very different sub-populations: One population was the pupils in the richest part of the country, the rich suburbs Asker and Bærum of the capital, Oslo. The other area was the county of Finnmark in the extreme north. In most respects, these two parts of the country are extremes on most statistical indicators, like education level, income, occupational pattern etc. (Personal income as well as personal capital is more the double in the South.) Also geographically they represent extremes. The first region is urban and with a population density about 500 per sq. km, Finnmark is very rural and with a population density of less than 2 inhabitants per sq. km. The climate in the South is comfortable, with moderate winters and mild summers, lots of sunshine, and seldom any extremes like storms etc. The climate in the North is extremely harsh, including a long winter with permanent darkness and temperatures down to – 40 degrees Celsius (The lowest recorded is about –51 degrees)

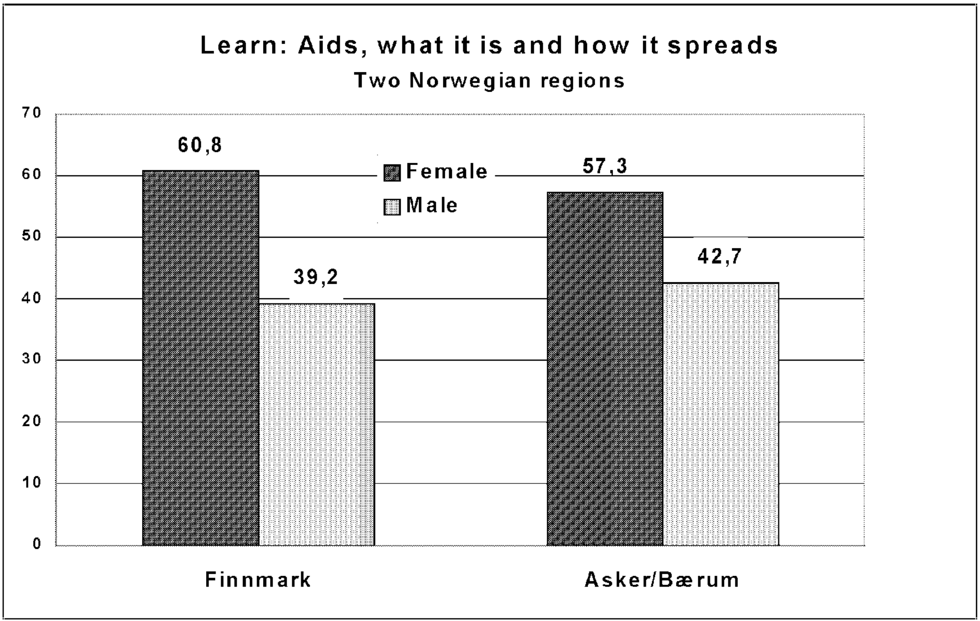
Growing up in these two places represents extremes in a Norwegian context. One might expect that children in these areas would get very different life experiences, hopes and aspirations. It is also to be expected that they may demonstrate very different interest profiles when it comes to learning science. We wanted to shed light on the relative importance of the geographical (i.e. in part the social) and the gender aspect for the discussion of the science curriculum.

We therefore analysed the data on pupils' interests from these two perspectives (Myrland 1997). The total sample of pupils (N = 1 483) was divided in four groups: Girls and boys in the south, and girls and boys in the north. Details are not given here, only an indication of the rather surprising result: Gender is more important than the geographical (and hence social) background. Let us illustrate this point with some results from item 3, "Learn about". The first two graphs are typical "boys' interests":





These are, as indicated earlier, boys' interests, and we recognize the pattern discussed earlier. Finnmark as well as Asker/Bærum follows the overall, strongly gendered pattern. For both items, however, we see that the children in the rich and more educated region of Asker/Bærum are *more* gender stereotyped than in the much poorer Finnmark. Let us now turn to some typical girls' interests of the type that we have identified earlier.



In general, we were surprised by the results. Although there were some differences between pupils in the south and north, these differences are very small compared to the differences between girls and boys. We also noted that on many items, the children in the relatively poorer and less educated area of Finnmark were more 'advanced' with respect to gender equity than the much wealthier Asker/Bærum region. On the particular topics as well as on different aggregates of data, this was the overall pattern.

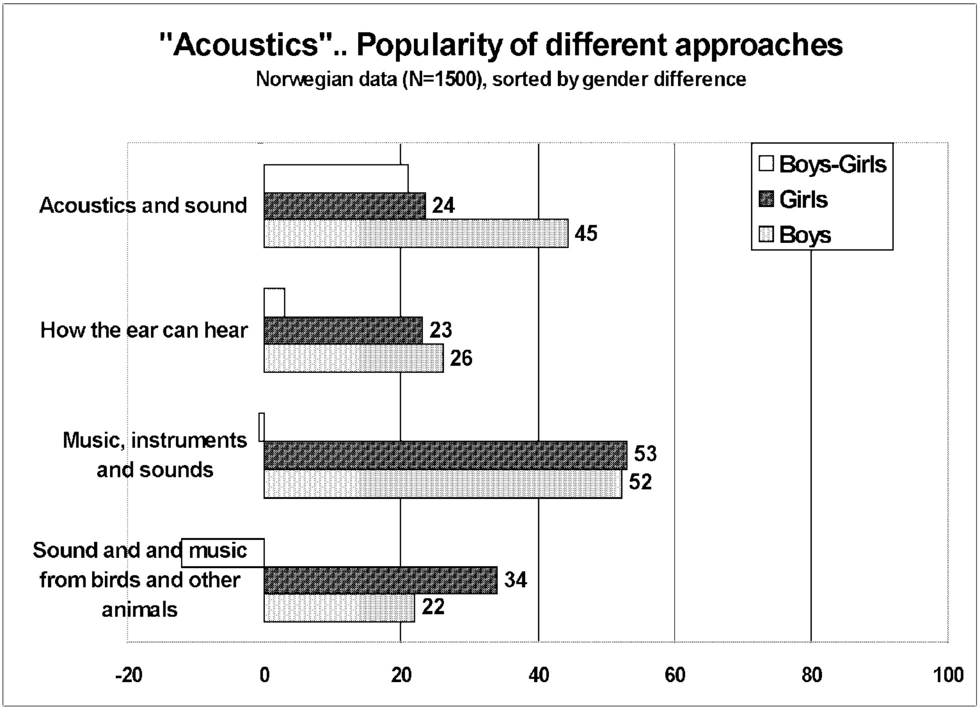
When it comes to the interests in science topics, it seems that "girls are girls" and "boys are boys" – rather independent of their backgrounds. And stereotypes do not seem to decrease with wealth and education, most often it seems to be the contrary.

This result is a strong indication that a debate over equity in the science curriculum should focus more on the gender differences and less on other aspects. It is of course important not to over-generalize from this conclusion; the results are from Norway and they relate to science contents only!

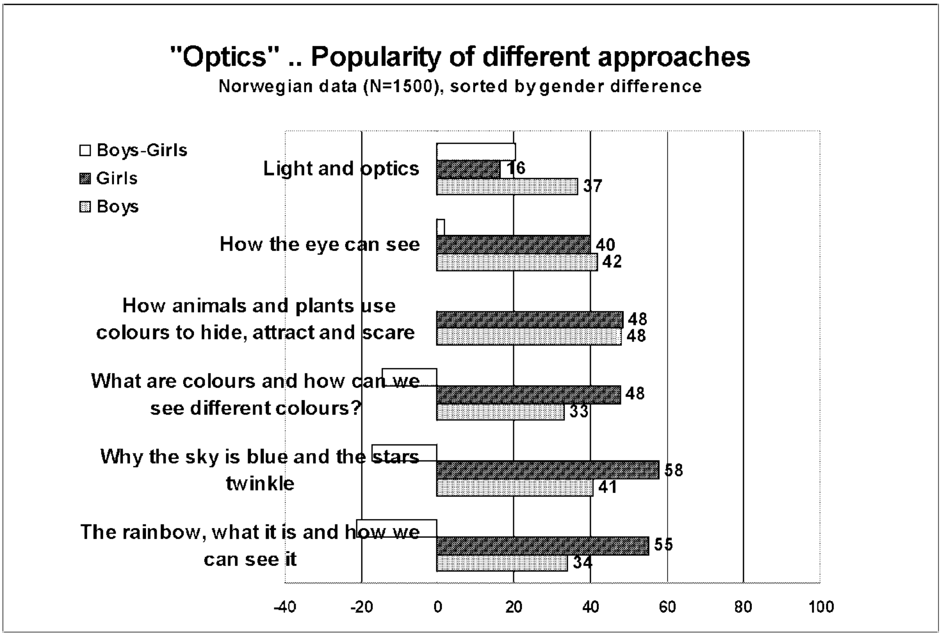
Same science different approaches

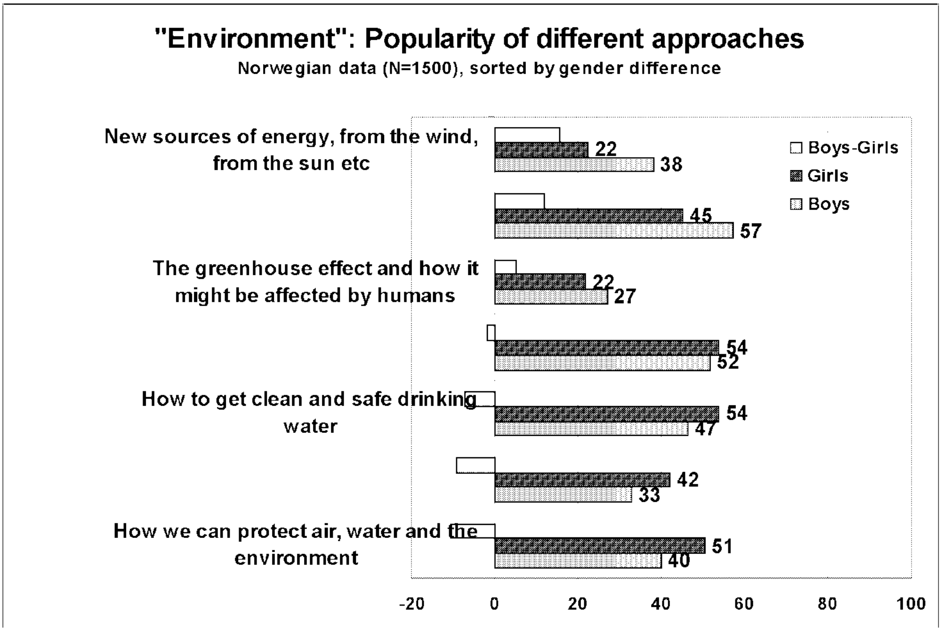
Let us take the gender perspective a step forward. It is evident from the data presented above that there are some dramatic differences between the interests of girls and boys. It may even seem that one might conclude that biology is a girls' subject, physics is a boys' subject. Such a conclusion is not very productive, and it will certainly not help us in making all sorts of science knowledge attractive to all sorts of learners. Below is a possible way to approach the concern about a more gender fair curriculum.

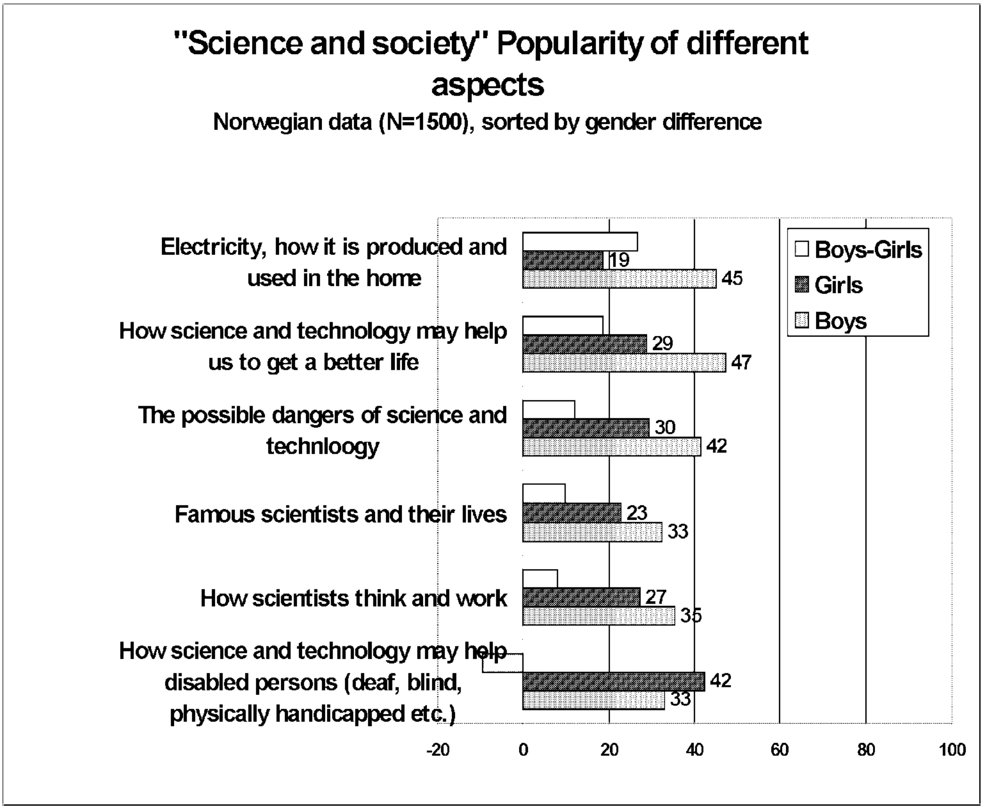
In the list of possible topics to learn about, "the same " science content is put in different contexts. A topic like "acoustics" may be approached in different ways in a school setting. Possible topics may be: "Acoustics and sound", "How the ear can hear", "Music, instruments and sounds", "Sound and music from birds and other animals". Below is graph that shows the popularity of these topics among Norwegian pupils. The results are sorted by the difference between girls and boys. As we can see, the first topic come out as "male", the last as "female", with the in the middle as rather gender neutral.



