Science education and youth's identity construction - two incompatible projects?

Camilla Schreiner and Svein Sjøberg,

University of Oslo, Department of Teacher Education and School Development

Introduction[1]

"Europe needs more scientists!" is the title of the final report from a large EU project addressing the condition of science and technology (S&T) in EU, with special attention to the number of people entering S&T educations and careers (EU, 2004). The title of the report reveals the point: The falling recruitment to most S&T educations is seen as a large problem in most European countries. The same tendencies are noted in the US (NSB, 2004).

There are large and interesting differences between the countries, both in respect of number of students, which subjects that have the weakest recruitment, how large the recruitment problem is perceived to be, etc. Especially the "hard" S&T-subjects, such as technology, engineering, physics and to some extent chemistry are stricken. In addition, the gender differences vary from one country to another. In most countries, although with large variations, the boys outnumber the girls in physics and engineering studies, while the gender balance is shifted towards the girls in studies like medicine, veterinary medicine, environmental science and biology.

However, the overall picture regarding the interest in S&T is not at all negative. Popular science magazines, books and radio and television programs still attract audience, and science museums and science centres report increasing numbers of visitors. Interesting results can be read from the Eurobarometer surveys. These studies monitor views, values and attitudes held by European citizens on many aspects of life and culture. Some of these studies relate to issues concerning S&T in society, and they indicate a rather widespread respect for, belief in and positive interest in S&T issues. The interest scores are, however, not the same for girls and boys. While girls express more interest for medicine and the environment, boys are more interested in technology (EU, 2001). An interesting result from the most recent Eurobarometer on S&T (EU, 2005) is that the level of knowledge about S&T in most European countries seems to be improving, although one often hears claims of an increasing scientific illiteracy. What we can learn from these studies seem to be that "the problem" is not a general decline in interest in and respect for S&T as such, but rather a decline in the willingness to enter into S&T-related studies and careers. Our contention is that this reluctance of young people in

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[1] This chapter is a shortened and partly rewritten version of a Norwegian paper published in Nordina, Nordic Studies in Science Education (Schreiner & Sjøberg, 2005).

many modern countries to enter S&T fields has more to do with the perceived values and images of S&T than with lack of respect and lack of knowledge.

The "spirit of the age" and the predominant zeitgeist, ideas and values in a society have a major influence on young people's way of thinking about and understanding the world, their surroundings and themselves and what young people regard as interesting, important and meaningful for their lives and for society. In this chapter, we will discuss some tendencies in the late modern[2] zeitgeist that may be relevant for understanding youth's educational choices. May perhaps trends and fluctuations in student recruitment follow the society's level of development and modernisation? May the low recruitment to S&T studies in some highly developed societies be related to the social development and the associated changes in the spirit, values and ideas of the society?

More specifically, we ask:
- Do young people value the outcomes of the scientific and the technological development?
- Do young people find their science classes interesting?
- What values guide young people in their choice of an education and a job?

Our focus will be on youth in Western, highly modernised countries, but in order to understand these young people better, they will be studied against a background of youth from other countries and cultures. Therefore, we will also report on data collected in less developed countries. In order to shed light on the questions raised above, we will draw on sociological perspectives describing aspects of youth culture in late modern societies. We wish to emphasise that this perspective applies to Western highly developed and modernised countries only, and that interpretations of data from developing countries should be based on other theories. Next, we will present some results from our empirical data analysis. Finally, we will discuss whether school science and educations and jobs related to S&T meet young people in their values and priorities. We will also suggest some possible ways ahead.

Our data are collected through the ROSE project, and we will start with a brief presentation of the project.

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[2] According to sociological theories on modernity, modernisation of societies is connected to the cultural, economic and political development in Western societies. The present-day post-industrial period is referred to as "high modernity", "late modernity" and "reflexive modernity" (Giddens, 1991), "second modernity" (Beck, 1999),"liquid modernity" (Bauman, 2001), etc. We will use the terms "Western", "developed", "modern", "modernised" and "late modern" synonymously.

ROSE – a brief presentation

ROSE, The Relevance of Science Education, is an international comparative project meant to shed light on affective factors of importance to the learning of science and technology. The target population is students towards the end of secondary school (age 15). The research instrument is a questionnaire mostly consisting of closed questions with four-point Likert scales. Among other issues, the questionnaire addresses their interests in learning about various topics, their experience with and views on school science and their views and attitudes to science in society. The rationale behind the project, including the questionnaire development, theoretical background, procedures for data collection, etc. is described in Schreiner and Sjøberg (2004).

