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Summary
This document attempts to describe and analyse some challenges facing Science and Technology (S&T), mainly in education, but also relating it to a wider social setting. After describing the problematic enrolment pattern, the paper goes on to suggest a series of underlying reasons for why we have this problematic situation. This description is tentative and explorative, and is meant to give ideas for a discussion of possible explanations. This is followed by a similar analysis of who needs S&T – and for what purposes. The point here is that the challenge may be perceived differently from different perspectives and interests. Hence, there may also be different views on suitable strategies to solve 'the problem.'
A critical description of S&T in schools is offered, and some international recent trends are briefly described. These trends may provide ideas for possible ways ahead.

Science and Technology1: Key features of modern societies
Our societies are dominated and even 'driven' by ideas and products from science and technology (S&T). It is very likely that the influence on S&T on our lives will continue to increase in the years to come. Scientific and technological knowledge, skills and artefacts 'invade' all realms of life in our modern society: The workplace and the public sphere is increasingly dependent on new as well as the more established technologies. So are also the private sphere and our leisure time. Knowledge and skills in S&T are crucial for most of our actions and decisions, as workers, as voters, as consumers etc. Meaningful and independent

1 Science and technology are different, but related as forms of knowledge and as forms of activities. Science is concerned about general explanations of reality; technology is concerned about finding workable solutions to practical problems. Technology is not the same as applied science, and scientific understanding does not always precede technological developments. In spite of the differences, the acronym S&T will be used in the following.
participation in modern democracies assumes an ability to judge evidence and arguments in the many socio-scientific issues that are on the political agenda.

In short, modern societies need people with S&T qualifications at the top level as well as a general public with a broad understanding of S&T contents, methods and as a social force shaping the future. S&T are major cultural products of human history. All citizens, independent of occupational 'needs', need to be acquainted with this part of human culture. S&T are important for economical well-being, but also seen from the perspective of a broadly based liberal education\(^2\).

One might expect that the increasing significance of S&T should be accompanied with a parallel growth in the interest in these subjects as well as increasing understanding of basic scientific ideas and ways of thinking. This does, however, not seem to be the case.

The evidence for such claims are in part based on 'hard facts' (educational statistics etc.), in part on large comparative studies\(^3\) and in part based on research and analysis of trends in our societies. The situation is described briefly described and analysed in the following.

**Challenges and perspectives**

*Falling enrolment, increasing gender gap?*

In many countries, the recruitment to S&T studies is falling – or at least not developing as fast as expected or planned for. This lack of interest in science often manifests itself at school level at the age where curricular choices are made. In many countries there is noticeable decrease in the numbers of students choosing (some of) the sciences. This trend is further enlarged in the enrolment to tertiary education. A similar trend occurs in some areas of engineering and technology studies. It should, however, be noted that there are large (and interesting!) differences between the various countries and between the different areas of S&T. The fall in recruitment has in particular hit the 'harder' parts of S&T, in particular physics and mathematics.

In many countries, one also observes a growing gender gap in the choice of S&T subjects in schools as well as well as at the tertiary level. Many countries have had a long period of steady growth in female participation in traditionally male fields of study, but this positive trend seems to be broken in some countries. It is a paradox that this trend is strongest in (some of) the Nordic countries, where gender equity has been a prime educational aim for decades.

The concern about unsatisfactory enrolment is voiced from many interest groups. Industrial leaders are worried about the recruitment of qualified work force; universities and research institutions are worried about the recruitment of new researchers; educational authorities are worried about the already visible lack of qualified S&T teachers. In some countries, the grave situation for the recruitment of new students as well as for the substitution of those who retire has caused great national concern. This concern is often based on comprehensive reviews of the current situation in the education sector and the labour market.

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\(^2\) The notion 'liberal education' is here used as synonymous to the concept of 'Bildung' (used in e.g. German and Swedish), 'formation' used in e.g. French, 'dannelse' (used in Danish and Norwegian) etc.

\(^3\) The large comparative studies of science achievement, attitudes and interests (TIMSS, PISA etc.) are briefly described in the Appendix (not included here).
The concern is not only about the actual numbers, but also about a more or less identifiable fall in the quality of the newcomers. A weaker quality may of course be a consequence of the fact that very few candidates 'compete' to get places at institutions where the entrance qualifications previously were very high. Many tertiary S&T institutions are unable to fill their study places with students.

