Students´ attitudes to science and technology

First results from The ROSE-project in Sweden

Anders Jidesjö (PhD student)
Linköping university
andji@tema.liu.se

Magnus Oscarsson (PhD student)
Mid Sweden University
magnus.oscarsson@mh.se

National Graduate School in Science and Technology Education Research, Linköping university, Sweden

Abstract

ROSE tries to trap aspects of the interest in science education through a questionnaire concerning 15 year olds attitudes to science and technology. The underlying idea is that the lack of relevance of the science and technology curriculum is one of the greatest barriers for good learning, as well as for interest in the subjects. In Sweden we received data from 29 schools with a total sample of 751 pupils. Girls, just like the boys, show interest about space and life in other places in universe. However, girls' most favourable items are about health, fitness, dreams and occultism. Boys display a keen interest in cosmology, how technological advices work and what can happen with the human body in different situations.

All along the line, girls are more interested than boys and we interpret the result as an effect of the fact that girls seems to be more successful in the "read and write school" we have created. Many of the items we traditionally teach in our science classes are found among items students' don't want to learn. Science facts come up in the bottom of the pupils list. Instead students want to learn about things we cannot yet explain and don't have a clear opinion about.

With these results and the ROSE project we find clear and distinct proofs of that the science curriculum has a great deal of worry, if we want the rising generation to experience science and technology as being relevant.

Many countries have described a decline in the number of students studying science and technology (Osborne et al., 2003). Havard (1996) point to the fact that even if there are more students taking science courses today, it is less part of the population compared with other educational programmes. There are also expectations that science and technology can stimulate growth economy. We are on the horns of a dilemma. Another perspective on this is that no one can survey the amount of information in a modern society and therefore we need superior and specialized people in science and technology (DeBoer, 2000). This means that teachers should be able to choose content and type of teaching in a flexible way. Some young people will become scientists and other work with social issues related to science and technology. Teachers need to show consideration for different interests in different groups. Still more, even if society needs expertise, an important perspective on the dilemma mentioned above is a person with a good all-round education (Sjöberg, 2000). More and more decisions are made on a scientific basis. A well-informed person taking part in clashes of opinions, are the foundation in the process of democratisation. With all that this implies, it has produced a whole area of research in what is called "scientific literacy", and this is an ongoing debate (DeBoer, 2000, Fensham, 1999). What is still missing is a science agenda that all people grasp as being important and for everyday use. Science and technology have become more and more important for society and at the same time, generations to come keep away from it and do not find it interesting or relevant (Sjöberg, 2000).

In these circumstances the research area concerning students´ attitudes to science and technology continue. The motive is to elucidate what attitudes being prevalent and trying to understand what kind of behaviour it might lead to.

Many different factors have been explored and put forward as being of great importance. Hendley et al. (1995) shows that when pupils are invited to rank school subjects, science, maths and technology are among the least popular and there are great differences between boys and girls. Girls show a lack of interest in almost all aspects. Breakwell & Beardsell (1992) underline that problems related to gender can be changed, so it is not gender in itself that is the problem. It is factors related to gender, like peers, friends, parents, TV, film media etc. Television and advertisement are discussed by McSharry & Jones (2002). Hendley et al. (1996) interviewed pupils about why they rank school subjects as they do. The pupils related a lot to interest, the teacher and how they manage with the content / subjects in school. Pell & Jarvis (2001) discuss the importance of the teacher and they show that interest for science fall as the pupils go through the educational system. Havard (1996) points out a complex of problems. He argues that there are great differences dependent on what part of science we talk about. Breakwell & Beardsell (1992) shows another important aspect. Their presentation of the problem is that there are big differences in attitude between science in school and science in society, often as technological progress.

Social group is another factor discussed (Breakwell & Beardsell, 1992; Lemke, 1990). The line of argument is that different groups have different interests and attitudes to what counts as necessities and what is a must. Lemke (1990) emphasize the use of language as a key factor and that we need to find new and different ways of talking and presenting science content, if we want more groups in society to find it important. Therefore this perspective points back to the importance of well educated teachers that can treat the science content in a flexible way. Yet another factor is the curriculum (Donnelly, 2001). He shows that in several aspects it is most ticklish to interpret the science curriculum and this leads to the fact that teachers have troubles putting it into practice.