The participating researchers in different countries were requested to apply random sampling methods. For various reasons, e.g. due to limited financial resources, some countries have not been able to comply with the request. This means that not all of the 40 participating countries have samples that without reservation can be regarded as representative for 15 years old students in the country[3]. We will, however, note that in spite of non-random sampling procedures, countries that are commonly considered as similar to each other (for example African, Baltic or Scandinavian countries) do in most instances show similar or related response patterns. This can be seen as some validation of the data. In some of the diagrams in this chapter, results from a single country may differ from the general pattern in the diagram. Here, we will not discuss whether such peculiarities might have been caused by errors in the measurement, the coding, the translation, etc., or by particular cultural-, political- or school-related issues.

Identity construction and educational choices

Across all epochs and cultures, the youth phase is commonly seen as a period in life which is particularly occupied with identity construction (Coleman & Hendry, 1999). The individualisation processes characterising the development in many modern societies imply that the society accentuates the individual's freedom and independence. The "unit" of the society is the individual; liberated from collective structures such as social class, gender, place of living, family institutions, etc. In pre-modern societies, one's identity is *ascribed* and determined on the basis of sex, parents' social status, etc., while in late modern societies one's identity is increasingly *managed* through one's personal choices (Côté, 1996).

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

Young people in late modern societies may thereby feel culturally, socially and geographically liberated (Ziehe & Stubenrauch, 1993). They may have the idea that, regardless of home background, they are free to choose their address, religion, social group, politics, education, profession, sexuality, lifestyle and values (Beck & Beck-Gernsheim, 2002). This may foster the feeling that one's life, including one's educational choice, has a range of possible ways ahead. From the cultural liberation of the individual follows that one's identity is no longer perceived as something that is handed out or given, but rather something one has to choose and develop by oneself (Giddens, 1991). Who one will be and how one will do it are up to each person to decide.

Even though a person's identity is a relatively stable perception of who a person is, it is also in continuous development. In light of new knowledge and new experiences, people are continuously reconsidering and redeveloping their self (Giddens, 1991). The American sociologist Erving Goffman sees social life as performances with agreed rules for behaviour. Based on empirical analyses of human interaction, he describes how every facet of people's public choices and behaviour, such as language, actions, values and beliefs, are tacit symbols or codes of social identities (Goffman, 1959). Choices are continuously made and remade on everyday matters, such as clothing, appearance, leisure activities, music taste, sports, sexuality, beliefs, etc. (Giddens, 1991). Also in the school and classroom context, young people define and communicate their identities through signs like school performance, subject preferences, behaviour in the classroom and in the breaks, etc. All these signs carry a message of one's identity (Lyng, 2004). In order to communicate one's identity, signs of what one *is not*, are just as important as signs of what one *is* (Frønes, 1998).

Constructing and developing one's identity is, according to Illeris et al., at the heart of the late modern youth project:

> [...] And precisely this identity development can be seen as the essence or the driving force behind all the lots of choices that young people today are plunged into, as the very central task of youth today (Illeris, Katznelson, Simonsen & Ulriksen, 2002, p. 26, my translation)

These authors argue that the traditional question "What do you want to be when you're grown up?" addresses a more far-reaching issue than before. Today, the answer of this question should in less extent be seen as perceptions about a job and income, and more as an answer to the question "*Who* do you want to be when you're grown up?" (ibid., 2002, p. 57, authors' emphasis, my translation). When young people choose an education or a job, they do at the same express important components of their identity. Education is seen as a means for self-actualization and for fulfilling and developing one's personal talents and abilities. Youth wish to find a study they can *burn for;* something exciting and enriching (Illeris & al., 2002; Simonsen & Ulriksen, 1998; Ulriksen, 2003). An empirical study of

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Danish students' explanation for their educational choice showed that the majority of the students had chosen their subject for "existential and individualistic" reasons – they wished to "develop themselves", "get wiser", "become deeply absorbed", etc. (Simonsen & Ulriksen, 1998).

Several studies of youth's educational choices find that *subject interests* is a key criteria (Angell, Henriksen & Isnes, 2003; Lindahl, 2003). Abilities also play a crucial role (ibid.), but even students who perform well in mathematics and science often choose other studies and jobs. This is particularly the case for girls (Støren & Arnesen, 2003).