The evidence for claims about problems in recruitment stems from objective and uncontroversial educational statistics concerning enrolment etc. Comparative data on such issues are now collected and published by UNESCO, OECD, the EU and other bodies, and the development of common descriptors and criteria facilitate comparisons. Evidence about pupils' achievement, quality, interests etc. stem from many research projects, the main one being the large comparative surveys like TIMSS, PISA etc. in which most European countries take part. Similar data from the population at large are available from other forms of survey research, like the Eurobarometer.

Statistical data and most surveys do, however, not shed much light on the underlying causes. Why has S&T apparently lost its attraction among young people? Unless one has some ideas about this, intervention programs to increase the interests in S&T are not likely to have success. The following points are attempts to suggest explanations, although some of claims can be backed up with research evidence.

**Disenchantment with S&T? 13 possible reasons....**

It is not easy to understand what causes the difficult situation for the recruitment to S&T, the problematic gender gap etc. Reasons for the doubt in and dissatisfaction with S&T have to be found in the youth culture and in society at large. The decline in recruitment must be understood as a social and political phenomenon that occurs in many (but not all!) highly industrialized countries. This means that the current situation can hardly be explained fully by events or reforms in each individual country. One should seek for more general and common trends found in different countries. The following is an attempt to suggest underlying reasons for the present situation. The listing is tentative, and it needs critical scrutiny and modification in each country. The first point refers to schools, the other are related to wider social trends.

1. **Outdated curriculum**
   Many studies show that pupils perceive school science as lacking relevance. It is often described as dull, authoritarian, abstract and theoretical. The curriculum is often overcrowded with unfamiliar concepts and laws. It leaves little room for enjoyment, curiosity and a search for meaning. It often lacks a cultural, social and historical dimension, and it seldom treats the contemporary issues (see later paragraph)

2. **Science: Difficult and 'untrendy'?**
   Scientific knowledge is by nature abstract and theoretical. It also often contradicts 'common sense'. It is also often developed through controlled experiments in artificial and 'unnatural' and idealized laboratory settings. Learning science often requires hard work and intellectual efforts (although school science should be tailored to better meet the needs and abilities of the pupils!)
   Concentration and hard work is not part of present youth culture. In a world where so many 'channels' compete about the attention of young people, such subjects become untrendy.
3. **Lack of qualified teachers** –
Science and technology are often poorly treated in teacher preparation for the early years. Moreover, the students who choose to become primary school teachers are often those who did not take or did not like science themselves in school. The present decline in recruitment of science teachers is now being felt also in secondary schools.

4. **Anti- and quasi-scientific trends and 'alternatives'**.
   In many Western countries there is an upsurge of 'alternative' beliefs in the metaphysical, spiritual and supernatural. These movements are often labelled 'New Age', and comprises a rich variety of world-views, therapies etc. They include beliefs in UFOs, astrology, several forms of healing. A common denominator is often the rejection of scientific rationality, often characterized as mechanistic, reductionist etc. Although most 'alternatives' reject science, some do, however, also base their ideas on misinterpretations of ideas taken from modern science, like quantum mechanics.

5. **Postmodernist attacks on S&T**
   This may be seen as the more 'serious' and academic version of the critique imbedded in the above mentioned 'alternative' movements. Many postmodernist thinkers reject basic elements of science, and reject notions like objectivity and rationality. The more extreme versions assert that scientific knowledge claims say more about the researcher than about 'reality', and that all other 'stories' about the world have the same epistemological status. Notions like 'reality', 'truth' etc are seldom used without inverted commas! These postmodernists attacks on scientific thinking has even been called "Science War" in the US, and book titles like "The flight from science and reason" and "Higher superstition" indicate the tone of the 'debate' and how these trends have been met by the scientific community.

6. **Stereotypical image of scientists and engineers**.
   Many research projects indicate that the perceived image of the typical scientist and engineer is stereotypical and problematic. The image of the 'crazy scientist' is widespread, possibly supported by cartoons, plots in many popular movies and in media coverage. Scientists (especially in the hard, physical sciences) are by pupils often perceived to be authoritarian, closed, bored – and somewhat crazy. They are not perceived to be kind or helping and working to solve problems of humankind.