At last we point to the fact that there are cultural differences and there are few investigations concerning this (Sjöberg, 2000). Perhaps lack of interest in science and technology can be explained by analysing how attitudes vary in different parts of the world.

Together these factors sum up to a problem drama and it is like ringing the changes on a theme. Many variables have been proposed and explored but very few studies have considered what the pupils' attitudes are (Osborne et al., 2003). Different people have different interests, necessities and experience science different from a utility point of view. How and why these vary is the key to understand what we mean with pupils attitudes to science and technology.

With this in view, we participated in the international project ROSE, the Relevance Of Science Education (ROSE, 2004). In this paper we present and discuss the first results from ROSE-Sweden.

The ROSE project

ROSE tries to trap aspects of the interest in science education through a questionnaire concerning 15 year olds attitudes to science and technology. The ROSE-project therefore pays attention to the pupils´ attitudes direct and not by way of other factors like ranking school subjects or selection of courses. The underlying idea is that the lack of relevance of the science and technology curriculum, is one of the greatest barriers for good learning as well as for interest in the subject. The questionnaire is divided into seven different categories, What I want to learn about, My future job, Me and the environmental challenges, My science classes,

My opinions about science and technology, My out-of-school experiences and Myself as a scientist.

In these categories are questions concerning astrophysics, earth science, human biology with sex and reproduction, genetics, zoology, botany, chemistry, optics, acoustics, electricity, energy, technology, STS (Science, Technology and Society) and NOS (Nature Of Science).

The questions are put in different contexts like: Spectacular phenomena, fear, technological ideas and inventions, aesthetical aspects, beauty, care, health, personal use and everyday relevance.

The ROSE survey in Sweden – Methods and carrying through

The Swedish school-system

All education throughout the Swedish public school system is free. There is usually no charge for teaching materials, school meals, health services or transport and this is true for both compulsory and upper secondary school. In the year 2002, about 6 % of compulsory school students attended one of the Swedish independent schools. Independent schools are free, open for everyone and must be approved by the National Agency for Education.

Almost all compulsory school students continue on directly to upper secondary school and the majority of these complete their upper secondary education in 3 years. Upper secondary education is divided into 17 national 3-year programs. All of the programs offer a broad general education and basic eligibility to continue studies at the post-secondary level. (The Swedish National Agency for Education, 2004).

Swedish science syllabuses are divided in three different subjects: Biology, Chemistry and Physics. In addition, there is also one general science syllabus. Technology has an own syllabus, but in many schools technology is taught together with science

Carrying through

We organised the survey for the age group 15 to 16 (ninth and last year in the Swedish compulsory school) and there were about 110 000 pupils in this population. 30 schools were randomly selected from a sample with nine stratum variables for assuring a correct weight of each type of school. The schools themselves selected one class at each school. The size of the classes differed between 20 and 35 pupils but in one school there were just 15 pupils in ninth year. We sent a leader to each school conducting the questionnaires and collected them.

We received data from 29 schools with a total sample of 751 pupils. Two schools were reporting some dissatisfaction from the pupils concerning the length of the questionnaire but 27 schools reported that the pupils worked peacefully for about 30 or 40 minutes.

The material will give a good overview over the Swedish pupils' opinions but the sample is not big enough to compare different kind of schools. We will however try to compare gender differences and also differences between students with different upper secondary choices. The translation was made carefully with the aim to make it as verbatim as possible without loosing shade of meaning:

1. We translated the questionnaires from the English version and made comparisons with the Norwegian one.
2. Other researchers read the translation and compared it with the original questionnaire.
3. From this we made a revised and final version.