Values, interests and priorities: Some illustrative data

It is in the nature of quantitative research to compare *groups* of students rather than individuals. Students are categorised according to, for example, sex, age, socioeconomic status of the home, religion, race, language, school type and urban/rural place of living. All research based on groups of respondents entails a loss of information at the level of the individual. This means that quantitative data facilitates characteristics of the *typical* – but inevitably at the expense of the particular. In the present study, too, *groups* of respondents will be the unit of the research. The individuals are categorised into sex/gender categories. Characteristics of girls and boys, represented by mean scores for all students of the same sex, will unavoidably do injustice to the individuals. The focus of this study is on the *typical,* rather than on the particular. Thus, this injustice is a compromise that the study will make.

We will report results from analysis of the ROSE material. All diagrams show mean scores for 14-16 years old girls and boys from a number of countries in the ROSE sample. The countries are sorted partly geographically, with neighbouring countries together; and partly by level of development, with more modernised countries in the bottom.

The Likert scales have four response categories. The responses are coded from 1 (Disagree) to 4 (Agree). This means that the value 2.5 lies in the middle of the scale. We will in the following interpret average scores of 2.5 as the students in the country in average are *neutral* to the statement; that they neither agree nor disagree.

School science is somewhat interesting

One questionnaire item asks the students whether they agree that *School science is interesting* (Figure 1). Compared to the less developed countries, the students in the modernised countries show little interest in the subject. But the picture is not strikingly bleak, since in nearly all countries the average scores both for the girls and the boys lie on the "agreeing" side of the neutral value. This means that

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although modern youth do not express that school science is especially interesting, the subject do nevertheless attract some of the students' curiosity.
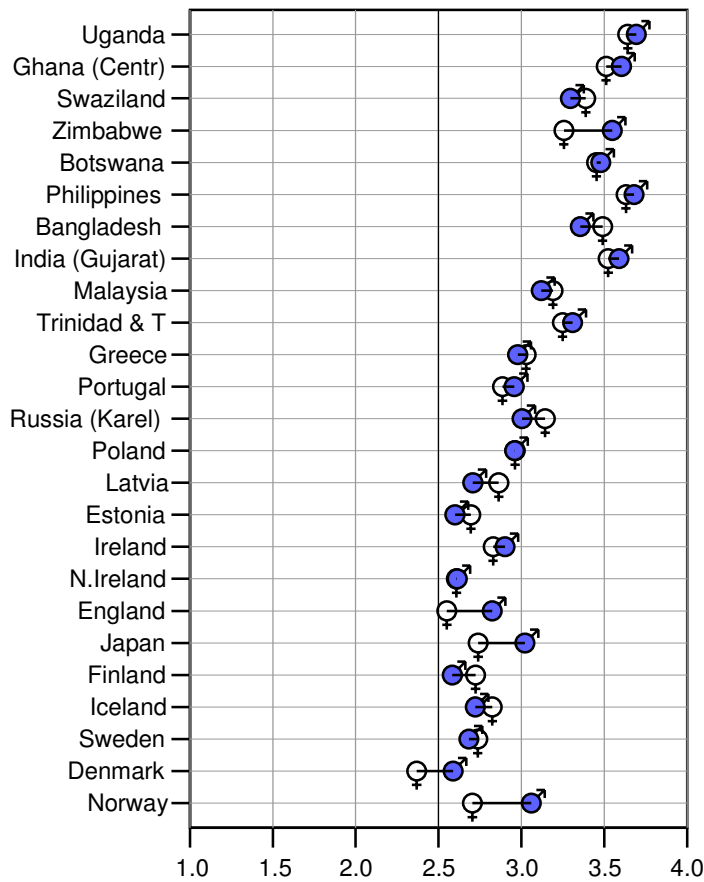

Figure 1. *School science is interesting.* Average scores for boys (filled symbols) and girls (open symbols). In countries that has a set of brackets next to the country name, data were sampled from a country region: Ghana has data from the Central region, India has data from Gujarat, and in Russia the data are collected from Karelia. "Trinidad & T" denotes Trinidad and Tobago.

Similarly, the responses to the items *I think everybody should learn science at school, The things that I learn in science at school will be helpful in my everyday life,* and *School science has increased my curiosity about things we cannot yet explain* indicate that the students do not have solely negative views on school science. Even though young people in the less developed countries are far more positive towards such statements than in the modernised, the average scores of the modern youth also lie above the neutral value. This means that also the modern youth are inclined to agree that school science offers something that they can appreciate.