In the following three graphs, a similar approach is used for topics that may be classified as "optics", "environment" and some aspects of "science and society". The important point is that a change in context may change the "gender profile" of the science content.







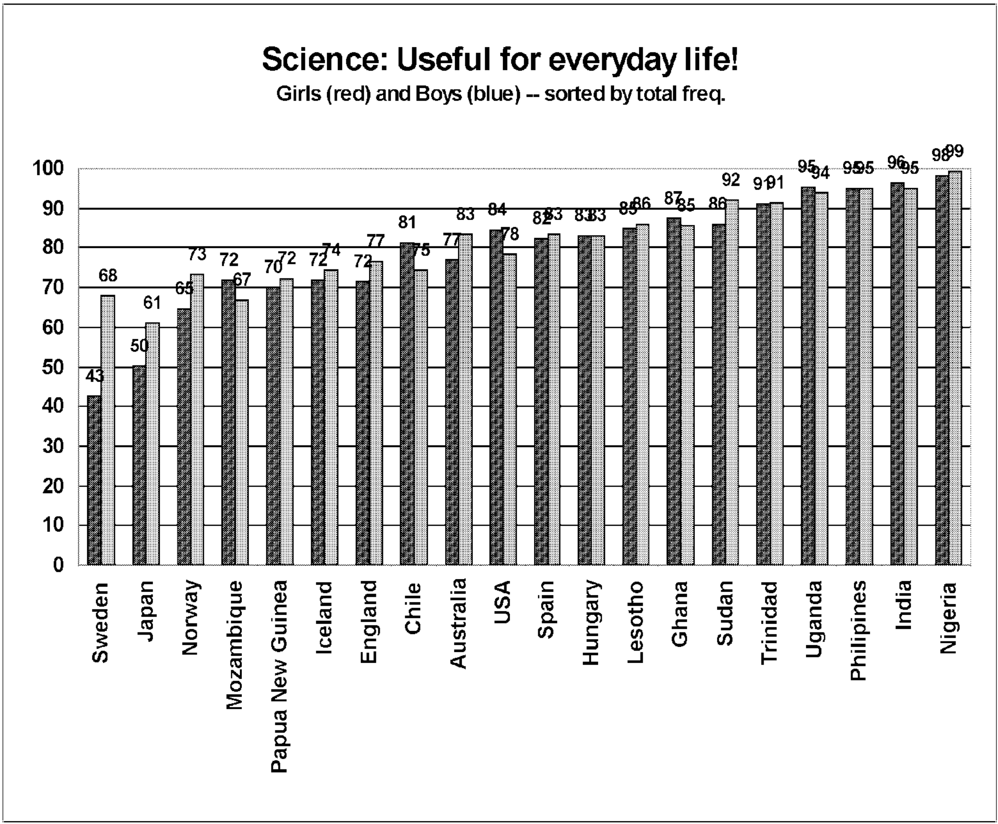
Several comments can be made to such data (of which only examples are given above): For all these science areas, we see that the "popularity" varies strongly with the context indicated, for girls as well as for boys. The contexts seem to appeal more to girls when they may be related to life (human or animal), aesthetics and personal experiences. Aspects that relate to earth science are also popular among the girls. This picture is, however, not always clear-cut and simple: In the examples classified as "Science and society" in the illustration above, we note that several topics with a "human touch" are in fact more popular among the boys than among girls. ("How science and technology may help us to get a better life", "The possible dangers of science and technology" and "Famous scientists and their lives".) Only for the last item, the girls are in majority: "How science and technology may help disabled persons (deaf, blind, physically handicapped et.)

The general trend in the results given above is not very surprising. They support general statements about the interest profiles of girls and boys in very many countries. The advantage of this study is, however, that the data are concrete and take us beyond the general statements. In this way, they may actually be productively used in debates about the curriculum. Or they may be communicated to textbook authors, who in most countries have some freedom in choosing different approaches, even within a given national curriculum. Results like the ones presented may of course be of value for student teachers or practising teachers. Data may sensitise them to the fact that children can be rather different, and that they, as teachers have different options and possibilities in their teaching of science concepts and ideas. If student teachers get involved in collecting data themselves, the ownership may of course be much stronger.

Perceptions of science: "Science is ..."

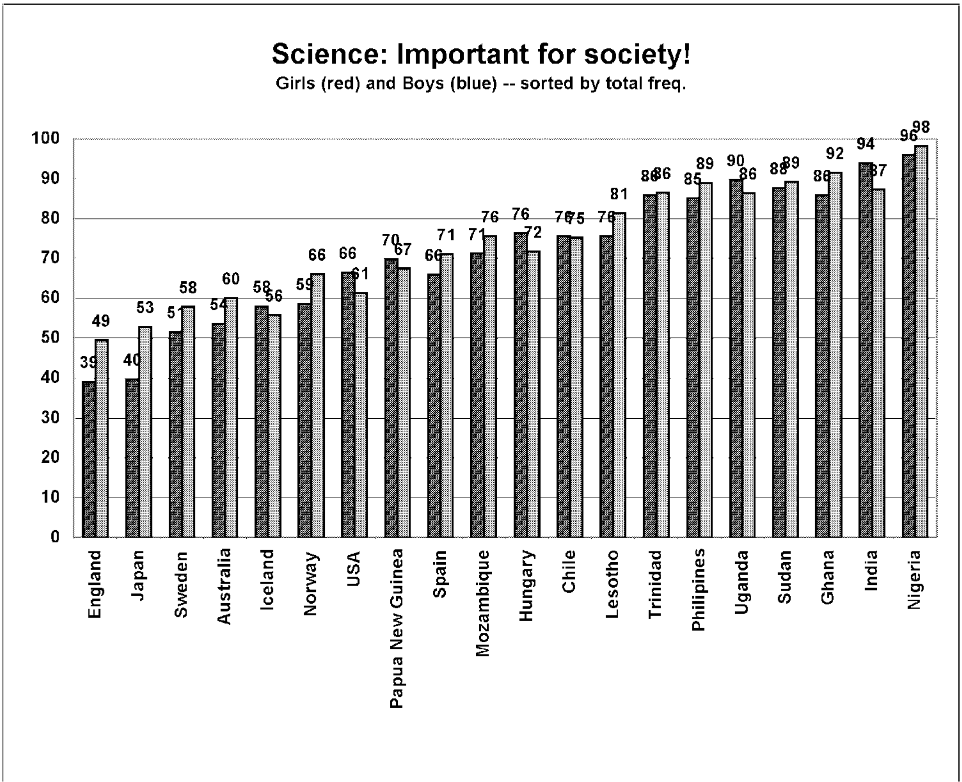
Item 5 consisted of a list of expressions or key words, and the pupils were asked to tick the ones they associated with science. Some results (for "Interesting, exciting!" and "Easy to understand!" have been given earlier. Here follows some more, in the same format, sorted by the total frequency for the countries, and with data given for girls and boys separately.

Let us first look at two aspects of the perceived "relevance" or usefulness of science. The first considers the individual level:



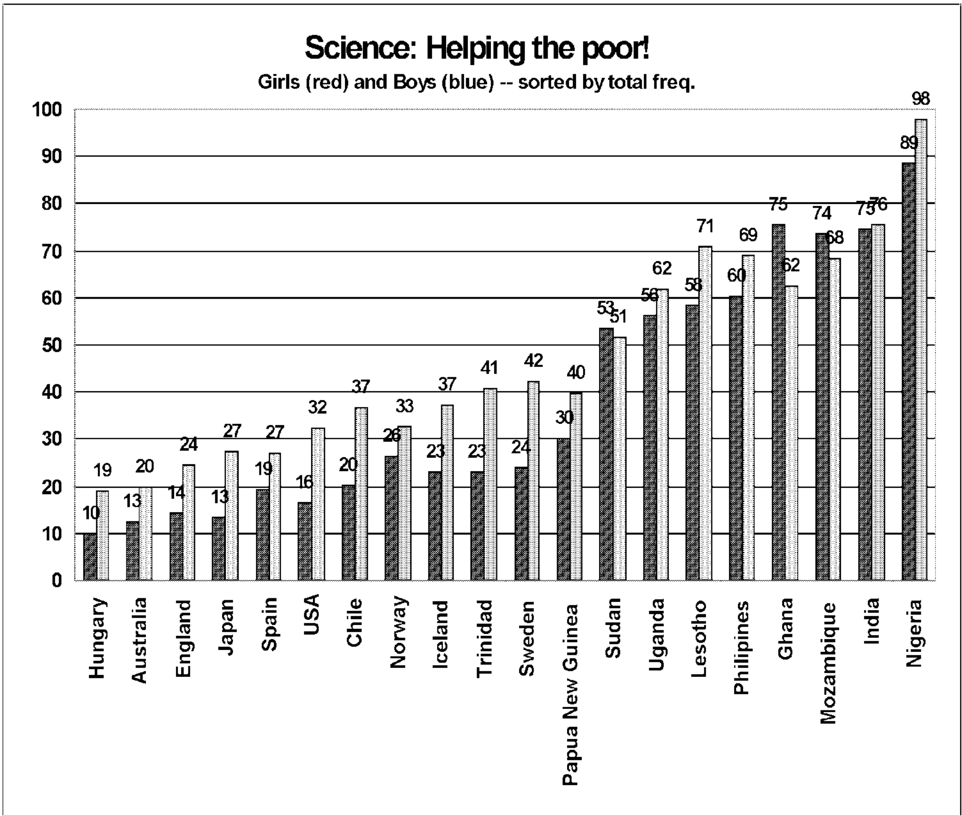
Although there are exceptions, the general pattern is that children It is noteworthy that the children in Sweden, Japan and Norway are the countries where the children consider science to be of least importance to everyday life. These countries also show the greatest gender difference. Of all groups, the girls in these countries are the groups that consider science least useful for everyday life.

The other aspect of importance or relevance is the societal level. The responses are shown on the following graph.



The overall pattern is as on the previous graph. Children in developing countries consider science to be of high importance to society. Gender differences are in general rather small. It is interesting to note that children in the most industrialized countries, which depend so much on science and technology, do *not* consider science to be of very high importance for society.

The last aspect concerns the "social profile" of science, whether or not it is seen to operate in the interest of the poor.



Here the division of countries is very clear. Children in the developing countries rate science very high on this dimension, while children in the richer countries to a rather small degree associate "science" with the notion of "helping the poor". In fact, the frequencies for these countries are amazingly low on this aspect. The gendered nature of the responses is also noteworthy, especially for the rich countries. In most developed countries, less than about 20% of the girls think of science as "Helping the poor!" while the number for boys is often close to the double!