At last we tested the whole questionnaire on a couple of nine graders, assuring that the questions could be clearly understood

The ROSE questionnaire

In the first part of the questionnaire, students were asked how interested they were in learning about 108 different items. The idea about these questions was to get evidence on what sort of items pupils were interested in, and give us insight into how science curricula may be constructed to meet the needs or interests of different groups of pupils. Some of the items may seem controversial and unusual in a science educational context, e.g. items regarding ghosts, horoscopes, mind reading, clashes between science and religion, etc. The inclusion of these items does *not* mean that we think these items are legitimate parts of a science curriculum! They are included because we want to explore the variety of pupils' interests, also in some unusual contexts. The analysis of the data from these items may illuminate questions like, how does the *context* versus the *subject matter area* influence young peoples interest and if we can see gender differences. (ROSE 2004)

They answered on a four-graded Likert scale from Not interested (value 1) to Very interested (value 4). Below an example from the questionnaire:

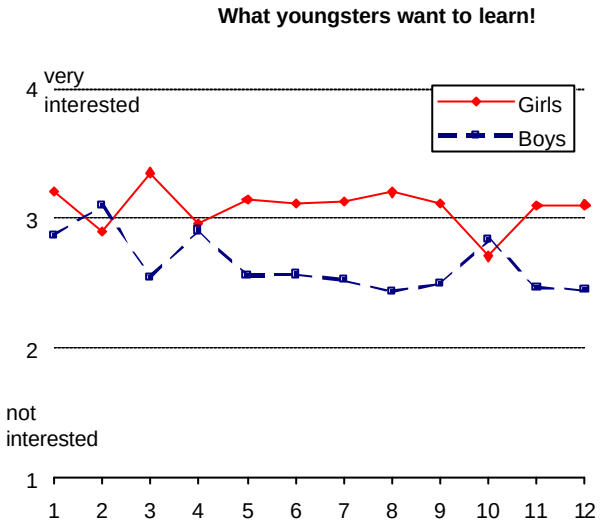
A. What I want to learn about
How interested are you in learning about the following?
(Give your answer with a tick on each line. If you do not understand, leave the line blank.)

Coding Value ***(Not printed in the questionnaire)***	***1***	***2***	***3***	***4***
	Not interes-ted			*Very interes-ted*
Stars, planets and the universe	?	?	?	?
Chemicals, their properties and how they react	?	?	?	?
Cloning of animals	?	?	?	?

Results

What pupils´ want to learn about

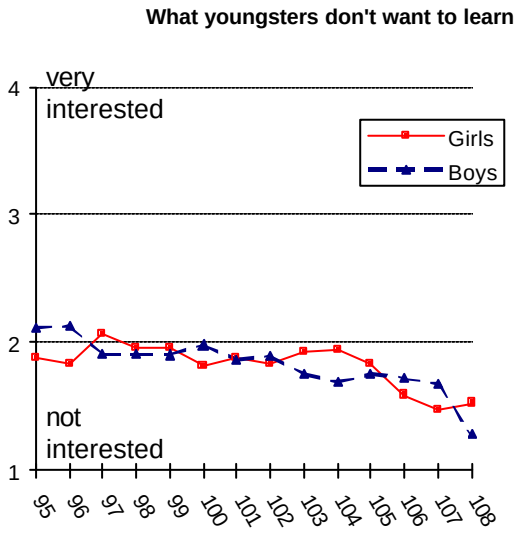
First we show the pupils´ 12 most popular items followed by the 14 least popular.



1 How to exercise to keep the body fit and strong
2 How it feels to be weightless in space
3 Why we dream while we are sleeping, and what the dreams may mean
4 The possibility of life outside earth
5 How different narcotics might affect the body
6 How alcohol and tobacco might affect the body
7 What to eat to keep healthy and fit
8 What we know about HIV/AIDS and how to control it
9 How to perform first-aid and use basic medical equipment
10 Phenomena that scientists´ still cannot explain
11 Thought transference, mind-reading, sixth sense, intuition, etc.
12 Sexually transmitted diseases and how to be protected against them

Figure1 The 12 most popular items.

Most popular items are those concerning students' own body and health and those concerning diseases. We also see that space and phenomena we still can't explain are popular. Girls have a higher score and an overall mean of 2.41 with boys on 2.31.