Modern youth appreciate S&T in society

A possible explanation for young people's lack of interest for studying S&T could be that they hold a negative view of the role S&T play in society, and that they blame S&T for the unintended catastrophes and risks (e.g. the Chernobyl disaster in 1986, BSE (Bovine Spongiform Encephalopathy

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or "mad cow disease"), ozone layer depletion, global warming and overpopulation) following in the wake of the technological development (Beck, 1999; Sjøberg, 2004).

In all countries, including the modernised, youth express a positive view on S&T. Average scores for girls and boys in nearly all countries show strong agreement with statements like *Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc, Science and technology are important for society, Thanks to science and technology, there will be greater opportunities for future generations, New technologies will make work more interesting, The benefits of science are greater than the harmful effects it could have,* and *Science and technology make our lives healthier, easier and more comfortable.*

Figure 2 illustrates this with one example. The diagram shows responses to *Science and technology are important for society.* In average, girls and boys in all countries agree that S&T are important for society, and the gender differences are negligible.
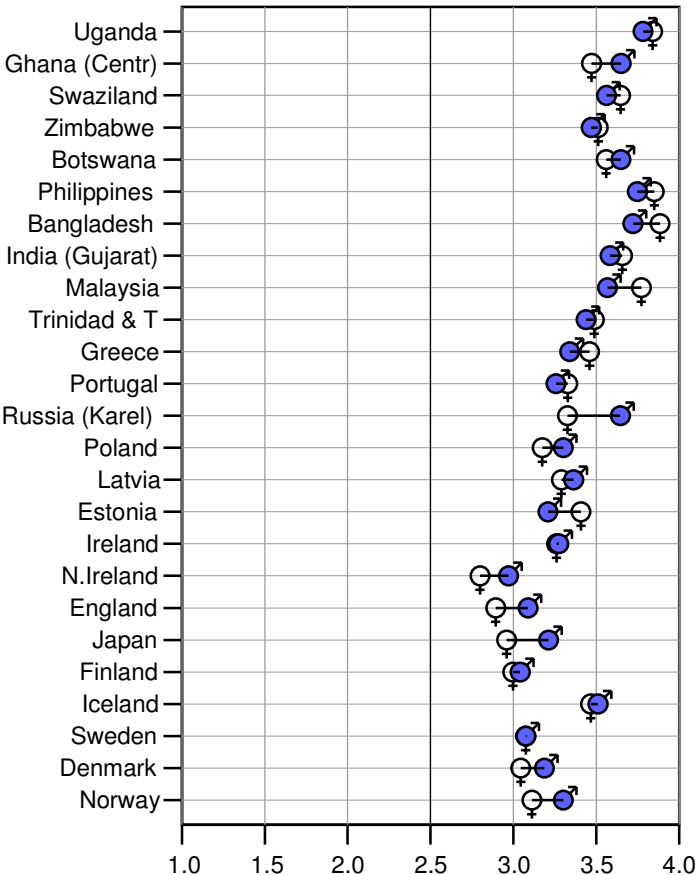

Figure 2. *Science and technology are important for society. See caption 1 for diagram explanations.*

Consequently, we may, on the basis of these items, conclude that modern youth are relatively positive to the influence of S&T on society.

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Youth do not prefer school science above all!

From Figure 1 we saw that the students after all express that they find school science relatively interesting. However, a somewhat different picture appears in Figure 3, where science is seen in comparisons with other school subjects. Average scores in most Western countries show that the students disagree with the statement *I like school science better than most other subjects.*
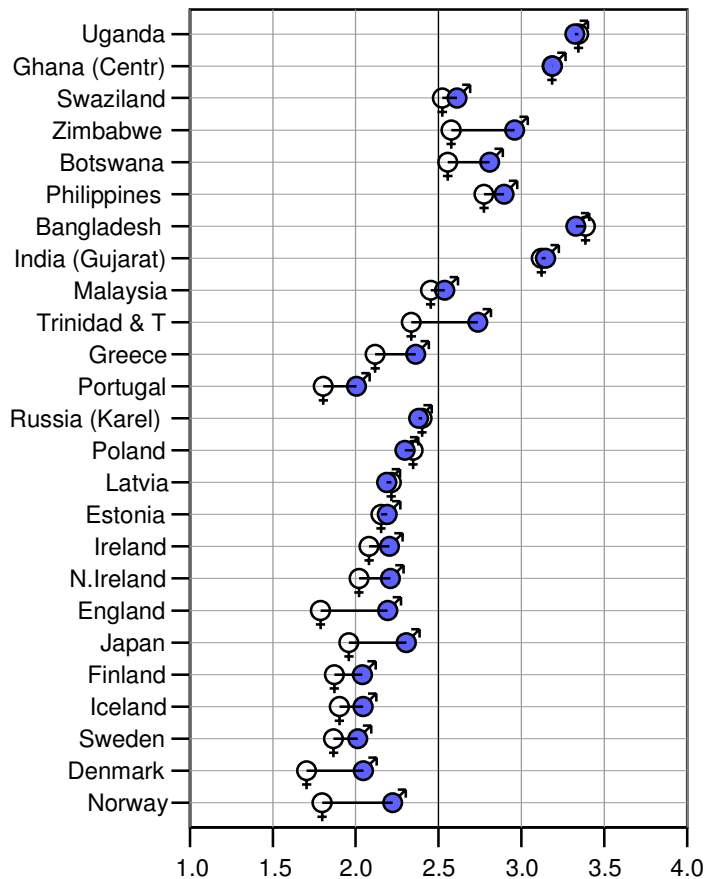