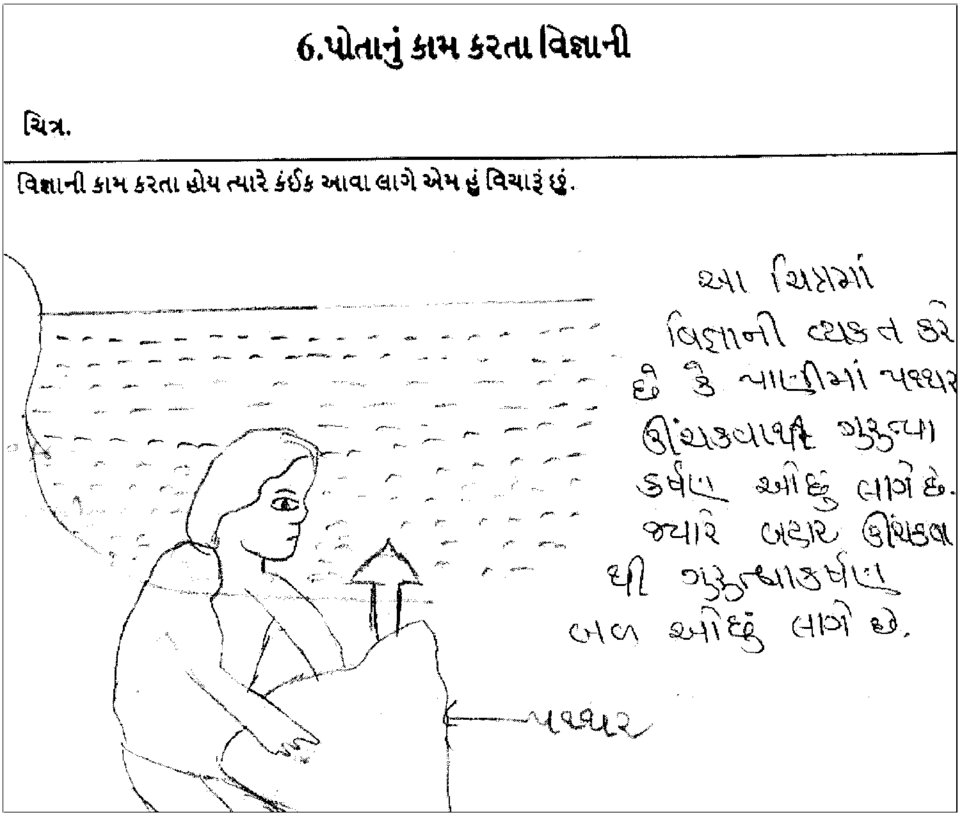
This is not the place to judge whether or not the girls' perception of science is "correct" or not. Findings like these may, however, be part of the explanation for why so few girls in the developed world choose science education or careers. Such findings give reason to critically examine examples and curricular contents in school science.

Drawing and writing about science and scientists

As can be seen from the description of coding etc., the organizers (in Oslo) now have available the drawings and writings from the 9350 participating pupils. These have not yet been fully coded or analysed.

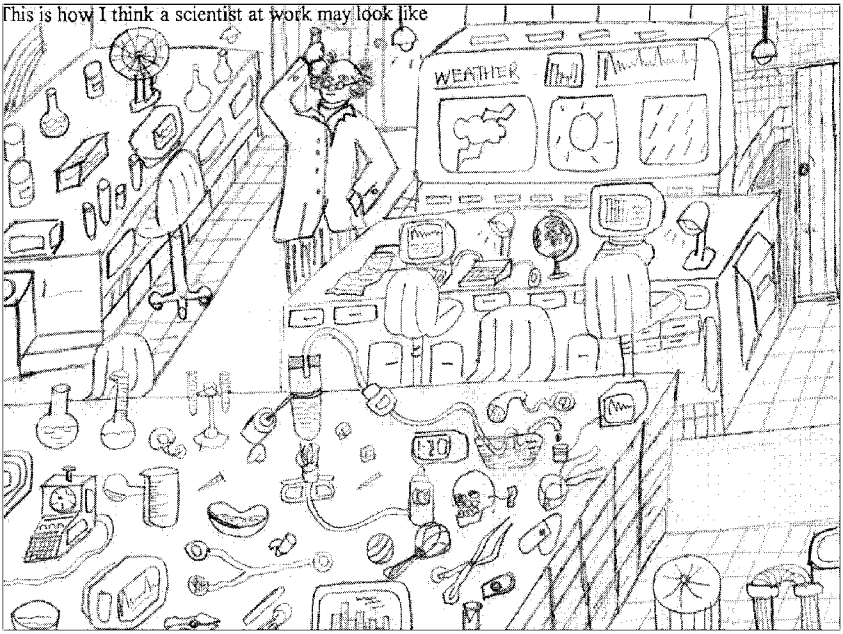
The last two items do not lend themselves to straightforward coding. In item 6, the pupils make drawings of scientists at work and they complement this by some writing about what they think they do. In item 7 they are free to write about what they would like to do themselves, if they were scientists. Since responses have been made in many different languages, the project as such has not been able to code and interpret this material in a thorough way. Some national studies have, however, been published in different languages.

An example of the exotic nature of these data (and the difficulty in interpretation by the Norwegian researcher) is given here: The drawing below is made by a girl in the state of Gujarat in India.

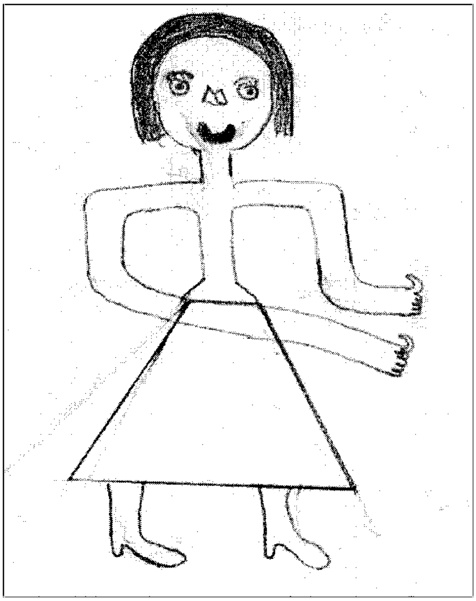


Drawing of a scientist by a girl from the state of Gujarat, India

One is also struck by the great difference in the quality of drawings. Two extremes are given below to indicate the degree of variation. These also seems to be "systematic" variations. Children from some countries or regions seem to be much more confident and able in making drawings and using these as a means of expression. It falls beyond the scope of this report (and the qualifications of this author) to in detail on this issue.



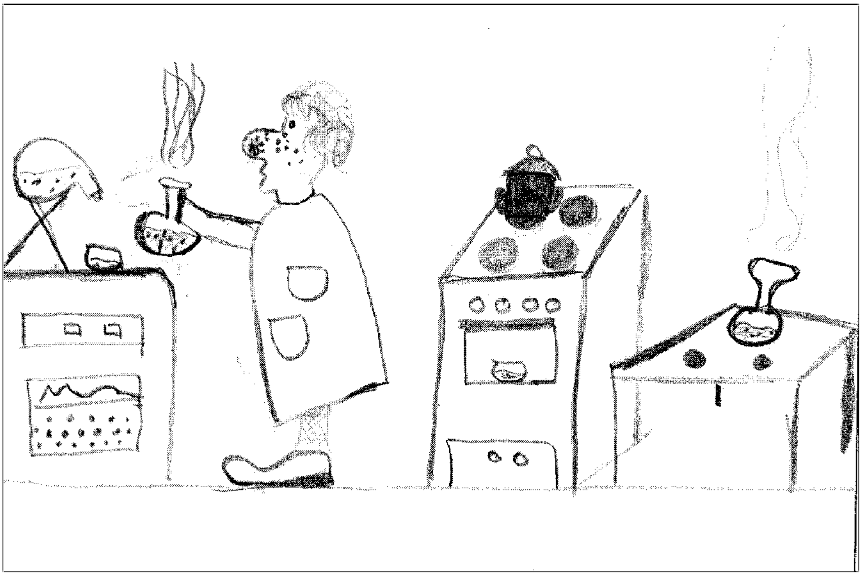
Boy, Uganda



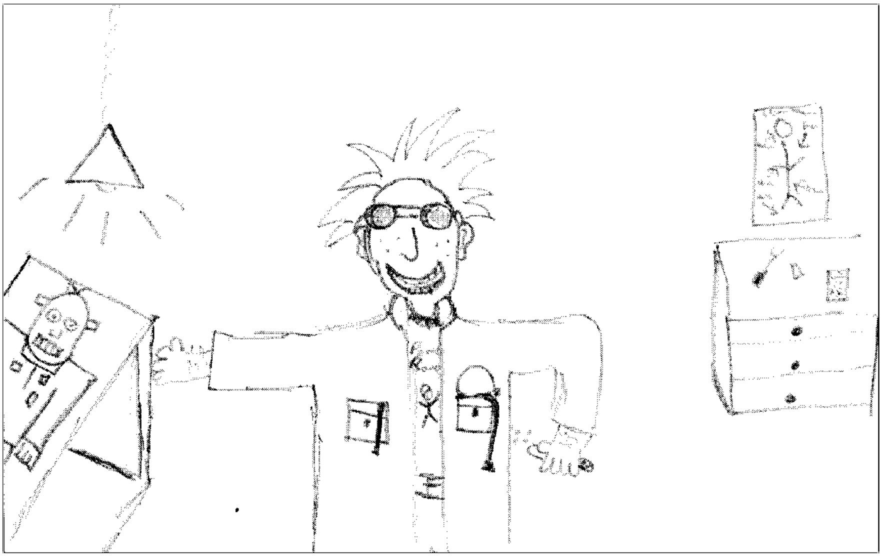
Girl, Lesotho

The following is therefore a more qualitative and tentative description of the impressions from looking through the material.

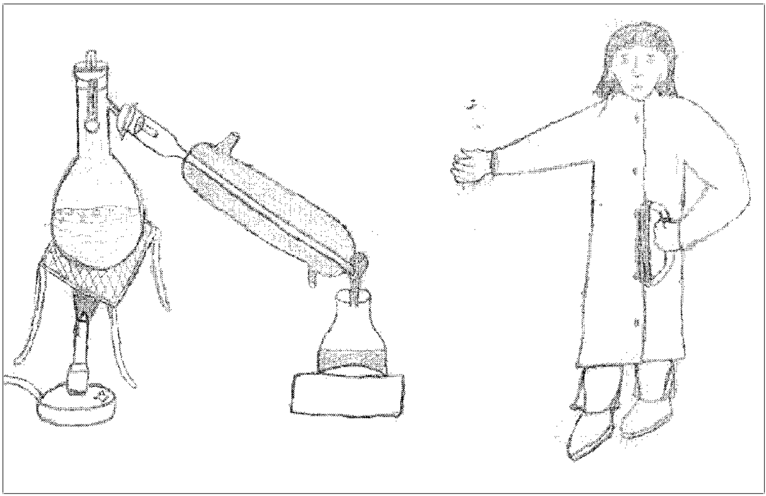
Here is a collection of drawings as an indication of the kind of data that is collected. The pupils' written explanation is given below each drawing.



Scientists work with the ozone layer and the greenhouse effect, and maybe they make dinner like everybody else. (Girl, Norway)



I think scientists try to improve our way of living. They do this by improving how we live (Girl England)



Scientists helps people regained their health.
They help those that are sick or ill to get well.
They are fund of discoveries.
They are also kept in the hospital to take care of those that are not healthy.
(Girl, Nigeria)

1. They are always thinking
2. They always have ideas
3. They (most) are brilliant people.
4 They are always making experiments new discoveries
5. If scientists were not here we ordinary people wouldn't know anything.
(Girl Trinidad)

For the rich, industrial countries, the data seem to support findings from similar published research (references are given earlier). The researcher is drawn mainly as male. Only girls (but not many!) seem to think of the scientist as female. The researcher is often placed in stereotypical laboratory contexts and is depicted as an often bald-headed, bearded man with a lab coat, test tubes and other symbols of research.

As many researchers have noted, the Draw-a-scientist-test actually begs for stereotypes of this nature, so care should be taken not to overgeneralize from the mere drawings. But the free writing that accompanies the drawings adds some information. An analysis of the Norwegian sample (Kind 1996) showed that practically only boys' drawings and writing might be classified as "science fiction" (Boys: 6%, 1% girls). Some pupils envisage the scientist as cruel and gruesome (boys 11%, girls 2%). Among the examples given are cruel experiments on animals. From the writing about "me as a scientist", the Norwegian data show the clearest difference for topics classified as "technology": (Boys 36%, none of the girls!). Twice as many girls, however, see themselves doing research in medicine and health: girls: 37% boys: 18%. Also for the topic of "environment/ pollution", the girls dominate: Girls: 15% , boys 9%.

These results are rather similar to Norwegian findings a decade ago (Kjærnsli 1989). She also noted that 18% of the girls and only 2% of the boys would do research that could help other people.

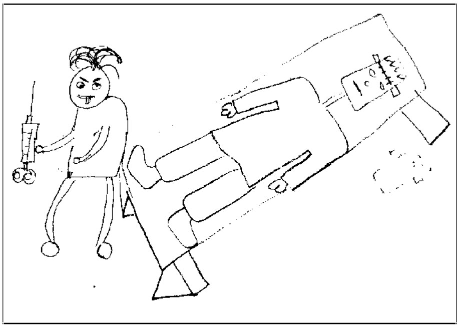
A similar pattern seems to emerge from drawings and writings in other industrialized countries. The image is rather stereotypical as indicated above, also with a certain (but not very high) percentage of the crazy or mad scientist. It is, however, interesting to note that very few pupils in western countries explicitly write that they want to help other people – or that they think scientists actually help other people.