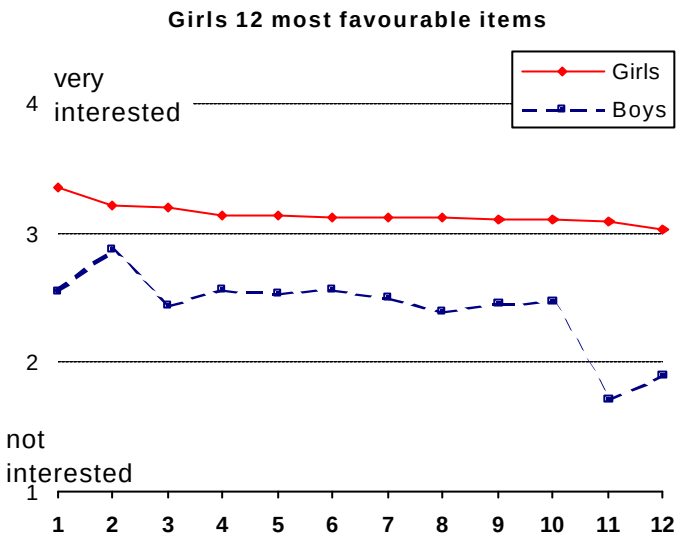
95 Optical instruments and how they work (telescope, camera, microscope, etc.)
96 Atoms and molecules
97 Organic and ecological farming without use of pesticides and artificial fertilizers
98 How scientific ideas sometimes challenge religion, authority and tradition
99 How mountains, rivers and oceans develop and change
100 How technology helps us to handle waste, garbage and sewage
101 Why scientists sometimes disagree
102 Benefits and possible hazards of modern methods of farming
103 Plants in my area
104 Detergents, soaps and how they work
105 How plants grow and reproduce
106 Famous scientists and their lives
107 How crude oil is converted to other materials, like plastics and textiles
108 Symmetries and patterns in leaves and flowers

Figure 2 The 14 least popular items.

Atoms and molecules are one example of items students' don't want to learn about, even though it's a cornerstone of Science.

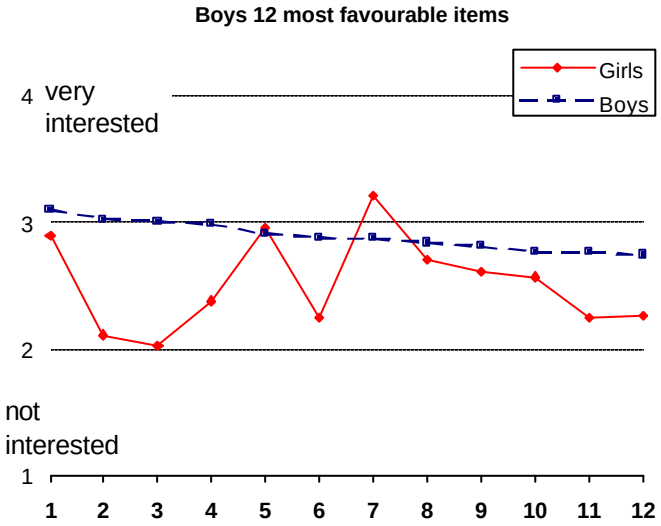
Gender

Of our 108 items girls are more interested in 63 items and boys in 45 items. We can also see big differences between girls and boys in what items they like most.



1 Why we dream while we are sleeping, and what the dreams may mean
2 How to exercise to keep the body fit and strong
3 What we know about HIV/AIDS and how to control it
4 How different narcotics might affect the body
5 What to eat to keep healthy and fit
6 How alcohol and tobacco might affect the body
7 How to perform first-aid and use basic medical equipment
8 Cancer, what we know and how we can treat it
9 Sexually transmitted diseases and how to be protected against them
10 Thought transference, mind-reading, sixth sense, intuition, etc.
11 Eating disorders like anorexia or bulimia
12 Biological and human aspects of abortion

Figure 3 Girls 12 most favourable items.



1 How it feels to be weightless in space
2 How the atom bomb functions
3 Explosive chemicals
4 How computers work
5 The possibility of life outside earth
6 Biological and chemical weapons and what they do to the human body
7 How to exercise to keep the body fit and strong
8 Phenomena that scientists´ still cannot explain
9 How meteors, comets or asteroids may cause disasters on earth
10 Black holes, supernovas and other spectacular objects in outer space
11 How cassette tapes, CDs and DVDs store and play sound and music
12 The effect of strong electric shocks and lightning on the human body

Figure 4 Boys 12 most favourable items.