Figure 3. *I like school science better than most other subjects*. See caption 1 for diagram explanations.

A synthesis of Figure 1 and Figure 3 may indicate that school science is somewhat interesting, but when compared to other school subjects, science cannot compete. Western students do *not* like school science better than most other subjects. Exactly this point may be crucial for their later rejection of S&T studies, since other options may be even more attractive. As described above, Western youth see numerous options for their educational choice, and their interests play a key role in their decision. As long as science is not *the* most interesting subject, they will not choose to pursue it further.

The good job

One question in the questionnaire lists a range of job qualities and asks the students to indicate on a four-point Likert scale how important they perceive each of these qualities for their future job. *Not*

important is coded 1 and *Very important* is coded 4. One of the items reads *Working with something I find important and meaningful*. Results are presented in Figure 4.
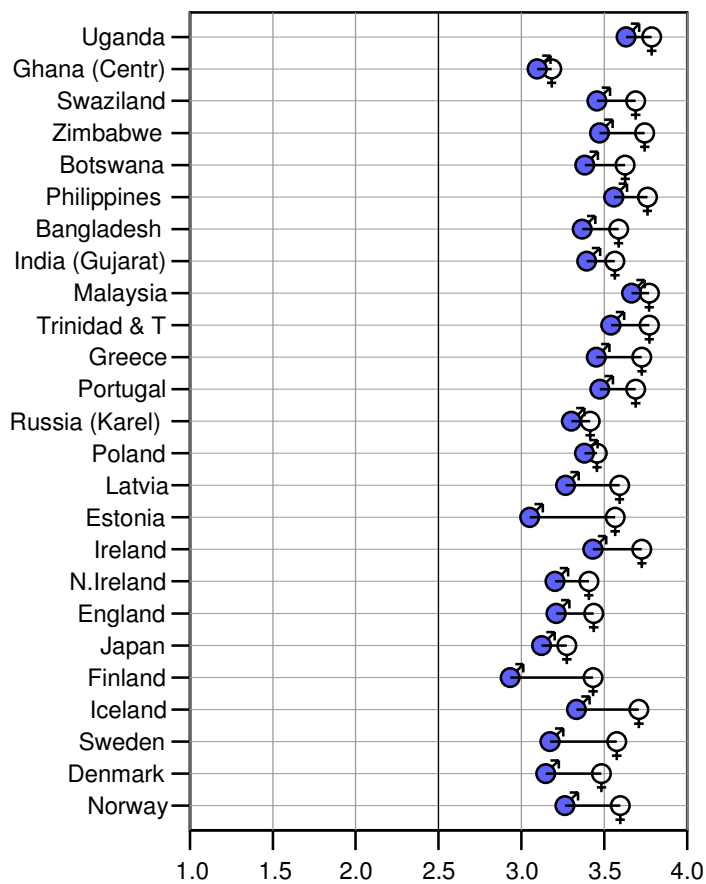

Figure 4. *Working with something I find important and meaningful.* See caption 1 for diagram explanations.

Figure 4 shows that in each and every country, youth hope to get a job in which they can do something they find important and meaningful. Most of the countries' mean scores lie close to 3.5, which is a very high value in this four-point scale. In all countries, girls find it somewhat more important than boys, but the average scores indicate that this is *very* important for *all* youth; including the boys.

In addition, both girls and boys in modern societies strongly agree that their job should offer opportunities for *Using my talents and abilities, Making my own decisions, Having lots of time for my friends,* and *Earning lots of money.* For some of the items, we find large and interesting gender differences, for example in *Helping other people, Working with people rather than things,* and *Working artistically and creatively in art.* Here, the Western girls give noteworthy higher priority than the Western boys.