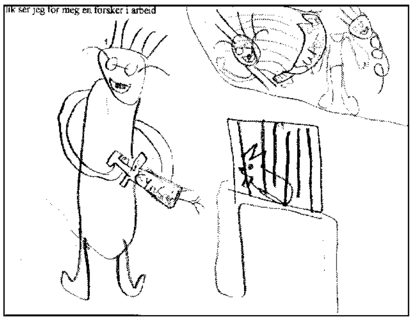
Most of these observations are in a stark contrast to writings and drawings from pupils in developing countries. They see the scientist as a very heroic person. Scientists are often seen to be brave and intelligent, they are seen as helping other people, curing the sick, improving the standard of life for everybody. They are also often seen as helping the poor and underprivileged, aspects that are never mentioned on responses from pupils in the West. The scientists are seen to be the servants of humanity and the heroes of society.

This means the image of the scientist is indeed very different in the developed and the developing parts of the world. This is not the place to discuss whether the views of the children are "correct" or not. But this image – real or fantasy – surely influences the motivation and willingness to engage in science. To a certain extent it surely also determines what kind of pupils who feel at home with the culture of science – and who will feel alienated or even hostile. This may also indicate that the perceived "values of science" or "sub-culture" of science may be seen very different in different parts of the world. Although school science often is characterised as "western science", and based on a western "world-view", these data indicate that children from poor non-western countries have a much more positive image of the culture of science than most children in the west have. This paradox may be a challenge for discussions about the possible match or mismatch between the sub-culture of science and indigenous (as well as western) cultures. As indicated before, this issue has become an area of great concern to science educators in recent years.

The crazy scientist?

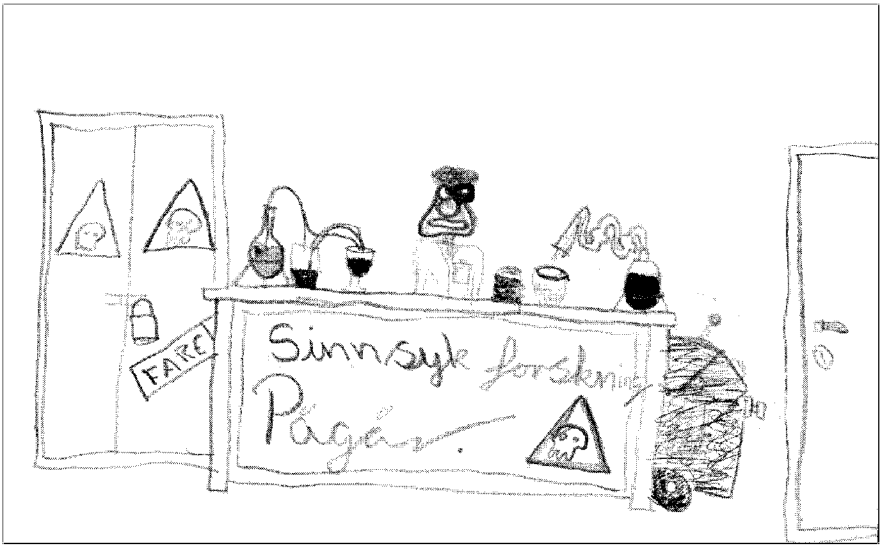
The well-known cartoon image of the crazy scientist is found on some drawings, but the proportion is rather low, and it only occurs in the richer countries. And boys only draw it! Below are some examples of such drawings.



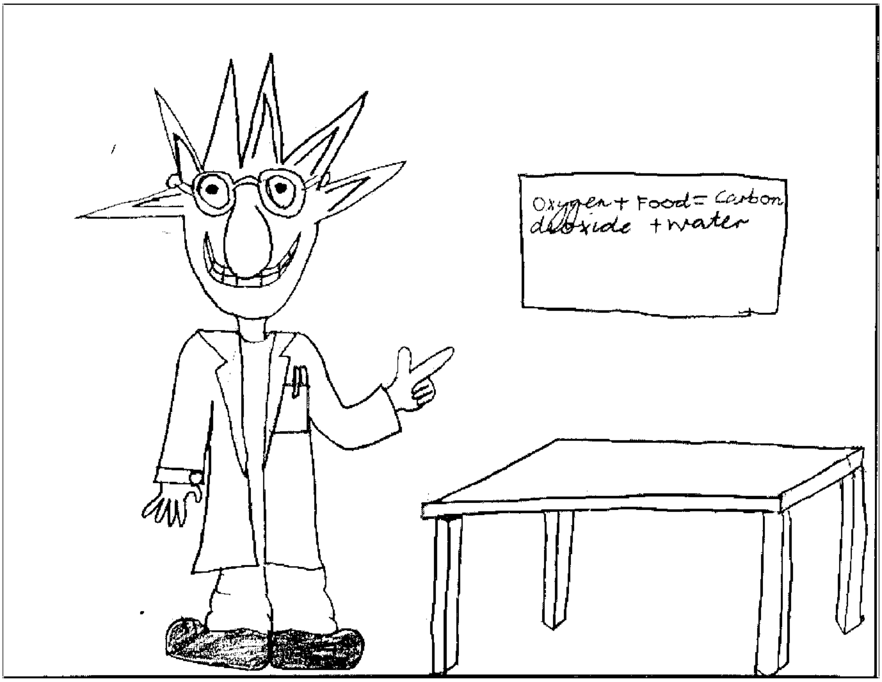


To the left: A cruel scientist – inspired by Frankenstein? (Boy, Norway)
To the right: Writing: "I think they do experiments on animals and kill them! And they develop new poisonous gases and atomic bombs!" (Boy, Norway)

Here are some more examples of the weird and crazy scientist, typical in some of the drawings from children in richer countries, mainly boys.



Text on drawing: "Danger! Crazy research going on" (Boy, Norway)



Boy, England

What do scientists do? Some quotes

The free writing on Item 6 "What do scientists do?" and item 7 "What would you do if you were a scientist?" allows pupils to express views on different aspects of science. The writings show a great variation in themes and perspectives. Some reveal how they perceive the nature of science, other describe scientists as persons. Some examples are given below the drawings above. The following is a small collection of other statements from item 6 about "what scientists do and what issues they work on."

"Scientists travel around and collect facts. They write all facts in a report." (Boy, Norway)

"Scientists use chemicals and try and save people and other's just look at them." (Girl, England)

"Some scientists do experiments. Others use their brains." (Boy, England)

"I think scientists usually carry out researches and then make experiments. After doing so they go and discuss what they have done and show their fellow scientists.
If there needs to be a change anywhere they try to see how and reason why. When all is finished it is taken to a much better person than them and also examines the research they have carried out or experiment." (Girl, Uganda)

"Scientists divide many things out of particular thing. He study and finds out more about it, like for example if a scientist want to study about animals without backbones he may divide animal in two parts. One is animal without backbone and another is animal with backbone." (Boy, Papua New Guinea)

"Scientists do many things for people in the whole world. Scientists help people on the world because they can tell what is bad and what is write, even what is going to happen in the feature." (Boy, Lesotho)

"Scientists work hard long hours every single day for a whole week." (Girl, England)

"I think scientists are nuts because they say they have a cure but it never works." (Boy, England)

"Most scientists are just doing completely stupid things." (Boy, Norway)

"They research on animals. Very stupid."(Boy, Norway)

"They try to blow up the world with an atomic bomb." (Boy, Norway)

"Scientists make tests on chemicals and test perfume on helpless rabbits and rats." (Boy, England)

"Scientists work on issues to improve the standard of living. They also work on medicines for diseases that cannot be cured and to help feed the world. Sometimes science is used in crimes and pollution but the future hopefully will bring an end to it. So scientists can help to make this world a better place." (Boy, Trinidad)

"I think scientists are always trying to find a solution for everything, e.g. the drinking of milk by Shiva. Scientists always want to know more. Some issues they probably work on are: about saving the earth, wanting people to live longer and look younger, researching bacteria and viruses to find cures for diseases. I picture scientists always reading some book trying to analyse problems like on the movie X-files. (Girl, Trinidad)

"I think scientists are creative as well as destructive. They are creative in the sense that they invent new things and destructive in the sense that they experiment with things they don't know about and this may cause widespread damage." (Girl, Trinidad)

Most scientists look dull and boring, but looks are deceiving. Scientists are very brilliant people. They are important to society, without them there would be no television, radio etc. Although some of their topics are boring they are needed and we should appreciate them." (Girl, Trinidad)

"Scientists discover petroleum in Nigeria and other parts of Africa. They killed the Our (?) from the Earth." (Boy, Nigeria)

"Scientists find out about things. They are very curious people but they help in inventing things and they have modernized the world and have made things easier for us to." (Boy, Nigeria)

"They may work on experiments. Like I always read in some story books that sometimes their lives are in danger. Like when they want to make things that would benefit the whole world, some criminal may also want to get them. (Girl, Nigeria)

Writing: "Me as a scientist"

The very last item (no 7) in the questionnaire is a kind of follow-up on the drawing and writing about scientists. Here they express their own research priorities. A group of Norwegian students have analysed a selection of these writings as part of their studies. They chose to look at a selection of responses from England, Nigeria and Norway. A total of 828 pupils' writing was analysed. Details are given in the table below.

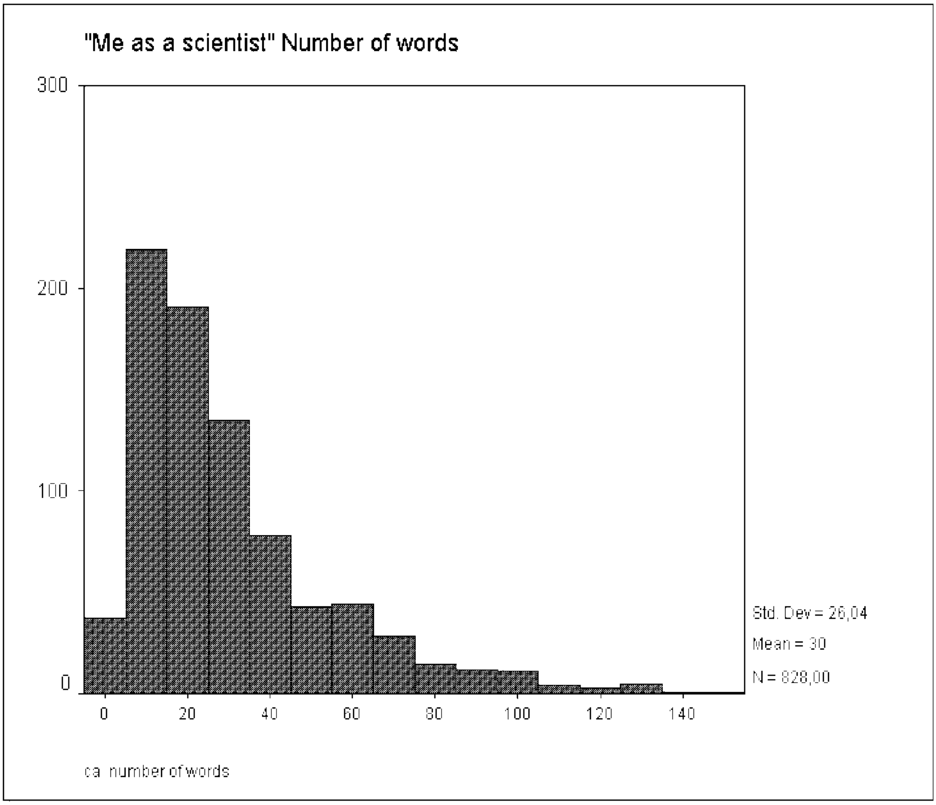
Item 7 "Me as scientist...", Sample size for text analysis

	Girl	Boy	Total
England	194	95	289
Norway	159	167	326
Nigeria	126	87	213
Total	479	349	828

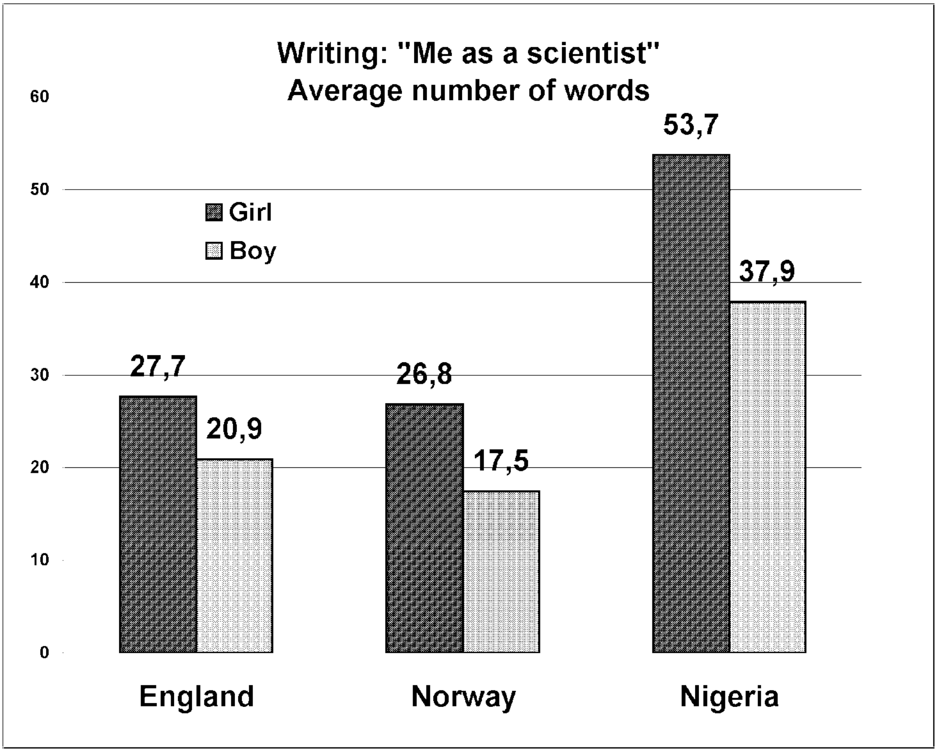
Length of writing

One is immediately struck by the great variation in the length as well as the quality of the writing. This is a parallel to the variety we noted in the quality of drawings.