7. **Disagreement among researchers perceived as problematic**.
   Scientists debate and disagree on many contemporary socio-scientific issues (like causes of global warming, effects of radiation, possible dangers of GM food etc.) Such discussions are the normal processes for the healthy development of new scientific knowledge. Recently, such debates are also taken to the mass media and are not (as before) confined to professional conferences and journals. The disagreement in public may, however, confuse and disappoint people who are acquainted with 'school science', where scientific knowledge is presented as certain and uncontroversial.

8. **Problematic values and ethos of science**
   The traditional values of science are meant to safeguard objectivity, neutrality, disinterestedness and rationality. Taken to the extreme, however, these values may seem to justify absence of ethics, empathy and concern for the social implications of science. The search for universal laws and theories may lead to an implied image of science as abstract and not related to human needs. For many people, science is cold and lacks a
human face.

9. **Dislike of an overambitious science?**
The achievements of science may call for admiration, but also unease. Many people dislike the image and ambitions of modern biotechnology. They have emotional and rational fear about scientists who are 'tampering with Nature', and 'Playing God'. Similarly, many people react emotionally when physicists talk about their quest for 'The Final Theory', also called 'The Theory of Everything' or the search for 'The God Particle' (the title of a book by Nobel laureate Leon Lederman).
Such perspectives may attract some young people, but it is not unlikely that these ambitions of modern science will scare others. Many people feel that science intruding areas that they consider sacred – and they do not want a world where science can explain everything. Many people like to think of Nature as sacred and mystical – not as explainable, controllable and rational.

10. **The new image: Big Science and techno-science**
Science used to be seen a search for knowledge driven by individual curiosity. Scientists have historically rightfully been described as radicals and revolutionaries who often challenged religious and political authorities.
Present science is different in fundamental ways. We have in the last decades seen a fusion between science and technology into what is called techno-science and Big science (NASA, CERN, Human Genome Project etc.) The scientists and engineers of today often work close to industrial or military interests. The earlier image of scientists being dissidents and rebels has been replaced with a less exotic image of scientists being loyal workers in the service of power and authority. Scientists and other 'experts' are often on the pay-roll of industry, military or the State. Hence, their role as neutral defenders of objectivity and truth is questioned by many scholars – and also pupils in schools.

11. **Scientists and engineers: No longer heroes?**
Not very long ago, scientists and engineers were considered heroes. The scientists produced progressive knowledge and fought superstition and ignorance, the engineers developed new technologies and products that improved the quality of life.
This image is, however, 'history' by now. For many young people in rich, modern societies, the fight for better health and a better material standard is an unknown history of the past. They do not see the fruits of S&T, but are more able to see the present evils of environmental degradation, pollution, global warming etc. Forgetting the victories of the past, many put the blame of the current problems on S&T.
The heroic status of scientists and engineers has faded.

12. **The new role models: Not in S&T**
We live in a world that is in part created by the media. Football players and pop artists are exposed and earn fortunes. The lives of journalists and other media people seem interesting and challenging. Although few young people can obtain such careers, the new role models on either side of the camera create new ideals. The young people also know that lawyers and people at the stock exchange earn more money than the physicist in the laboratory. They also know that lack of physics knowledge is no hindrance to such careers.
A white-coated hardworking (and not very well paid) scientist in a lab is not the role model of young people of today! This social climate does not create an atmosphere
where it is easy to convince young people that they should concentrate on their science learning!

13. Communication gap between scientists and the 'public'? 
The S&T establishment is often confused and annoyed when met with critique. In the past, they have enjoyed enormous popularity, increasing budgets and excellent recruitment. They are not used to face distrust, and they have not been in need to justify their research in public debates. The immediate reaction to the new situation is the search for scapegoats, often found in the schools and in the media.
The problematic situation is often seen by the S&T establishment as a problem of information. Critique and scepticism are often interpreted as based on 'misunderstandings' and lack of knowledge from the public. In some cases this may, of course be justified, but the new situation does call for a form for self-critique within the S&T community.
Communication works 'both ways' and a lack of mutual understanding cannot only be blamed on one part only.

At least some of the points above may be valid explanations for the disenchantment with S&T. Some of these may be actively addressed, others are more deep-rooted and outside the direct influence of political decisions.