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Our hypothesis is that the reason for the low number of students choosing to pursue S&T studies in many Western societies is that the aspects that they apparently value so high will not be found in S&T subjects and careers.

Is not S&T meaningful?

We see from Figure 5 that there are large cross-national differences when it comes to students' agreement with the statement *I would like to become a scientist.* The mean scores in the developed countries are extremely low, and the girls are even more negative than the boys.
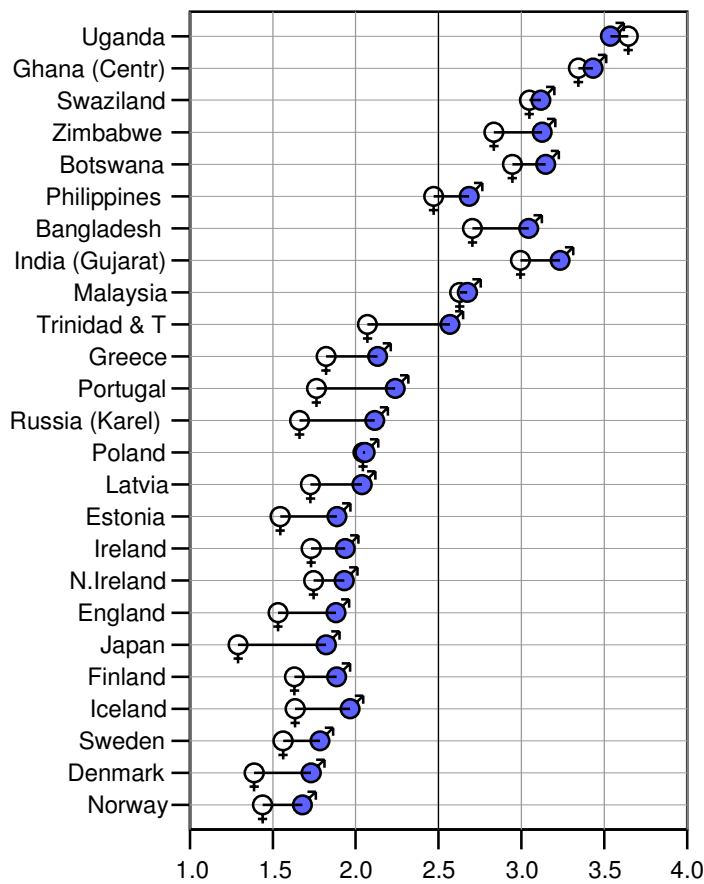

Figure 5. *I would like to become a scientist.* See caption 1 for diagram explanations.

Responses to the item *I would like to get a job in technology* are illustrated in Figure 6. Also in this diagram, we note pronounced differences between countries and between girls and boys in each country. While boys in modernised countries give average scores close to the neutral value, most girls in these countries do *not* want to work with technology. In developing countries, both girls and boys agree with the statement. Also in these countries there are some gender differences, but they are by no means as large as in the developed countries.
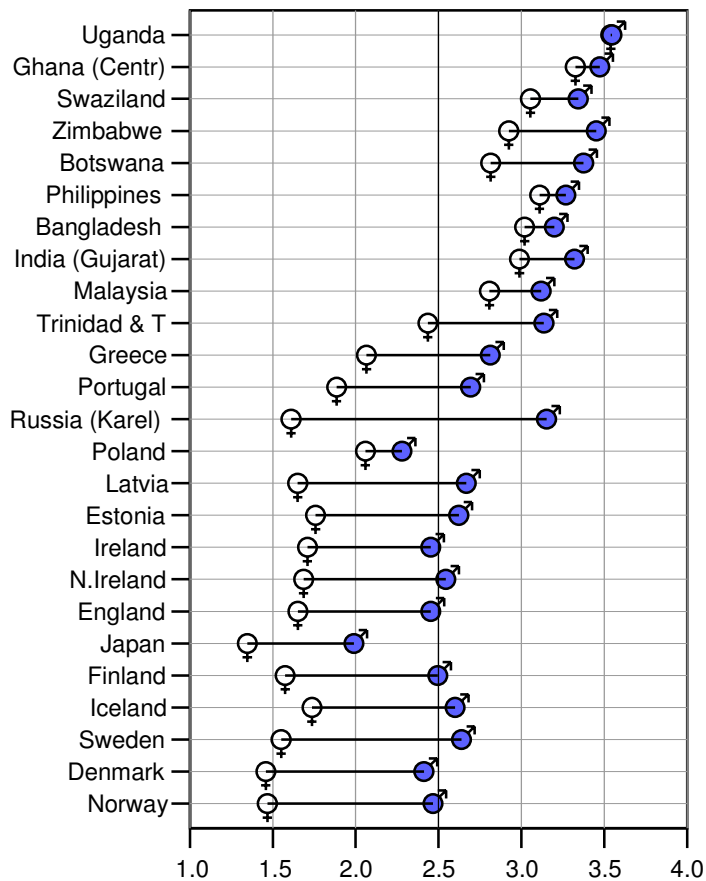
Figure 6. *I would like to get a job in technology*. See caption 1 for diagram explanations.