Boys take an interest in “Weapon and Space” and girls in “Body and Health”. Phenomena that scientists still cannot explain are also an interesting item for both boys and girls. Students who have chosen the Science or the Technology program have a mean on 2.53 compared with the overall mean 2.35. This is significant higher but the profile is the same for boys and for girls no matter what upper secondary school they have chosen. This means that both science students and non-science students want to learn about “Space”, “Health” and “Wonder”.

My science classes

We also analysed other categories in the questionnaire. Part F is about their science classes, analysing it we didn't find significant differences between boys and girls. That being so, we cross-tabulated different upper secondary choices towards the categories, and then picked out some specific questions where there were obvious differences. We grouped the upper secondary programmes according to the list below.

1. The Vocational programmes directed to health, childcare, commerce and restaurants, 14 % of our pupils'.
2. The Vocational programmes directed to industry, construction and engineering, 13 % of our pupils'.
3. The Social Science, Media and Arts Programme, 35 % of our pupils'.
4. The Natural Science and Technology Programme 27 %, of our pupils'.
5. Others 10 % of our pupils'.

Below is an example from the questionnaire. We brought together the two rightmost to agree and the two leftmost to disagree.

F. My science classes
To what extent do you agree with the following statements about the science that you may have had at school?

	Disagree		Agree	
School science has opened my eyes to new and exciting jobs.	?	?	?	?

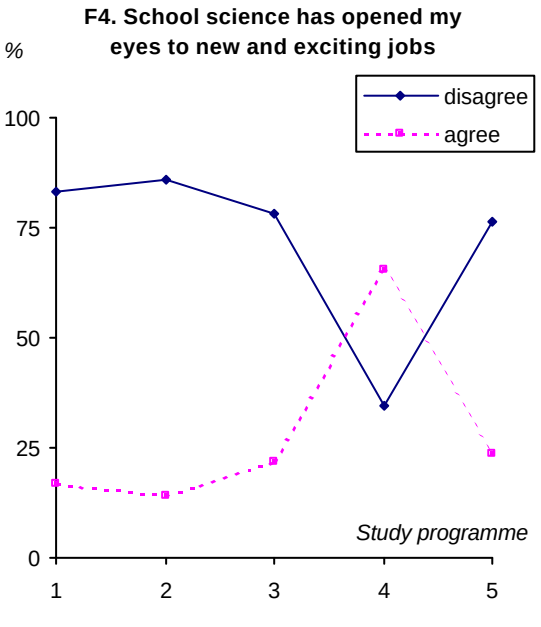


Figure 5 Percentage that finds that school science has opened their eyes to new and exciting jobs.

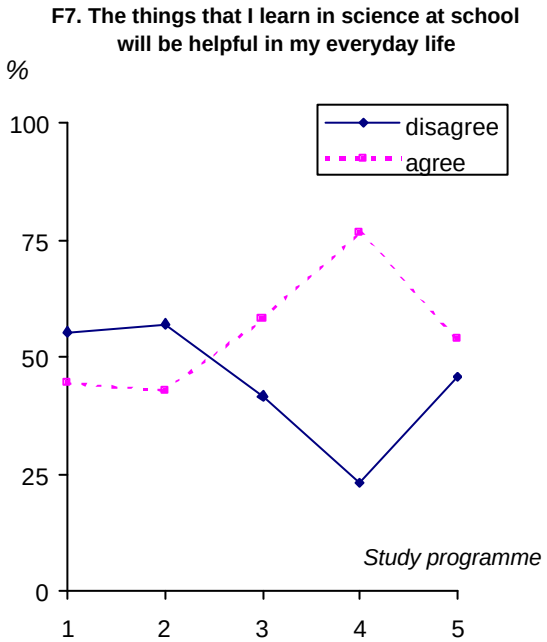


Figure 6 Percentage that finds that what they have learned in school science will be helpful in everyday life.