Contradictory (and optimistic) trends?
It is evident from the points raised above that the situation has many dimensions. Some of the recent trends are also contradictory. From the falling enrolment, one may deduce that there is a falling interest in S&T. On the other hand, young people are more than ever interested in using all sorts of new technology. It is a paradox that the countries which have the most problems with recruitment to S&T are also the countries with the most widespread use of new technologies among the young people. (Cellular telephone, personal computers, internet etc.) There seems to be an eagerness to use the new technologies, but a reluctance to study the disciplines that underlie the very same products.

Popular S&T magazines are also at least as popular as before, and television programs about science, nature and technology enjoy high popularity. Furthermore, survey data (like the Eurobarometer) do not give strong support to general claims about falling interests and negative attitudes towards S&T.

Skills and knowledge in S&T are learned and acquired in many different contexts, not only in formal settings like schools. The media, museums of various kinds, the workplace and even 'everyday life' provide other learning contexts. Most of the impressive skills that young people have in handling personal computers, internet, cellular phones and all sorts of electronic devices are acquired in informal out-of-school settings. Besides, young people have often developed more advanced skills in such areas than their teachers at school (although their understanding of the underlying physical principles may be totally lacking). Young people (as well as many older!) demonstrate an impressive ability to learn and to pick up new skills that they deem to be of relevance for their daily life. Educational authorities might learn important lessons from these arenas of learning. They should also seek ways to support such learning, also to avoid possibly growing inequalities in the area of new technology based on gender or economical and social background.
Public Understanding of Science and Technology: An international concern...

The situation that has been described above (a growing importance but increasingly problematic status of S&T in many countries) is the obvious background for a growing political concern about S&T in schools, higher education, media and the general public. Phrases like 'scientific illiteracy' are used, more or less rightfully, to describe the situation. Acronyms like PUST (Public Understanding of Science and Technology) have become expressions for the growing concern about the situation. Academic journals are devoted to these issues (i.e. *Public Understanding of Science*) and several research institutions study these challenges.

In many countries the situation has attracted public attention, and in many countries projects and counter-measures are planned or put in operation. The Swedish *NOT*-project and the Portuguese *Ciencia Viva* are examples of such national programs. Some of these national programs have also initiated research, discussions and other efforts to increase the understanding of the problematic situation.

Also S&T research institutions, universities and industrial organizations have established more or less coordinated intervention programs. CERN's Physics On Stage (POS), arranged in November 2000 is one such example. POS, as well as many other such intervention programs from professional bodies have seldom performed any convincing analysis as to why they are facing the problems of falling enrolment. Some of their descriptions of the situation lacks empirical evidence, and is more emotional than rational (!). Many institutions seem to be driven by a need to 'do something' about the situation.

It also seems premature to claim that the public understanding of S&T is deteriorating — although such claims are often voiced from S&T interests groups. On could, however, argue that the public understanding of S&T could be better, given the crucial role these domains play in contemporary society. But general claims about falling standards do not seem to be justified.

Who needs Science and Technology – and Why?

The problematic situation for S&T can be seen from different perspectives and different interests. These range from industry's concern about national, economical competitiveness to a concern about an empowerment at the grassroots level for the protection and conservation of nature. Different conceptions of 'the crisis' may possibly lead to different solutions. Here is an indication of possible arguments for learning S&T.

1. **Industry**
   needs people with high qualifications in S&T. Modern industry is high-tech and often called 'knowledge industry'. This industry is in need for highly qualified scientists and engineers to survive in a competitive global economy. This aspect is of importance for the economy of the nation. (But young people do *not* base their educational choices on what is good for the nation!)

2. **Universities and research institution**
   have similarly a need for researchers (and teachers) to maintain research at high international level and to provide good learning possibilities for coming generations of experts, researchers and teachers.
The above-mentioned two groups constitute a highly skilled elite. But the actual number of such people may not necessarily be very high. It would also be a mistake to have mainly these groups in mind when reforming S&T in schools. A policy based on this perspective could even further decrease the proportion of young people who find S&T interesting, and who would choose to continue with S&T. The next perspective is one of high importance for a much larger group, the teaching profession:

3. **Schools need qualified teachers in S&T.**
The decline in recruitment has already hit the teaching profession. Well-qualified and enthusiastic teachers constitute the key to any improvement of S&T in schools -- and for the further development of knowledge, interests and attitudes of ordinary citizens when they have left school. The S&T teachers also play a key role in the recruitment of people to the S&T sector.
The long-term effects of a lack of good S&T teachers could be very damaging, although the effects are not so immediately observable as the lack of qualified people in industry and research. The S&T teachers need a broad basis for their activities. A solid foundation in the academic discipline is important, but not enough. They need broader perspectives and skills in order to cope with challenges of the sort outlined earlier in this document. In short: S&T teachers do not only need a foundation in S&T, they also need to have perspectives on S&T in a historical and social context. This may require reforms in teacher training.