Some children did not write anything. They are omitted from the analysis. All children who wrote more than one word are analysed. Of these, less than 5% of the responses were classified as "not serious" or "not readable". The histogram below demonstrates the variety of the length of the free writing. (A few of the responses were even more than 200 words and are outside the range of the displayed histogram.)



In addition to the enormous variation between individuals, one is also struck by some general trends: Children in Nigeria write more than children in England and Norway. In all countries, girls on the average give longer responses than boys do. The averages are displayed on the following graph.



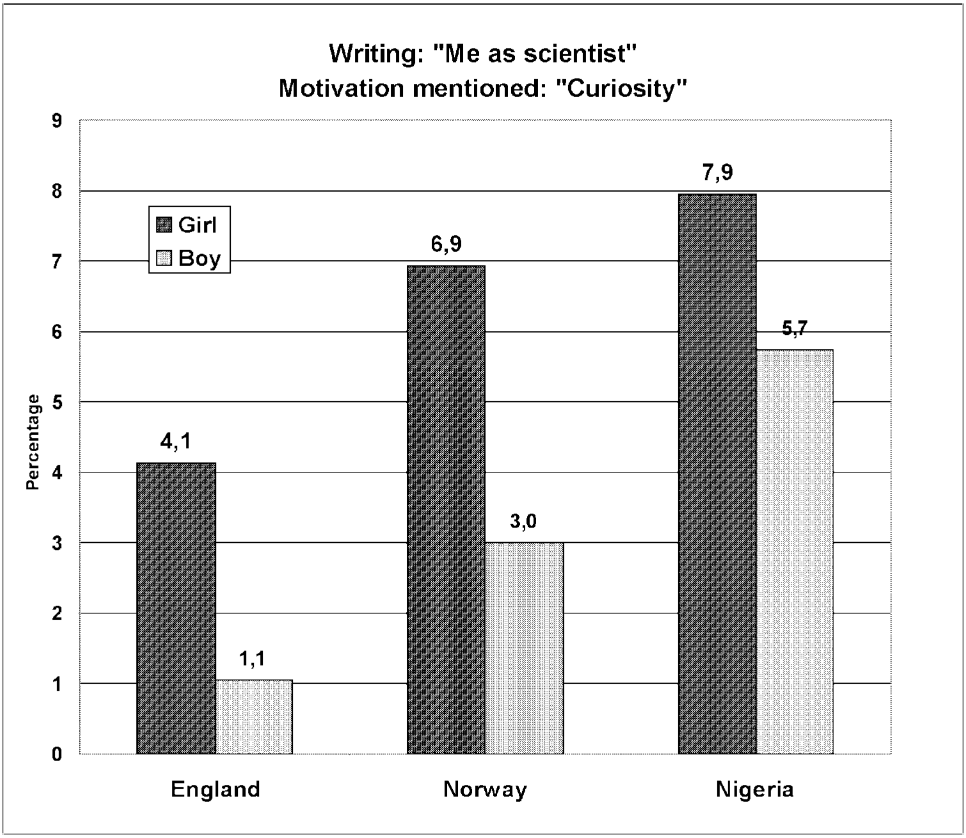
Categories for content analysis were developed collectively by the group of students. This proved to be rather difficult due to the great variation in approaches from the children! Here are some of the findings.

The variables were divided in three separate categories. The first category was related to any explicitly stated *motivation*, the second was reserved for any explicit naming of an *occupation*, and the third category was any explicit naming of *area of work* or type of problem or issue. Some children expressed more than one wish and one sort of motivation, and each statement was counted. Some children may therefore have practically zero "counts", while other may have many.

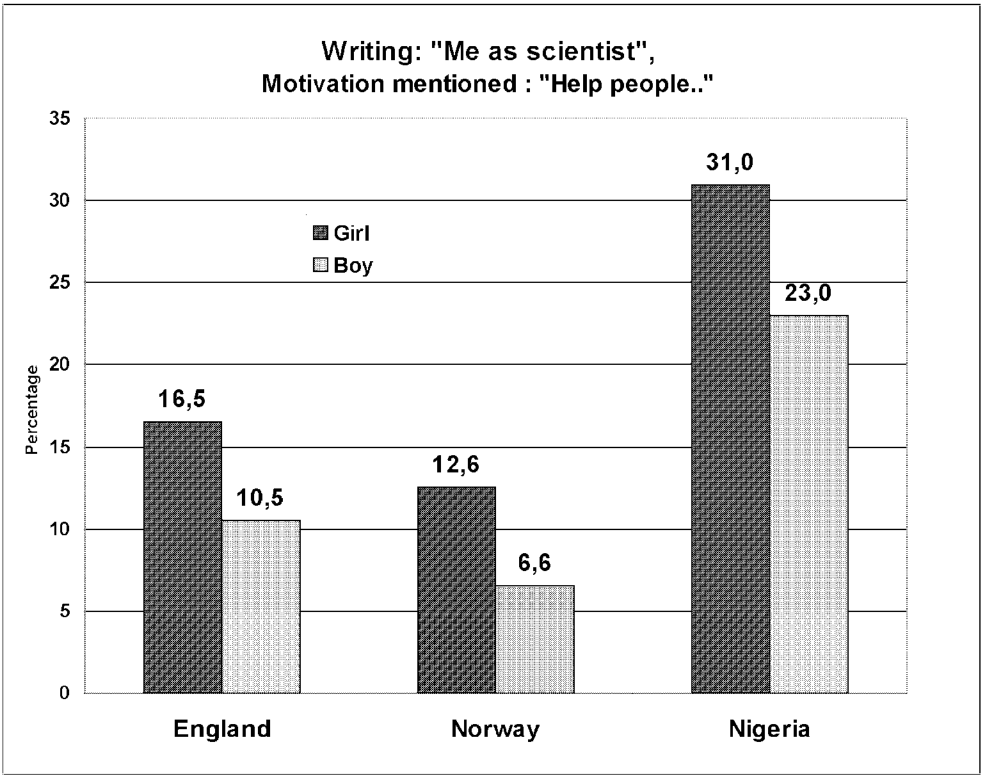
Motivation

Motivational factors like becoming *famous*, *popular*, or *rich* very have very low percentages in all countries. For any group, less than 5% for the children mention such factors as a motivation. .

The frequency of children explicitly mentioning *curiosity* is also rather low, but the pattern of responses is interesting, as can be seen on the graph below. Nigerian children express more curiosity, and in each country, girls explicitly mention curiosity more often than boys do.



An explicitly stated wish to *help people* was the most frequently occurring motivation in the responses. Frequencies are given in the table below.



We note that children from Nigeria mention "helping people" explicitly much more frequently than do children in England and Norway. This results supports the more qualitatively impression we reported as an impression from drawings. In all countries, fewer boys than girls mention helping people as a motivation to do engage in research. Norwegian boys constitute the group that by far has the lowest frequency of this kind of response.

Occupation

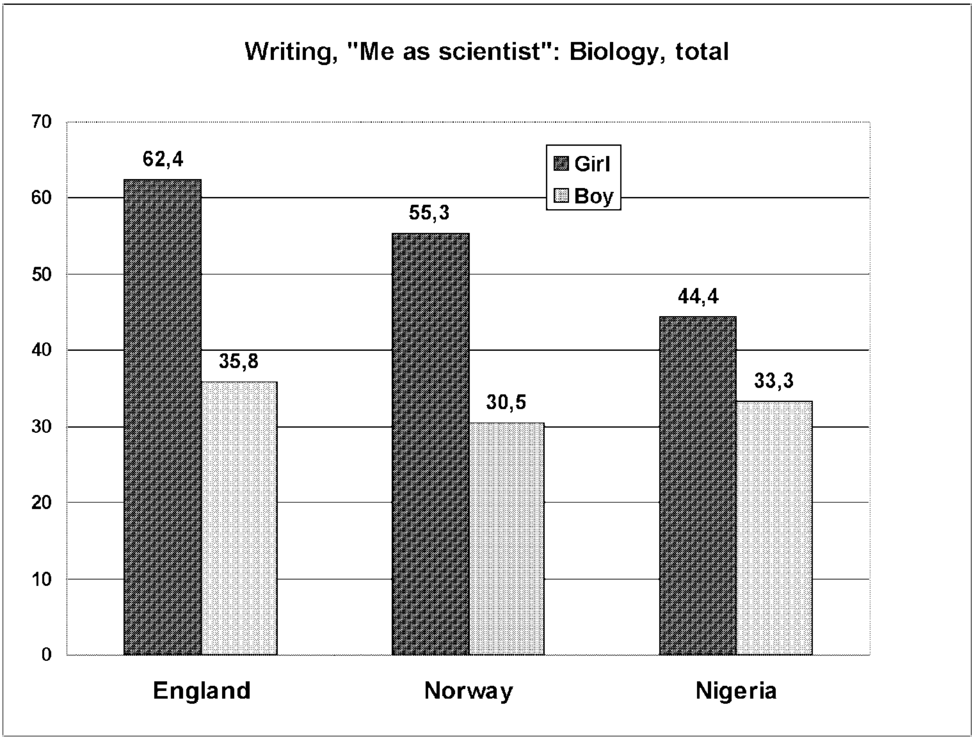
Most of the occupations mentioned received rather low scores. A general statement of wanting to become a *researcher* is mentioned by 12%, while 4% give an explicit statement of *not* wanting to become a researcher. *Doctor* is mentioned by 4 % of the children, *teacher* by 2% of the children, *veterinary* by 1% and *engineer* by 3%. An analysis of the mentioned problem area gives more concrete responses and higher frequencies as can be seen from the following.

Problem area, field of work

The number of sub-categories we used for this classification was rather high. The results reported in the following presents aggregates done after the initial coding. Some children mention several examples of topics for research. In the aggregate, a count of 1 is given to each pupil who mentions an aspect that belongs to the overall category one or more times.

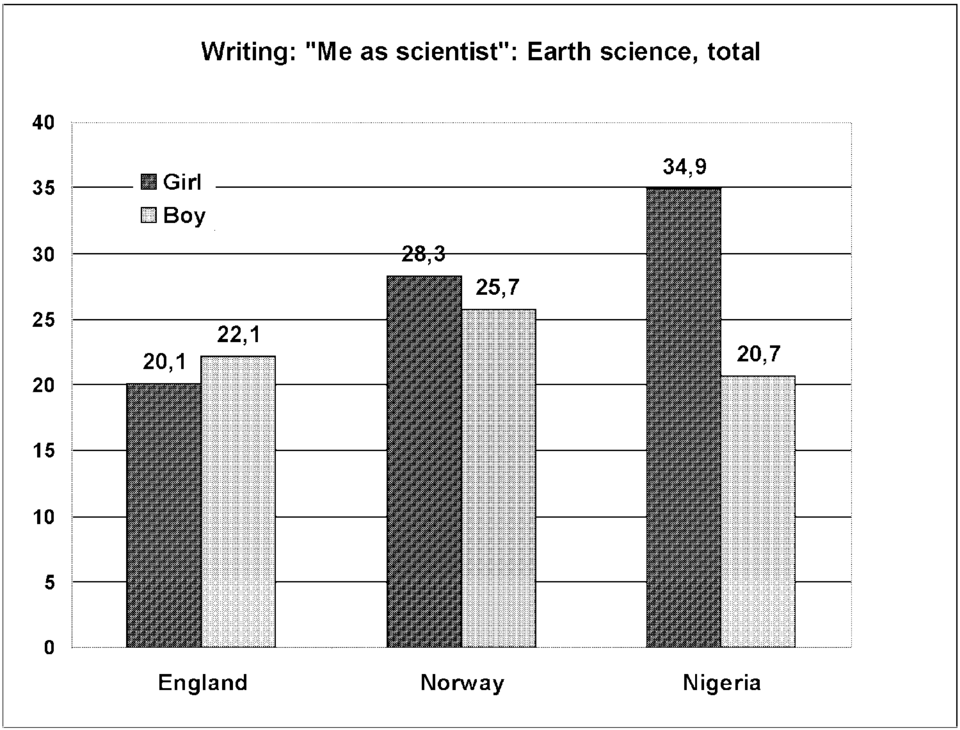
In the following, the broad areas are presented in falling popularity, i.e. we start with the most popular and move to less frequently mentioned aspects. All numbers are percentages of total number of children. Please note that the scale on the y-axis is different for the different aspects!