Only group 4 (future science students) agree in both statements above. Group 3 (Social science, art and media) find the things they have learned in science at school helpful but not those who has chosen vocational programs. 85 % of those from group 2 (Vocational

programmes directed to industry, construction and engineering) don't agree with the statement that school science has open their eyes for new and exciting jobs.

Only among future science students can we find a clear majority that thinks their curiosity have increased during their science classes.

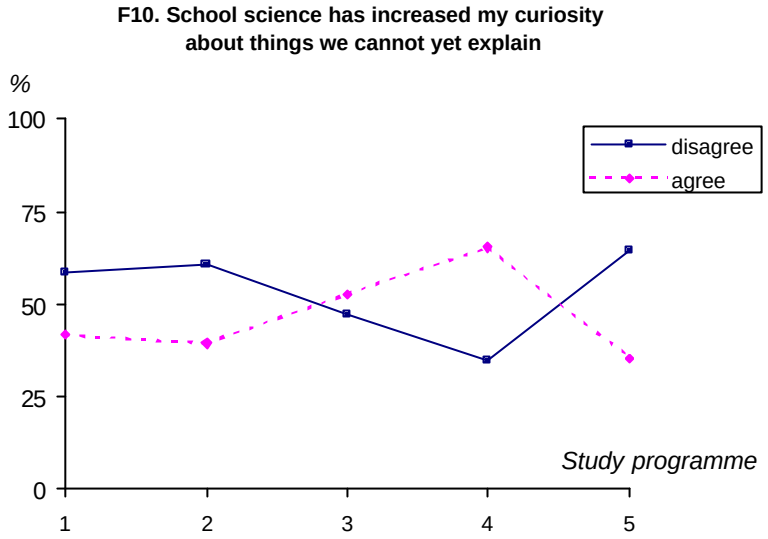


Figure 7 Percentage that think that school science has increased their curiosity about things we cannot yet explain.

Discussion

Some of the pupils´ popular items are covered in Swedish curricula and syllabuses for compulsory school, like the danger with alcohol and narcotics. But still, syllabuses are and especially textbooks, dominated by science facts. Even though the syllabuses have been rewritten in 2000, the textbooks are quite the same as before (Svennbeck, 2004; The Swedish National Agency for Education 2004).

Girls, just like the boys, show interest about space and life in other places in universe. However, girls most favourable items are about health, fitness, dreams and occultism. These are not prominent in a science agenda, except perhaps when the human body is treated in biology. Boys display a keen interest in cosmology, how technological advices work and what can happen with the human body in different situations. Just like for the girls: These items don't come out conspicuously in a science syllabus. Worth considering: Many of the items we traditionally teach in our science classes are found among items students' don't want to learn. Items like atoms and molecules, mountains, detergents, famous scientist and plants in their area, are apparently the least popular items among all 108! In this aspect, there are no big differences between boys and girls.

All along the line, girls are more interested than boys, which is interesting. Many campaigns have been carried through the last ten years with purpose to increase girls' interest in science. If our results are an indication of increasing interest among girls, or decreasing interest among boys, is not obvious. Girls are 45 % of the students at upper secondary science program. In Sweden today girls have higher grades in almost all subjects in the compulsory school, including science. We interpret the result as an effect of the fact that girls seems to be more successful in the "read and write school" we have created, and that this is true also for science but to a lesser extent for technology.

Indisputably, science facts come up in the bottom of the pupils list, and that is also true for items traditionally considered everyday cares and fun, like how the sunset colours the sky, detergents, soaps and how they work, how plants grow and reproduce. All these are among the least popular. Instead students want to learn about things we cannot yet explain and don't have a clear opinion about. This is in contrast with the traditionally science education culture and worth paying attention. It is not an imperative necessity to teach science like if it is a set of facts. Actually, this is a misunderstanding and does not say much about the nature of science. As a matter of fact, there are no science facts, but it seems like pupils apprehend the school science as being authoritarian and dead certain about things. Pupils take in science as being facts and at the same time, this is an attitude they don't prefer. They want to be part of discussions where there is no final answer. The incompatibility in this is that science has so much to offer in this connection.