The next points, although different, are of importance for more or less all citizens.

4. **A broader labour market needs S&T competencies**
People in general need qualifications in S&T to compete on the modern labour market. The need is great and growing fast, as knowledge and skills based on science and technology become prerequisites in new areas and new parts of the labour market. Not only doctors, pharmacists, engineers and technicians need S&T. Health workers handle complicated and dangerous equipment, secretaries and office staff need good computer literacy etc. New as well as more traditional technologies often dominate the workplaces, and those with skills in these areas may have a competitive advantage for their further career. Many countries have also identified a need for people with S&T skills to replace those retiring in the near future.
There is also a general need to become flexible and able to learn. A foundation in S&T as well as mathematics is of great importance to develop such learning skills. Besides, most of the changes are likely to be related to technological innovations, and people with basic S&T skills may be better equipped to cope with changes and innovations.

5. **S&T for citizenship and democratic participation:**
As stated in the introduction, our modern society is dominated by S&T. Many aspects of life have a dimension related to S&T. All citizens are confronted with such issues as consumers and as voters. As consumers we have to take decisions about food and health, quality and characteristics of products, claims made in advertisements etc. As voters we have to take a stand and be able to judge arguments on all sorts of issues. Many of these political issues also have an S&T dimension. In such cases, knowledge of the S&T involved has to be combined with values and political ideals. Issues relating to the environment are obviously of this nature, but also issues relating to energy, traffic, health policy etc. have S&T dimensions. It is indeed hard to think of any contemporary issue that does not have some aspects relating to S&T.
Social and political issues should not be seen as 'technical' – and left in the hands of the 'expert'. A broad public understanding of science and technology may in fact be a democratic safeguard against 'scientism' and a domination of experts.

The above 'democratic argument' does not only assume that people have some grasp of the contents of S&T. It also requires some public understanding of the nature of S&T and the role they play in society. Among other things, people need to know that scientific knowledge is based on argumentation and evidence, and that statistical considerations about risks play an important role. Everybody cannot become 'experts', but everybody should have tools to be able to judge which 'expert' and what kind of arguments one should trust.

The points raised here call for some caution, since some of the above aims may possibly compete. The concern for recruitment of possible Nobel Prize winners and researchers at CERN may not coincide with the concern for a broad public understanding of science – or for the protection of wildlife and natural resources.

The challenge may be how to combine these concerns in a flexible education system, including life-long learning. Some of the choices are these:

- Should one favour early specialisation, identification and recruitment of the more able?
- To what extent and to what age should one have a comprehensive system for all – or choose streaming and selection?
- Should one maximize individual freedom for pupils to choose according to interests and abilities – or should one postpone choices and hold on to a core of important contents to be covered by all?
- How should one support 'life long education' and develop adult education and on-the-job-training?

Science and technology in schools

Present curricula – the critique

Science curricula are key factors to sustain and develop the interest in science. There seems to be a broad agreement about the critique of the old curricula – still the dominating in most countries. The criticism was mentioned in points 1-3 in the earlier listing, but is elaborated somewhat more here:

Science education in most countries is criticized for being traditional and rather old-fashioned. The implicit image of science is that it is mainly a massive body of authoritative and unquestionable knowledge. Most curricula are overloaded with facts and information at the expense of concentration on a few 'big ideas' and key principles. There seems to be an attempt to cover all parts of the established academic science, without further arguments for putting this material in a school that caters for the whole age cohort. Although very few pupils will pursue further studies in science, preparation for such studies seems to be a guiding curriculum principle. There is often repetition, where the same concepts and laws are presented year after year. Such curricula often lead to rote learning without deeper understanding.