The broad category *Biology* is by far the most popular, and includes aspects like working with plants and animals, medicine, human biology etc.



We note that biological topics are popular in all three countries, and that the gendered pattern is clear; biology enjoys higher popularity among the girls than with boys, although the frequencies are also high for the boys! We note that this gender pattern is clearer in Norway and England than in Nigeria.

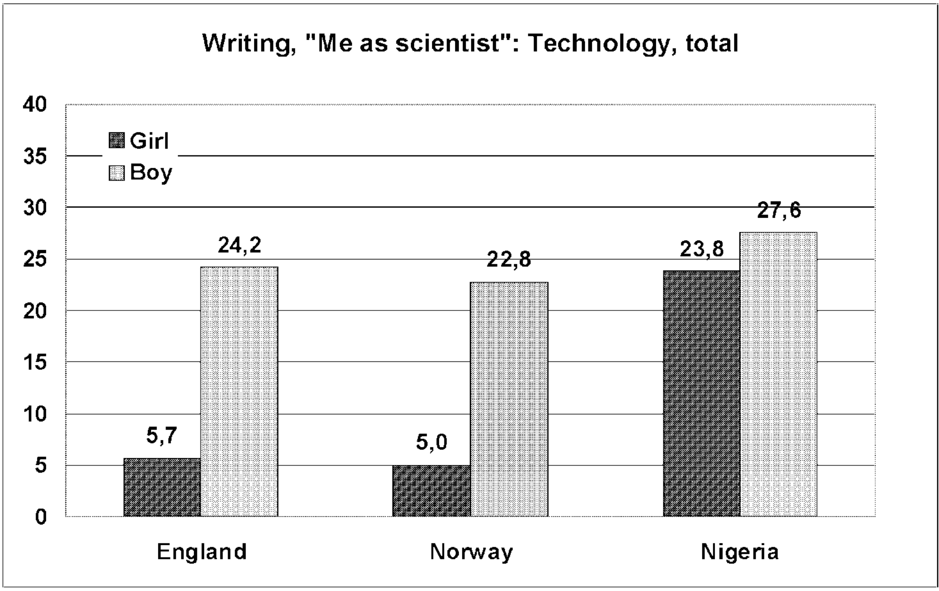
Next to *Biology* in popularity is the broad category of *Earth science*, including research on the earth, the weather and space. Results are presented on the graph below. (The vertical scale is about half of the one used for biology.)



Aspects classified *as Earth science* are rather popular among all groups of children. Only in Nigeria is the gender pattern rather strong. We have earlier noted that all children seem to like to learn about aspects that may be classified as earth science, and these free writing support these data.

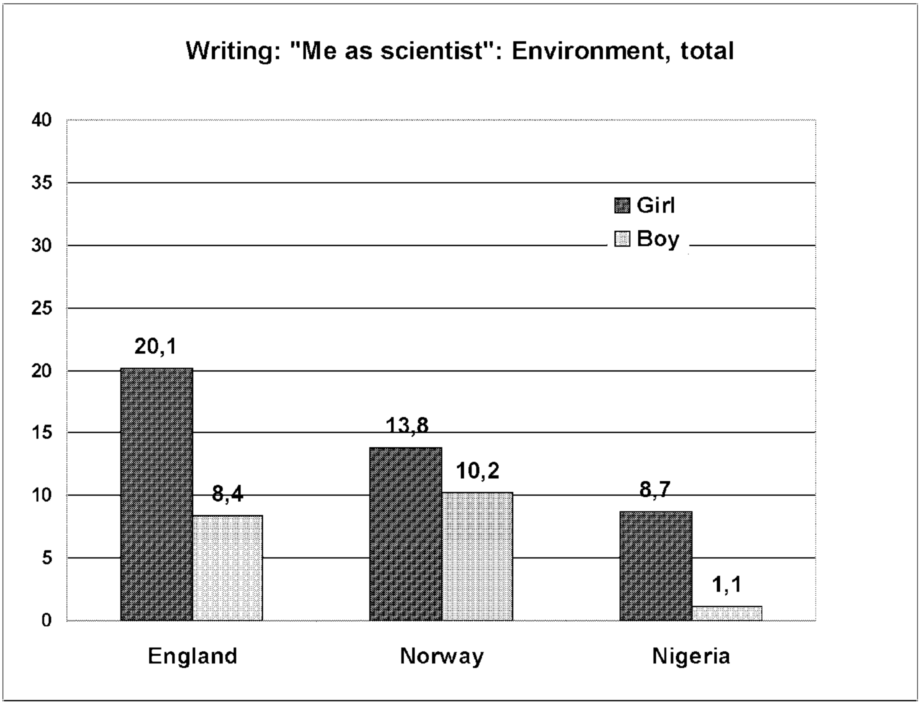
Somewhat lower in popularity are the two following broad fields, classified as *Technology* and *Environment*. The scale is the same as on the previous graph.

Under the heading *Technology* is included aspects like technology in general, computer and information technology, weapon technology, transport, building of roads, houses etc.



We note that *Technology* enjoys a rather high popularity among boys in all three countries. The interest among Nigerian girls is on about the same level. The remarkable result is the very low interest in technology among the girls in Norway and England. This result supports the findings that we have reported earlier in the report.

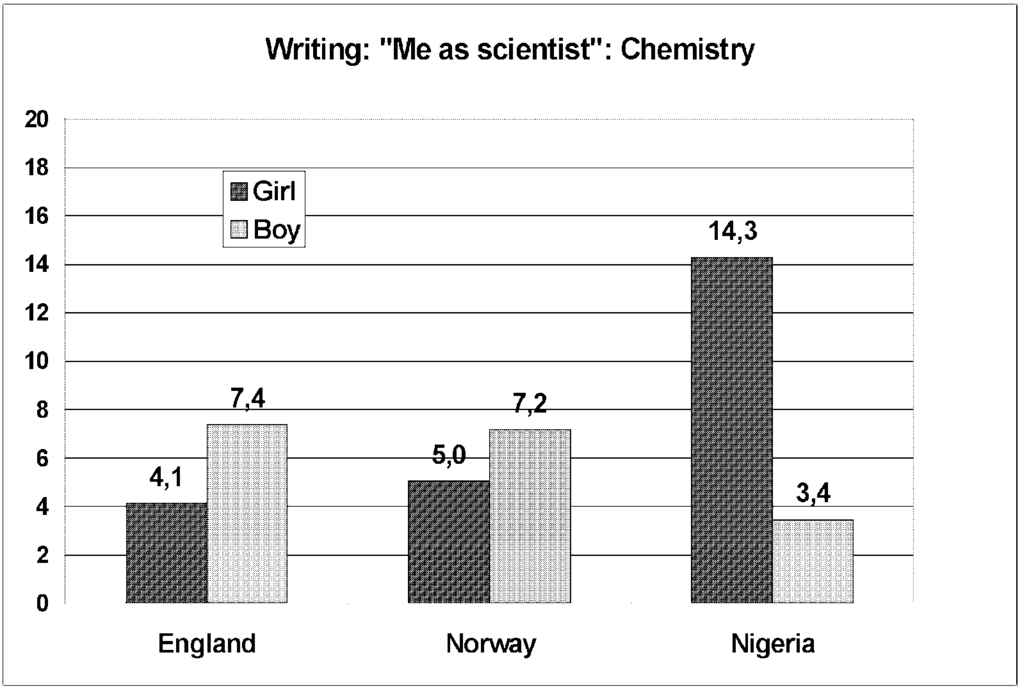
Under the heading *Environment* is included aspects like research on the greenhouse effect, the ozone layer, clean air and drinking water, pollution etc. Results are given below.



We note that children in England and Norway have this relatively high on their "research agenda", with Nigerian children much lower. This may be seen in the light that environmental concerns are high on the political and public agenda in richer countries. Developing countries are to a greater extent concerned about raising the material standard and a general improvement of living conditions. More global concern about the ozone layer and the greenhouse effect may for them seem to be matters of less immediate relevance.

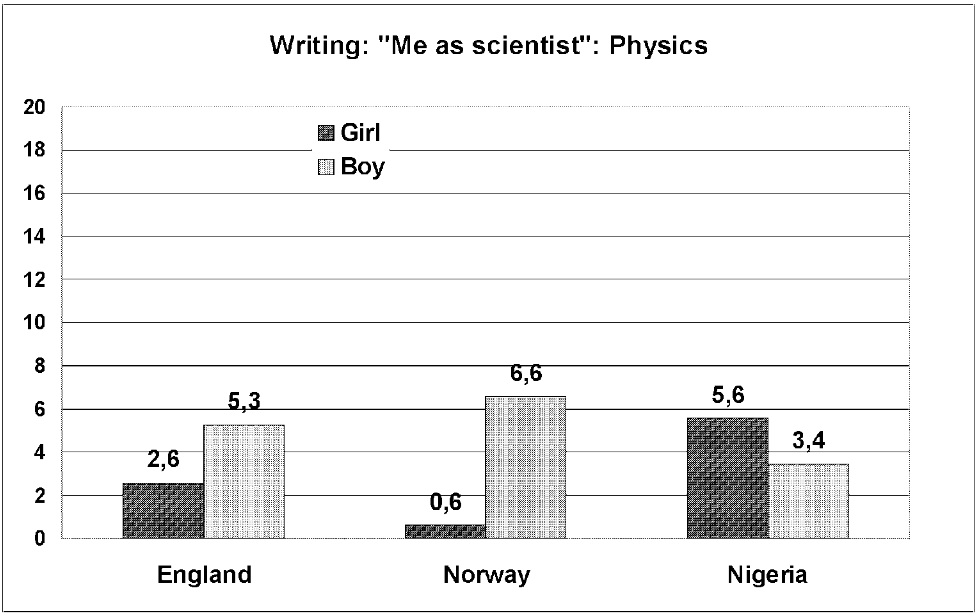
In all three countries, girls seem to be more oriented towards environmental concerns than boys do.

The next two graphs show the percentage of pupils who mention aspects of *Chemistry* or *Physics* more or less explicitly. Please note again that the vertical scale on these two graphs is the double of the one used in the three previous graphs!



Chemistry (as such) is not mentioned very often, except by Nigerian girls. The expressed "popularity" of chemistry among girls and boys in Norway on this item is relatively gender neutral. This corresponds quite well to later curricular choices, where Chemistry is chosen by about similar proportions of girls and boys in secondary school as well as in tertiary studies.

The popularity of *Physics* as a potential field for research is displayed on the following graph.



We note that *Physics* does not appear to be a popular research priority for any of the groups in this analysis! The extreme gendered pattern in Norway is noteworthy. This corresponds quite well with enrolment data as well as other results from e.g. the TIMSS study. Among all the TIMSS countries, Norway has the lowest proportion of girls choosing physics as a school subject. It seems that such attitudes may be observed at a very early age. We return to the gender issue in a later paragraph

Some paradoxes and surprises

Many findings in this study are hardly surprising. The overall gender profile follows a pattern that is well documented. But some results are rather unexpected (at least for this author). Two such examples will be shortly mentioned below.

Japan: Top in score – lowest in attitudes and interests!

Many results from Japan seem to need an explanation, also seen in connection with other sources of information. Let us look at some of the paradoxes:

Japan tends to be on top on most international tests on pupils' achievement (SISS, TIMSS etc.). On the TIMSS test, however, Japan actually was ranked as "only" number three, "beaten" in mathematics by Singapore and Korea and in science by Singapore and Czech Republic (TIMSS 1996). This "low standard" is causing official concern in Japan!

In spite of high scores on achievement testing, the TIMSS data (TIMSS 1996 p 121 ff.) also indicate that Japanese children have more negative attitudes to both mathematics and science than pupils have in any other (of the nearly 50) TIMSS countries

The data presented in this paper supports and gives more detail to this observation. Item by item, we find similar results. Japanese children are much less likely to be interested in most science items – in particular those related to modern advances in technology – the area where Japan is probably the world leader.

In the light of the high test scores, it is also rather paradoxical that Japanese children find science more *difficult* than children in any other participating country. Are Japanese schools putting a too high demand on the pupils? Or is the response simply another way of saying that they dislike science?

Gender differences are in many aspects large in Japan. According to our study, Japanese girls are at the lowest place when it comes to interest in science, both when the question is a global one (like item 5) and on the very specific topics in item 3. Japanese girls also state that they find science more difficult to understand than any other group in this study.