Can school science meet youth's interests and values?

When today's Western youth choose an education, their decision is based on more than family traditions and a need for ensuring a safe job with a stable income. We have pointed to identity construction and students' interests as two important factors that influences their educational choices. Their education and their future job have to be interesting and meaningful, to harmonise with their identity and to open up for self-actualisation and self-development.

Our empirical analysis shows that Western youth consider school science to be rather interesting. However, contrary to youth in developing countries, they do not agree that school science is *more* interesting than other subjects at school. Furthermore, our data suggest that students in all countries hold a relative positive view on many aspects of S&T in society. Students in all countries wish to work with something they find important and meaningful, and girls also wish to work with and help other people. Youth in developing countries say that they would like to work within the fields of S&T, while in modernised countries some boys can see themselves working with technology, while the girls do not share this view. Moreover, neither girls nor boys in Western societies want to be a scientist.

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The mechanisms behind young people's priorities are multifaceted and difficult to understand, and no theory alone has the capacity to give a complete explanation of youth's rejection of S&T studies and jobs. We will draw on three perspectives that may be significant for understanding our empirical results as well as the low recruitment of students in wealthy, modern societies to S&T studies: (1) Issues that are perceived as *meaningful* for young people in a country is dependent on the culture and the material conditions in the country. (2) An educational choice is an identity choice. (3) Young people wish to *burn for* what they are doing and they wish to develop themselves and their abilities. They have a range of possible and accessible ways ahead, and they choose *the* most interesting of the many alternatives they have. In the following, we will briefly discuss these three perspectives and some implications for the science curriculum.

Meaning - linked to the level of development in a country

Young people's values, views and ways of understanding themselves, their surroundings and the world are products of the culture in which they are growing up. We have seen that youth in all countries wish to work with something they find meaningful. But what meaning do they put in the concept "meaningful"? We interpret from our data that whether a job in S&T is perceived as meaningful for the individual is closely related to the country's level of development. The pronounced interest for a job in S&T in developing countries may indicate that youth in these countries find S&T meaningful. An important challenge in poor countries is of course related to the betterment of material conditions, economic growth and to improvement of health and the welfare system. Further material development of the society is naturally a main political and public issue, and in this respect S&T are seen as fundamental driving forces. One may assume that in such societies, a job in S&T is perceived as important for society and thereby as meaningful for the individual.

When today's modern societies were in the era of early industrialisation, the focus was directed towards *progress*, *growth* and *building the country*. Consequently, exactly this - to build the country - was perceived as important for the society and meaningful for the individual. It may be that we now have passed the era in which the work of physicists, technicians and engineers are seen as crucial for people's life and well-being. Studies also indicate that in poorer countries, young people have a rather heroic image of scientists as persons, while this is not the case in highly developed Western societies (Sjøberg, 2002). In modern societies, neither scientists nor engineers are heroes or attractive role models for the young generation.

Obviously, the level of development influences people's expectations to the expected benefits of developments in S&T (Sicinski, 1976). The recent Eurobarometer (EU, 2005) also shows that the belief in the benefits of S&T is much stronger in the less developed EU countries than in the wealthier

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and more developed[4]. According to Inglehart (1990), late modern societies can be characterised as post-materialistic societies emphasising values like environment, democracy, care for others, self-actualisation, etc. The recruitment of Western students to medicine, biology and environment studies are *not* falling, and in these subjects the girls often outnumber the boys. This may indicate that modern youth believe that the most important challenges facing our society are related to health and environmental issues, and, consequently, that these fields can offer meaningful jobs.

Non-modern identities associated with S&T?