Moreover, this textbook science is often criticized for its lack relevance and deeper meaning for the learners and their daily life. The content is often presented without being anchored to social and human needs, neither present nor past. The historical context of discoveries is often
reduced to biographical anecdotes. Moreover, the implicit philosophy of textbook science is by most scholars considered a simplistic and outdated form of empiricism.

It should also be noted (as in point 2 in the previous listing) that science often is seen as demanding and difficult. The ideas are not always easy to grasp, and their understanding often requires concentration and hard work over a long period of time. The youth of today are not used to cope with such demands. If one shall hope for such efforts, the pupils will need a strong motivation, and they need to find something that is seen as very valuable. This is not always the case. Although science per se can be seen as difficult, the demands of school science may of course be adopted to suit the age of the learners!

This science curriculum has to 'compete' for popularity and attention with other school subjects. Many of these subjects have qualities that meet the students' needs for meaning and relevance. The content of such subjects is less authoritarian, and there is a place for opinions and feelings of the learners. This is seldom the case in school science.

The situation described above is well captured in a headline in Financial Times: "Science attracts fewer candidates. Students switch to newer subjects thought to be more interesting and less demanding". (FT 15. august 1996)

**Science and Technology in schools – recent trends and responses**

The challenges for S&T education outlined in this document have been met in different ways. Many countries have introduced more or less radical reforms, and there has been support to curriculum development and experiments. Reforms are related to the content and framing of the curriculum as well as to pedagogies: teaching methods and organization of the learning processes.

A general trend is that there seems to be less influence from the (traditional) academic organization of curricula and contents. An underlying concern is that S&T should contribute to more general aims of schooling in a situation where 'everybody' attends school for 12-13 years. The general tendency is a widening of the perspective and a gradual redefinition of what counts as valid school science. Social and ethical aspects of S&T are often becoming part of the curriculum. The following is a listing of some trends. Many are related, but still mentioned separately. Not all these trends are found in all countries, but together they represent a series of identifiable tendencies:

A. **Towards "Science for all"**
   More weight on aspects of science that can be seen to contribute to the overall goals of schooling. Key concern: liberal education ('allmenn dannelse', 'allmän Bildning' Bildung, Formation.....) Hence; there is less weight on traditional academic contents and science as mainly as preparation for tertiary studies in science. Specialisation postponed to the last few years of school.

B. **Towards more subject integration.**
   In the early years of schooling, S&T is usually more or less integrated with other school subjects. Only later are the sciences presented as separate disciplines. The level where this specialization starts varies between countries. It is a general trend that separate science subjects are taught only at a late stage. (e.g. in Norway, only the two last years of upper secondary school have single science subject.)
C. **Widening perspectives**
More weight on cultural, historical and philosophical aspects of science and technology. S&T are presented as human activities. These aspects may also appeal to the pupils that are in search for 'meaning', not only factual information and the accepted correct explanations.

D. **NOS: The Nature of Science**
The 'Nature of science' has become an important concern in the curriculum. This often means a rejection of the often stereotypical (and false) image of science as a simple search for objective and final truths based on unproblematic observations. The weight on recent understanding of the nature of science also implies a stress on the social, cultural and human aspects of science. Science is presented as knowledge that builds on *evidence* as well *arguments* in a creative search for meaning and explanation. This aspect also strengthens that human and social relevance of science, and may attract pupils who value such aspects.

E. **Contexts become important**
More weight on putting science and technology in meaningful contexts for the learner. This often implies examples from everyday life and current socio-scientific issues. These themes or topics are by their nature interdisciplinary, and require teacher cooperation. Such issues often requires methods like *project work*. (For which teachers have to be adequately educated.)

F. **Concern for the environment**
Towards more weight on environmental questions as part of the S&T curriculum. (The name of the S&T subject in the new Norwegian curriculum is "Science and environmental study") Environmental issues are often of the socio-scientific nature mentioned above, and their treatment often requires *project work* in *interdisciplinary* settings.

G. **Weight on Technology**
Technology has recently been introduced in many countries as a subject in its own right, also in the general part of the education system. In other countries, it has received a broader place within the science curriculum, not only as interesting concrete examples to illustrate scientific theories and principles. (The name of the new S&T subject in Denmark is "Nature and technology"). The curricular definition of 'technology' is, however, often confusing and incoherent. In some countries technology is placed in a context of 'design and technology' (in the UK). In other countries the term technology implies modern information technology and ICT. In some places, the stress is on the technical (and underlying scientific) aspect of technology. In other countries the weight is put on human relations to technology, society and technology etc.