There are also other rather confusing evidence relating to the role of science and technology in Japan. Survey data (Miller 1996 in OECD 1997) indicate that the level of *public understanding* of science is very low in Japan; they come out on bottom of a list of 14 countries in an international survey (Miller 1996). The low level of (adult) public understanding of science is in sharp contrast to the fact that Japanese school children are on the world top in science achievement! (Although the tests are rather similar.) It also seems paradoxical that these "scientifically illiterate" adult persons are in fact the very same people who have developed Japan to be a world leader in modern technology!

The same study also concludes that the Japanese public is less interested in and attentive to science issues presented in media (Miller 1996 in OECD 1997). The many paradoxes relating to science and technology in Japan is also a matter of official concern. The Japanese report to OECD summarises the situation like this:

> "Interest in S&T among young people is waning in Japan. [....] The declining popularity of science and technology among young people is of serious concern to the nation as a whole." (Official Japanese report, OECD 1997)

Akito Arima, the Science Adviser to the Minister of Education, Science Sports and Culture is very explicit:

> "The tendency for young people to turn away from the study of science and technology is a source of great concern in Japan. The educational system should make every effort to stimulate interest is these areas." (Arima in OECD 1997)

Science educators in Japan have recently become very interested in these matters, and possible explanations as well as possible policies are hotly debated. Some parts of these debates are also available in English, se e.g. Ogawa (1995) and Kawasaki (1996). They have different approaches to the issue, Ogawa using an anthropologically oriented "world-view" perspective, Kawasaki seeking the explanations more in linguistics. Masakata Ogawa has engaged researchers from many different cultures in an effort to jointly shed light on the cross-cultural aspect of the issue (Ogawa 1997). Ogawa was also the Japanese researcher who collected the SAS data from Japan in this study.

It falls beyond the scope of this chapter to explore this extremely interesting issue, but it is expected to be an area of interesting debate and stimulating cross-cultural research in the coming years. Professor Ogawa has recently (spring 2000) received a research grant for a project called "International Joint Research in Science Teacher Education Programs Sensitive to Culture, Language, and Gender." This author is invited as member of the research group, and perspectives and results from the SAS study will be an important input in the project.

Norway and the Nordic countries: What about the gender equity?

The present study has shown that the Nordic countries (here represented by Norway, Sweden and Iceland) on many aspects come out with greater differences between girls and boys than most other countries. In particular, we documented the large difference in the interest to learn science. Other data from this study also indicate large differences in values and priorities, like in the ranking of factors that are important for them in their choice of job (item 4, not analysed in this paper.) Girls are more "person-oriented" than the boys, they want to "help other people" and to "work with people instead of things", while boys are more oriented towards making money and getting personal benefits. The analysis of children's drawings and their free writing on "Me as a scientist.." supports the strongly gendered profile.

The Scandinavian countries often consider themselves "world champions" in gender equity. Gender equity has been a major political concern since the mid 70-s. Much has been accomplished, and the overall picture is undoubtedly rather positive. In my country, Norway, legal barriers have been removed a long time ago, laws against discrimination and unequal pay are in operation. Female participation in politics and the labour market is among the highest in the world. Even textbooks in all subjects have to pass a gender equity test before they are allowed to be used in schools. In the education system, girls and women dominate the overall picture, with some 56% of tertiary students being female.

Official statistics and international reports confirm the leading position of the Nordic countries regarding gender equity. UNDP (United Nations' Development Program) publishes an annual influential Human Development Report. The analysis and conceptual development behind these reports is well respected. Among other things, they have developed a *Human Development Index* to describe and monitor progress in this complicated area. All the 5 Nordic countries are among the 15 on the top of this list, which includes 174 countries. But UNDP has also developed indices that describe the situation of particular social sectors. In 1995 the focus was on gender, and UNDP introduced a so-called *Gender Empowerment Index*. This index measures the degree of achieved equity regarding aspects like education, salaries, participation in politics and on the labour market etc. In the 1999 report, the Nordic countries have the following ranks on this list of 150 countries: 1 Norway, 2 Sweden, 3 Denmark, 6 Iceland and 7 Finland. (UNDP 1999). The international reputation for gender equity seem well deserved.

But. The percentage of women in science and engineering is very low – lower than in most other countries. And the enrolment has actually gone down the last years. TIMSS results also indicate great gender differences in the Nordic countries, in enrolment, achievement as well as in attitudes.

The issue is of great political concern. The reason does not seem to be the girls' lack of ability or lack of self-confidence! It seems that even very able girls turn their backs to science and engineering. The choices seem to be rather deliberate, based on value-orientations and emotional, personal factors. Some of the underlying values are indicated above: The girls' high person-orientation and relatively low orientation towards money, career and things.

If this is correct, it shows that we should pay more attention to the underlying values, ideals and ideologies in science education. Textbooks as well as classroom teaching carry implicit (sometimes also explicit) messages about the nature of the subject and the underlying values. If we believe that these values are not strictly determined and logically deduced from "science", then we should analyse, discuss and possibly reconsider these aspects.

Science educators have recently drawn our attention to the fact that the culture of science is alien to people from non-western cultures. An overview over research and perspectives is given in Cobern and Aikenhead 1998. My impression is that pupils also in western societies feel alienated by what they perceive as the culture, ethos and ideals of science – as well as the present sometimes frightening uses and misuses of science and technology. "Border-crossing" may be required also of many pupils in western society. It is my contention that concepts taken from these kinds of approaches might be used to understand why so many young people – in particular the girls – choose not to take science in countries that have actually removed most visible barriers for girls to enter the sciences.

Some conclusions and recommendations

It is evident from this study that children in most parts of the world come to school with a rich variety of relevant *experiences* that could and should be utilized in the teaching and learning science at school. This study does not indicate whether this is resource is actually used in a systematic way or not, but it may indicate how this might be done.

The *interest* in learning seems to be much higher in developing countries than in the rich and technologically developed countries. An explanation for this may be that education in developing countries is largely seen as a privilege that everybody strive for, while many pupils in the rich countries see school as a tedious duty that is imposed on them. The same perspective may explain the strong interest in science expressed by girls in developing countries: Girls in these countries often have less access to all sorts of education than boys have, therefore learning science may be seen as a very positive option.

The *profile* of the experiences and interests does, however, vary strongly between countries. This fact should call for caution when it comes to "importing" foreign curricula and scepticism against the pressure to "harmonise" science curricula to become similar across the globe. Although science *per se* may be universal (a debate that is not pursued here!), science curricula for children should reflect need and priorities in each country. Data from projects like this may provide a basis for deliberations about curricular priorities.

It is also evident that the *profile* of experiences as well as interests is very different for girls and boys in most countries. In general, the gender differences in interests are greater in rich countries than in developing countries, both when summed over all topics and when these are studies separately. Gender differences are very high in some North-European countries and in Japan, an aspect that is discussed a little above. If gender equity in science education is a national concern, one should go in some detail in analysing possible biases in the curricula, textbooks and classroom teaching. A study like this may be one approach to such issues, because it can lift the debate from a general level to a more concrete level, based on empirical evidence.

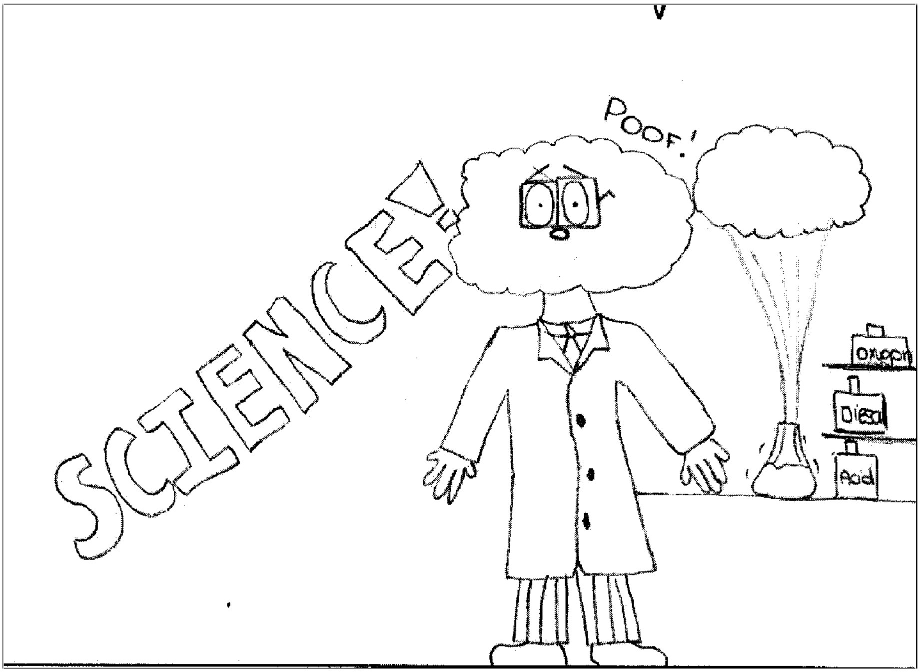
The *image* of science and scientists is more positive among children in developing countries than in the rich countries. Children in the developing countries seem to be eager to learn science, and for them, the scientists are the heroes. This is in marked contrast to at least a significant part of the children in the rich countries, who often express sceptical and negative attitudes and perceptions in their responses to several of the items. The notion of the crazy or mad scientist is often found in rich countries. Very few children in the rich countries envisage the scientist as a kind, human and helpful person, whereas this is often the image of scientist in developing countries.

This study does not tell which image is closer to "reality". But many of the data indicate that science has a problem with its public image in many developed countries. Most OECD countries are currently worried about the falling recruitment to science and technology studies. Why do children develop these critical attitudes to science and technology, although they live in societies based on such knowledge and its applications? One possibility is that this is a result of low public understanding of science, caused by bad teaching as well as a low or negative profile in the media. Many scientists hold on to explanations like these. But there is another possibility: It may be seen as an indication that many young people have a rather well informed sceptical attitude towards certain aspects of modern society. Maybe their doubts are based on real fears about an unknown future that scientists may lead them into?

This study does not answer these questions.

Final remarks

Let the closing words be said by two 13 year old girls from two very different parts of the world, England and Lesotho. The drawing below is accompanied by a text that demonstrates a balanced and critical stance that this author thinks that science education should encourage rather than see as a problem:



> **"Scientists do things to make our life easier but sometimes do more damage than good!" (Girl, England)**

The same view, but more elaborated, is expressed by a 13 year old girl from Lesotho:

> **"I think scientists help the society in some way and destroy it other way. Scientists help people by inventing modern technology, to help the blind to see and the crippled to walk, cures for viruses and so forth. But they also destroy the societies by pollution of air, creating bombs, nucleus used in wrong ways and so forth."**
> (Girl, 13 years, Lesotho)

These wise voices conclude this report.

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Appendix A: Participating researchers

Project team (also with nationally collected data)

Jayshree Mehta, INDIA
Jane N. Mulemwa, UGANDA
Svein Sjøberg, NORWAY

Researchers who have collected data:

Jophus Anamuah-Mensah, GHANA
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June M George, Trinidad, WEST INDIES,
Karl-Gøran Karlsson and Helge Strømdahl, SWEDEN,
Kjell Myrland, NORWAY
Rose N Agholor, T Ato, Chinedum Edwin Mordi and Uchenna Nzewi NIGERIA
Sugra Chunawala and M G Francis Xavier INDIA
Indira Chacko, PAPUA NEW GUINEA
Gaynor Sharp, Angela Srivastava and Jillian Spinks, ENGLAND
Marilu Rioseco, CHILE
Molnar Geza, HUNGARY
Wafaa Abdelrahman Abdelgadir and Durria Mansour El Hussein, SUDAN
Francisco Maria Januario and Oleg Popov, MOZAMBIQUE
Gilda Segal and Olugbemiro Jegede, AUSTRALIA
Jinwoong Song and Seung-Jae Pak, SOUTH KOREA
T. A. Balogun, LESOTHO
Masakata Ogawa, JAPAN
Stefan G. Jonsson and Stefan Bergmann, ICELAND

Appendix B
Some publications based on the SAS project

Iceland:
Hjartardottir, Gudrun Svava annd Arnadottir, Margret (1998): "Visindi og visindimenn. Kynin og visindin" Dissertation for B.Ed. University of Akureyri, Iceland

Sweden.
Bäckman, Paula (1997) "Flickor, pojkar och naturvetenskap" ("Girls, boys and science") As part of dissertation work in science education, Midthögskolan, Härnösand, Sweden

Norway:
Myrland, Kjell (1997): "Vitenskap og forskere Norske 13-åringers oppfatninger om naturfag og forskere innen naturfag" (Science and scientists. 13 year old Norwegian pupils' perceptions of science and scientists") Master thesis in science education (cand.scient.), Oslo university

Norway:
Sinnes, Astrid (1998): "Why are Girls Underrepresented in Science Education? A Cross Cultural Comparison of Obstacles affecting girls in Uganda and Norway" Thesis for cand.scient. in Science Education, The University of Oslo

India:
Chunawala, Sugra and Ladage, Savita (1998) "Students' Ideas about Science and Scientists" Technical Report no. 38, Homi Bhabha Centre for Science Education, Tata Institute for Fundamental Research, Mumbai, India.