Boaler and her colleagues argue that youth's identity development is an important, but neglected, factor in mathematics education (Boaler, 2002; Boaler, William & Zevenbergen, 2000). In order to understand why some of the "able" students continue with mathematics studies, while others do not, the authors take note of the youth's identity construction. Through their mathematics lessons, the students learn "how to *be* a mathematics student", i.e. how to work, how to cope, how to act, how to think, how to discuss, etc. (Boaler & al., 2000). Thereby, they get an impression about the role, or the identity, of a mathematician. Boaler and her colleges infer that most high-achieving students want to be successful in school mathematics, so that they can have access to the job or education they want. But when mathematics is no longer compulsory, they reject the subject, because they do not want to "belong" to the mathematics culture, or to carry the identity of a mathematician.

Correspondingly, one may infer that young people, especially girls, do not want to have the *identity* that is seen to be connected with being a physicists or an engineer. May it be that young people, especially girls, perceive the identity of engineers and physicist as incongruent with their own? The masculine image of S&T and S&T careers is discussed in the literature (Lightbody & Durndell, 1996; Sjøberg, 2000). This may, naturally, have an effect on the girls' rejection of identities connected with S&T educations and jobs.

Students recognise that S&T are important for society, and they value the goods and the welfare coming along with the development. Nevertheless, they do not wish to have a job within these fields. We interpret that young people, especially girls, do not want to have the *identity* that is seen to be connected with being a physicists or an engineer. Is it possible that youth associate the tasks of these professions with the development of even broader bridges, even speedier airplanes, even newer techniques for pumping up fossil oil, even tinier mobile phones and even faster computers with even larger storing capacities? Is it possible that young people, in particular girls, believe that today's

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[4] The recent Eurobarometer (EU, 2005) has collected data in 32 countries: the '15 "old" EU countries, the 10 new member states (previously Eastern Europe), the four "candidate countries", including Turkey, Croatia, Bulgaria and Romania and the three EFTA countries Iceland, Norway and Switzerland.

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problems related to health and environment overshadow the difficulties we may have with slow computers and airplanes and less access to fossil fuels? May it be that young people, especially girls, although they appreciate the technology, rather would like to have an identity that is conveying late modern values? Such values may be self-realisation; creativity and innovation; working with people and helping others; and/or earning lots of money.

If this perspective has a point, then the fall in the recruitment to the hard S&T subjects may be met by upgrading the images associated with persons working within these fields. In addition to computers and oil pumps, the physicist and the engineer develops methods for utilising alternative energy sources, they develop technologies for eliminating landmines, methods for more animal friendly food production, solutions for protection against weapons, new instruments for treating diseases, etc. The driving force behind their work is their internal motor fired by their values, creativity, interests and abilities. If young people are not concerned about further national economic growth, but desire an identity that is coherent with the late modern post-material values, then school science could show the students that the S&T subjects play a crucial role for accomplishing exactly these values.

School science as the most interesting subject?

Illeris et al. (2002) argue that everyone working with youth and education in modern societies have to understand that the education is continuously evaluated against how the subject contributes to the students' self-development: "what does it mean to *me*, how does it fit with *my* self-orientation, how can *I* apply this in my self-development project?" (ibid., p. 60, authors' emphasis, our translation).

The fact that few of today's youth choose S&T subjects may indicate that the science which the students meet at school does not succeed in inspiring and exciting the students. But what are the students interested in? What topics and teaching methods have the potential of inspiring and exciting them? ROSE, as well as several other studies, have empirical data that can shed light on such issues (see e.g. the review article of Osborne, Simon & Collins, 2003), but this matter lies outside the scope of this chapter. There is no doubt that young people hold many and explicit interests in topics that may function as gateways into science teaching and learning. But can or should school science continually adapt to the prevailing spirit and ideas of the time? Would changing the science curriculum according to the current youth culture be at the expense of presenting high quality accepted science? Naturally, the science curriculum cannot be designed merely for meeting the current values and interests of young people. We cannot base our teaching on opinion polls among the students. Nevertheless, we argue that school science should to some degree be attentive to the students' values and concerns.

School science may appear as more meaningful by meeting the values or the youth, for example by promoting that even though the level of welfare in modernised societies is high; S&T are still facing huge and unsolved tasks for improving the conditions for life on earth. Such issues might show that S&T still can provide meaning and relevance for young people – also in rich, modern societies.

When young people make their educational choice, they have a range of options. Young people wish to develop their abilities and their identities, and they want a future that they find important and meaningful. Only by being aware of the values and priorities of the young generation can we have a hope to show young people that S&T studies may open up for meaningful jobs in their life.

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