Deepen this perspective and put it in concrete form: All questions students have concerning their body and its function could be dealt with, when they study the human body in their science classes. Why we dream, and what the dreams may mean, could be expressed in the same sense. If we teach about fats, carbohydrates and proteins it is possible to talk about what to eat to keep the body fit and if motion is taught, it is conceivable to link up with planets and stars. Here, there and everywhere it is possible to change descriptions that are more in line with 15 year olds attitudes. This perspective needs to be more substantiated and taken into details. In plain terms: This is a possibility of development.

We have accomplished a good many analyses of other parts in the questionnaire, and here we presented three diagrams from category F, "My science classes". Even though an unsophisticated analysis, we find very interesting results when cross-tabulating the items with upper secondary school choices. The pupils that had chosen the natural science and technology programmes, differ from other pupils in several aspects. What can be important for their choice? It is an obvious fact that they see that science can give new and exciting jobs, that it can be helpful in everyday life and that it can arise one's interest for things we cannot yet explain. These are three aspects where the science pupils differ in a striking way and this was one way of finding differences in this category when sex failed.

These three items have something in common: They treat things about science that is outside school context, for: They are all a matter of what you can call "science in society". Could it be that pupils need to see the usefulness of their science in school for being very fond of the subjects? Or do they understand the difference between "science in school" and "science in society" and just don't care about it? Or could it be just an accidental occurrence and not an important perspective? The enthralling thing is that we can go further with this as one category in the questionnaire is about "My out of school experiences" and another is about "My opinions about science and technology". It will be very interesting to see what we can find in comparison with those.

With these results we can support curriculum development on a scientific basis. In this work we pay attention to the pupils' attitudes to science and technology. What can we learn from them? The matter is still left open, but with the ROSE project we find clear and distinct proofs of that the science curriculum has a great deal of worry, if we want the rising generation to experience science and technology as being relevant. With data like this we can carry the discussion forward and nail elusive patterns and trends. What we will do about it, insist on another rational.

References

Breakwell, G. M. & Beardsell, S., 1992. Gender, parental and peer influences upon science attitudes and activities. *Public Understanding of Science.* 1: 183-197.

DeBoer, G., 2000. Scientific literacy: another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching. 37: 582-601*.

Donnelly, J., 2001. Contested terrain or unified project? 'The nature of science' in the National Curriculum for England and Wales. *International Journal of Science Education. 23: 181-195*.

Fensham, P. J., 1999. School science and public understanding of science. *International Journal of Science Education. 21: 755-763.*

Havard, N., 1996. Student attitudes to studying A-level sciences. *Public Understanding of Science. 5: 321-330.*

Hendley, D., Parkinson, J., Stables, A. & Tanner, H., 1995. Gender differences in pupil attitudes to the national curriculum foundation subjects of english, mathematics, science and technology in Key Stage 3 in South Wales. *Educational Studies. 21: 85-97.*

Hendley, D., Stables, S. & Stables, A., 1996. Pupils' subject preferences at Key Stage 3 in South Wales. *Educational Studies. 22: 177-187.*

Lemke, J., L. 1990. *Talking science*: *Language, learning, and values*. Ablex Publishing. Westport, Connecticut, London.

McSharry, G. & Jones, S., 2002. Television programming and advertisements: help or hindrance to effective science education? *International Journal of Science Education. 24: 487-497.*

Osborne, J., Simon, S. & Collins, S., 2003. Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education. 25: 1049-1079*.

Pell, T. & Jarvis, T., 2001. Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal of Science Education. 23: 847-862.*

ROSE, 2004. http://www.ils.uio.no/forskning/rose/ 2004-06-30. University of Oslo, Norway

Sjöberg, S., 2000. Interesting all children in 'science for all'. In Millar, R., Leach, J. & Osborne, J., 2000. *Improving science education*. Open University Press. Buckingham, Philadelphia.

Svennbeck, Margareta (2004). *Omsorg om naturen: Om NO-utbildningens selektiva traditioner med fokus på miljöfostran och genus*. Uppsala, Acta Universitatis Uppsaliensis.

The Swedish National Agency for Education, 2004. http://www3.skolverket.se/ki03/front.aspx?sprak=EN&ar=0304&skolform=11&infotyp=2&id=11. 2004-06-28, Stockholm