Spain:
Vazquez, Angel and Manassero, Maria Antonia: "Escribir sobre ciencia: La imagen de la ciencia y de los cietintificos entre adolescentes" *Cultura y Education*, 1997 no 6/7

Chile:
Riosecu, Marilu and Pilar Reyes (1998) "The image of science and the scientist in Chilean girls and boys age 13" Universidad de Conception, Chile

Appendix C The SAS questionnaire

Reproduced, 12 pages

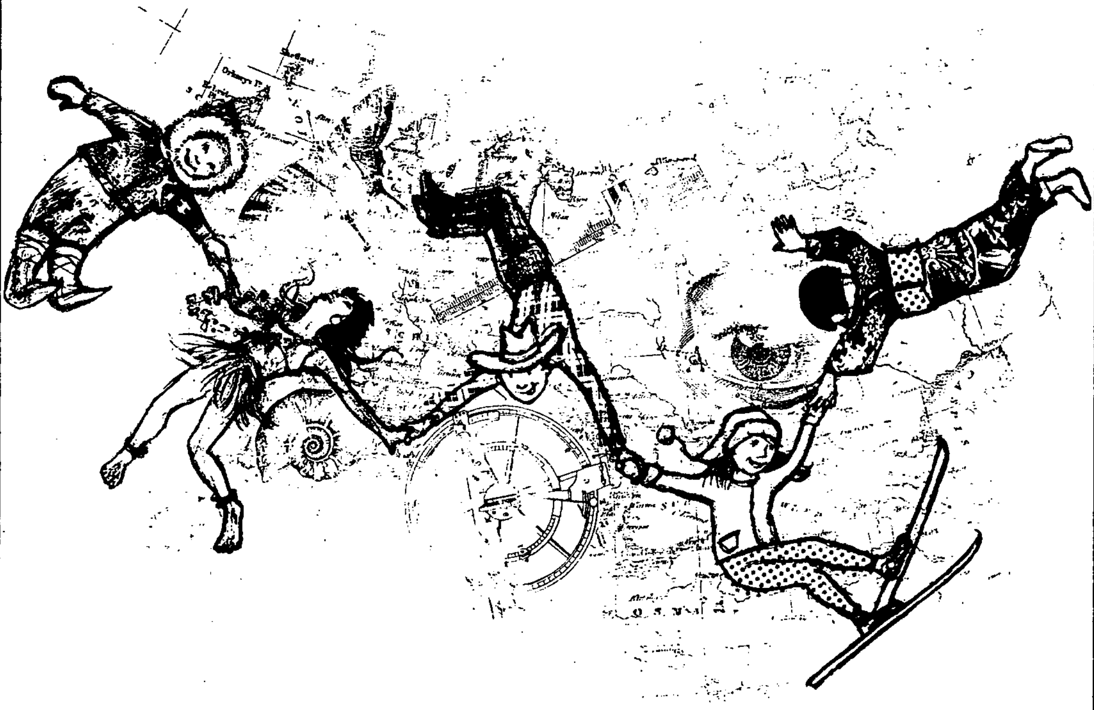
Science and Scientists

A scientist is a person who is curious and tries to find out about new things.
Sometimes they also try to invent and make new things
or find new ways of solving problems.

This booklet contains questions about science and scientists.
The questions are answered by children in many countries.
(That is why some of the questions may seem strange to you!)
The questions have no "right answers", but *your* views may help us to understand how children in different countries think, and in making science in schools better.

Please answer all questions as well as you can. Start here:

I am ..... years, I come from: ....(country) and I am: a girl☐ / a boy☐



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1. Scientists as persons

Here you may express how you think a typical scientist working with **physics or engineering** is like. Two words are put opposite to each other, like this:

Lazy (1) 2 3 4 5 Hard working

If you think the physicist or engineer is a very lazy person, circle number 1 as indicated above. If you think that the physicist is a somewhat hard working person, circle number 4 like this:

Lazy 1 2 3 (4) 5 Hard working

I think the physicist or engineer is:

Untidy, sloppy	1	2	3	4	5	Tidy, neat, orderly
Intelligent, bright, clever	1	2	3	4	5	*Not* intelligent, bright or clever
Lacking ideas and imagination	1	2	3	4	5	Imaginative, Full of ideas
Caring for others	1	2	3	4	5	Selfish
Lazy	1	2	3	4	5	Hard working
Unsocial, loner	1	2	3	4	5	Social, outgoing
Boring person	1	2	3	4	5	Interesting and exciting person
Kind, humane	1	2	3	4	5	Unkind
Authoritarian, dominating	1	2	3	4	5	Democratic

Next, do the same as above, but think of a person who works with **Biology or medicine**

I think the biologist or medical doctor is

Untidy, sloppy	1	2	3	4	5	Tidy, neat, orderly
Intelligent, bright, clever	1	2	3	4	5	*Not* intelligent, bright or clever
Lacking ideas and imagination	1	2	3	4	5	Imaginative, Full of ideas
Caring for others	1	2	3	4	5	Selfish
Lazy	1	2	3	4	5	Hard working
Unsocial, loner	1	2	3	4	5	Social, outgoing
Boring person	1	2	3	4	5	Interesting and exciting person
Kind, gentle, humane	1	2	3	4	5	Unkind, mean
Authoritarian, dominating	1	2	3	4	5	Democratic

2. Out of school experiences: What I have done

On the following list, you will find activities that you may have been involved in at home or at play - when you are not at school.

For each activity, ✔ ***tick*** in the right place to indicate your experience. If you do not understand what is meant, leave it blank.

Have you done this outside school?	**Often (Many times)**	**Seldom (Once or twice)**	**Never**
Used needle and thread for sewing			
Knitted, or made baskets or mats			
Weaved cloth or textiles			
Made your own clothes			
Used a saw			
Used a screw driver			
Used hammer and nail			
Used rope and pulleys for lifting heavy things			
Used hand-pump for water or other liquids			
Climbed a tree			
Made toys of wire, wood or other material			
Made a kite or toy plane of paper or wood			
Played with building kits (like Lego)			
Used a radio			
Recorded with a tape recorder			
Recorded on a video tape recorder			
Played video or computer games			
Used a calculator			
Used a PC (Personal Computer)			
Played with light and mirrors			
Used a magnifying glass			
Used a microscope			
Used binoculars			

Have you done this outside school? (Continued)	**Often (Many times)**	**Seldom (Once or twice)**	**Never**
Used a camera			
Developed or processed films			
Used a wrist watch			
Used a stop watch			
Used a measuring tape or stick			
Read the scale of a thermometer			
Used a kitchen scale or other scale			
Read a map or used a compass			
Used an air gun or rifle			
Made bow and arrows, sling, catapult or boomerang			
Preserved food by salting, smoking, drying etc.			
Made bread or pastry			
Collected edible berries, mushrooms or plants			
Made jam or juice from wild berries			
Planted and watched seeds grow			
Studied the life in a pond			
Read about how the body functions			
Made compost of grass, leaves or garbage			
Made a sieve or filter			
Made a funnel of leaves, paper or other material			
Put on bandages on wounds or used first-aid equipment			
Watched a bird make its nest			
Watched an egg hatching or an animal being born			
Watched an animal feeding their babies			
Cared for an animal like horse, cow, sheep, goat ...			
Milked a cow or a goat			
Made youghurt, butter, cheese or ghee			
Made chalk or candles			
Had your own pet animal (cat, dog, hamster, rabbit ..)			

Have you done this outside school? (Continued)	**Often (Many times)**	**Seldom (Once or twice)**	**Never**
Chopped wood or collected firewood			
Made charcoal from wood			
Made a fire using wood or charcoal			
Made natural colour dies from plants or stones			
Put up a tent or other shelter			
Walked while balancing a load on your head			
Played with magnets			
Played with electric batteries and bulbs or motors			
Used electric toys (cars, torches etc.)			
Changed a fuse or attached electric lead to plug			
Studied the inside of a radio, TV, video or similar			
Ridden a bicycle			
Mended a bicycle tube			
Used a car jack or changed wheels on a car			
Charged a car battery or other battery			
Made a cart or wheelbarrow			
Observed or studied the Milky Way or the constellations of the stars			
Observed or studied the phases of the moon			
Observed or studied the rainbow or different types of clouds			
Studied fossils			
Made anything from clay			
Made bricks for building			
Made a flute of straw, branches or wood			
Collected stones or gems			
Thrown stones on water to watch the ripples			
Made a windmill or waterwheel			
Blown soap bubbles			
Participated in brewing beer or making wine			

3. Things to learn about

Imagine that you could decide on what to learn more about. Below is a list of things you would like to learn about or that you enjoyed learning about. Tick the ones that looks interesting to you, leave the others blank

Things I like to learn about	✔ Yes!
The car and how it works	
The pollution and dangers of traffic	
Why birds and planes can fly	
How birds and animals communicate	
How animals like birds or fish manage to find their way home	
Plants and animals in my neighbourhood	
Plants and animals in other parts of the world	
How the body is built and functions	
Bacteria, virus and how they cause diseases	
Vaccination and prevention of diseases	
AIDS: What it is and how it spreads	
How plants grow, and what they need	
How to heat and cook food the best way	
What we should eat to be healthy	
How babies are made and how they grow and mature	
Detergents, soaps and how they work	
The evolution of life on earth	
Dinosaurs and why they died out	
The origin and evolution of the human being	
How different plants and animals depend on each other	
Light and optics	
How the eye can see	
What are colours and how do we see different colours?	
Acoustics and sound	
How animals and plants use colours to hide, attract or scare	

Things I like to learn about	✔ Yes!
How the ear can hear	
Music, instruments and sounds	
Sounds and music from birds and other animals	
Earthquakes and volcanoes	
Lightning and thunder	
Clouds, rain and snow	
The rainbow, what it is and why you can see it	
The weather and we can forecast it	
How mountains, rivers and oceans change and develop	
Why the sky is blue and why the stars twinkle	
The greenhouse effect and how it might be affected by humans	
The ozone layer, how it protects us from the sun and how it might be affected by humans	
The moon, the sun and the planets	
The universe, the star constellations and the galaxies	
Rockets and space travel	
The possibility of life outside earth	
Electricity, how it is produced and used in the home	
New sources of energy: from the sun, from wind etc.	
How things like telephone, radio and television work	
Computers, PCs and what we can do with them	
Latest developments in technology	
Sattelites and modern communication	
How science and technology may help us to get a better life	
The possible dangers of science and technology	
What plants we can eat and harvest	
Food processing, conservation and storage	
Poisonous plants and mushrooms	
How to improve the harvest in gardens and farms	
How to get clean and safe drinking water	

Things I like to learn about	**✔ Yes!**
How we can protect air, water, woods and the environment	
X-rays and ultrasound in medicine	
Test tube babies	
Birth control and contraceptives	
How children in other parts of the world live and think	
Why people in different parts of the world look different and have different colour of the skin	
How science and technology may help disabled persons (blind, deaph, physically handicapped etc.)	
How scientists think and work	
Famous scientists and their lives	
Important inventions and discoveries	
How a nuclear power plant functions	
What an atomic bomb consists of and how they are made	
How radioactivity affects life and my own body	
Atoms and molecules	
Chemicals and their properties	

4. Important for future job

If you were free to choose *any job or occupation you like*, what do you think is important? Below is list of things that may be important to you, and you may indicate wether you consider this aspect to be Very important , Of some importance or Not important

Place a ✔*tick* at the appropriate place for each factor

Of importance for future occupation or job	**Very important**	**Of some importance**	**Not important**
Work with people instead of things			
Have more time for my own friends			
Use my talents or abilities			
Earn lots of money			
Have an exciting job			
Have more time for my family			
Make my own decisions			
Make and invent new things			
Control other people			
Become famous			
Get a secure job			
Have more time for my own interests and hobbies			
Help other people			
Have an easy and simple job			
Developing new knowedge and skills			

5. Science in action

When you think of "science", what comes to your mind? Place a tick at the words that you connect with science, leave the others blank. You may tick as many places as you like.

Science is ...	✔ Yes!
Interesting, exciting	
Boring	
Creates problems for society	
Creates pollution	
Useful for everyday life	
Doing experiments	
Most suitable for boys	
Power	
Important for society	
Destructive and dangerous	
Helping the poor	
Difficult to understand	
Easy to understand	

6. Scientists at work

Drawing

This is how I think a scientist at work may look like

Writing

Write some words about what you think scientists do and what issues they work on

7 WRITING: "Me as a scientist."

Assume that you are grown up and work as a scientist. You are free to work and do research that you think is important and interesting. Write some words about what you would like to do.

THANK YOU, YOU HAVE BEEN VERY HELPFUL!!