H. **STS: Science, Technology and Society**
STS has become an acronym for a whole 'movement' within S&T education. The key concern is not only the Science and the Technology content, but also the relationship between S&T and society. The trends described in the preceding points (relevant contexts, stress on the environmental and the role of technology) can also be seen as belonging to an increase of the STS perspective.
I. Inclusion of ethics
When S&T issues are treated in a wider context, it becomes evident that many of the topics have ethical dimensions. This is of course the case when dealing with socio-scientific issues. But ethics is also involved in discussions relating to 'pure' science, like what sorts of research one ought to prioritise (or even allow), and the moral dilemmas in e.g. using animals in research. Again, this ethical dimension may contribute to giving S&T a more human face. It is also likely to empower future voters on important political issues on which they are invited to take a stand.

J. "Less is more"
This has become a slogan for curriculum development. More weight is put on 'great stories' of S&T and on presentation of key ideas and their development, often in an historical and social context. These key ideas replace (the impossible) attempt to give an encyclopaedic coverage of the whole of science. One hopes to avoid the curse of the overcrowded curriculum that leaves so little time for reflection and search for meaning. By choosing 'typical' and important stories, one hopes to convey an understanding of the nature of S&T. One also hopes to nourish curiosity and respect for S&T – and to inspire some students to pursue S&T. 'Narratives' have become a key word for this development.

K. Information technologies as subject matter and as tools
Information and communication technologies (ICT) are products that by their definition 'belong' to the S&T sector. (The 'hardware' is science-based technologies; the 'software' builds on basic mathematics etc.) Hence, the underlying physical and technical ideas are to an increasing extent treated as important subject matter on their own right in S&T curricula.
Besides, ICT provide new tools that are very suitable for teaching and learning in S&T. The whole range of 'ordinary' software is used, including databases, spreadsheets, statistical and graphical programs. In addition, modelling, visualization and simulations of processes are important. ICT is also used for taking time series of measurements for a wide variety of parameters ('data logging').
S&T subjects are likely to be key elements in strategies to develop ICT to become a better educational tool. It is also likely that S&T teachers are better educationally equipped for this task than most other teachers – although they are also in need for ways to be updated and retrained.

Ways forward?
As indicated in this paper, 'the problem' has many dimensions, and different interest groups may understand and conceive the challenges in widely different terms. The perspectives of industrial leaders are often different from those of the environmental activists. It has also been argued that the problems related to the interests in and attitudes to S&T can not only be perceived as educational challenges. They have to be understood and addressed in a wider social, cultural and political context. Hence, 'solutions' may be as different as the way in which the challenge is understood. One can, however, argue that there may be broad agreement about some reforms and innovations in spite of different reasons for concern.

Agreement can reached about the need to stimulate and maintain young children's' curiosity about natural phenomena and how things work. There can also be agreement that everybody will benefit from a broad base of knowledge about key ideas in science and basic principles in technology. Everybody should also understand and appreciate the key role played by S&T in
contemporary society. An understanding and appreciation of scientific theories and ideas as major cultural products of humankind is probably also uncontroversial. This list could be continued, and is an indication that different groups should be able to work together to achieve what is often called "scientific and technological literacy."

Other issues are more controversial, like how 'critical' one wants school S&T to be, and when one should allow for or even stimulate selection and specialization in order to identify and recruit students for higher S&T studies. It is the difficult task of educational and political authorities to balance contradictory concerns – and to stimulate a public debate on these important issues.

Finally, if one accepts that the problems of recruitment to and attitudes to S&T are embedded in a wider social context, one will also need a broader approach than only to address school reforms, curriculum reform, reforms in teacher training and in higher education. If the challenges are of a deeper social and cultural nature, as argued here, then there is no easy one-shot solution. One will need to look beyond the education system, and involve different stakeholders. There is a need for reforms that are context specific, that require multiple approaches and are implemented over long periods of time. Initiatives will also have to be monitored, and the development and results will need continuing discussions, informed by evidence and careful analysis.