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The Relevance of Science Education

Camilla Schreiner
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Sowing the Seeds of ROSE

Background, rationale, questionnaire development and data collection for ROSE (The Relevance of Science Education) – a comparative study of students' views of science and science education

DEPARTMENT OF TEACHER EDUCATION AND SCHOOL DEVELOPMENT
UNIVERSITY OF OSLO

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FOREWORD

ROSE, The Relevance of Science Education, is an international comparative research project meant to shed light on factors of importance to the learning of science and technology (S&T) - as perceived by the learners. This publication gives a description of the underlying rationale behind the project and how the ideas have been used to develop a research instrument called the ROSE questionnaire. We also give some details on the guidelines for data collection (population, sampling, logistics, data coding, etc.) that has been developed for the international partners who want their data to be part of comparative studies.

This means that this publication only gives an account of how the *seeds* of ROSE were sown - i.e. the development of the study up to and including the data collection. The ROSE harvest and bouquets, i.e. the comparative analysis and the results, will be described in later publications.

Many actors have been involved in the process of developing the ROSE instruments and its data collection guidelines. We have an international advisory team of science educators from all continents. Other international partners have participated in the process by correspondence and by piloting and reacting to draft versions of the ROSE instrument. We want to thank all these people for time, effort and professional advice. We will also thank the Norwegian TIMSS and PISA teams for advice relating to research methodology and all other colleagues in our department for involvement and inspiration.

ROSE data are currently being collected in some 35 countries; most of these have already completed this work. About 10 PhD students in many countries will use national and international data from ROSE as a basis for their thesis. We also hope that other S&T educators will find the ROSE instrument useful for their own local or national purposes. They may also want to use ROSE as basis for joint research with partners in other countries.

We want to thank The Research Council of Norway, the Norwegian Ministry of Education, the University of Oslo and the newly established National Centre for Science Education for financial support.

ROSE home page: http://www.ils.uio.no/forskning/rose/

Oslo September 2004

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CONTENTS

1 INTRODUCTION

ROSE is based on a conviction that science and technology (S&T) are important aspects of life in all countries, regardless of culture and level of material development. We believe that the S&T curriculum should be adapted to the needs of the learners, which may vary between countries and between groups of learners in each country. This means that we do not embrace the visions of a universally valid and culture-free (or culture-neutral) S&T curriculum as long as we are talking of S&T in a school that is meant for the whole age cohort and not only for the future S&T specialist. We are also convinced that one should put more weight on the voice and the views of the learners when curricula are made and when pedagogy is implemented. Such beliefs underpin the ROSE project, and will be further elaborated in this publication.

In this publication we argue for the value of international comparative studies. We also mention the large-scale comparative studies TIMSS and PISA as they play key roles in the area of comparative research in science education. The focus on these studies is to measure students' mastery of science contents. In contrast, the ROSE instrument is *not* a test for conceptual understanding of science contents. It is meant to gather information of *emotional* and *attitudinal* nature held by the students. We focus on aspects that may be of importance for how students engage with and relate to S&T in schools and in life in general. More explicitly, the ROSE instrument tries to describe the S&T-related *experiences* that students have, the kinds of *interests* they have for S&T related contents and what *views* and *attitudes* they have towards S&T in society. We also want to describe what they feel about the S&T they have experienced in their schooling, and to describe the *plans* and *ambitions* they hold for their future life. Special emphasis is put on the students' attitudes to and perceptions of *environmental challenges*.

We find it important to stress that affective aspects like interest, attitudes, concern for the environment, appreciation for S&T, motivation and engagement are not only *means* to recruit more people into these domains. These dimensions are important factors and outcomes by themselves - but they are often not measured or 'counted' through exams or large-scale comparative studies. The attitudinal outcomes of the encounter with a school subject is probably also more lasting in the mind of the learner than the actual S&T content that is mastered.

The purpose of the ROSE study is to provide empirical evidence and to stimulate theoretical discussions about priorities and alternatives in S&T education. The hope is that such data, seen from the perspective of the learners, may provide important input to an informed debate on how to improve the relevance, attractiveness and the quality of S&T education so that it can meet the hopes and aspirations of the learners in a diverse world.

This publication gives some details on the theoretical and ideological considerations underlying the project development. It also discusses aspects of methodological nature connected to the construction of a research instrument that is intended to measure complicated emotional dimensions. This difficult task is further complicated by our intention to construct an instrument that can be used in very different cultural and material contexts. We try to give a description of how the process has been, and to explain and justify the many

compromises we have made. We also describe and discuss issues of definitions of population and sampling and some practicalities of data collections.

ROSE is a further development of the project SAS (Science And Scientists), described later in this publication and in e.g. Sjøberg 2002. Based on SAS, an application for funding for a more systematic study was submitted to the Research Council of Norway. After an international referee process, the ROSE project got funded. A PhD student (cand. scient. Camilla Schreiner) was appointed, and the project development started autumn 2001.

In this publication we will give some details on the development of the ROSE project, the underlying rationale, sources of inspiration and how this has resulted in the ROSE instrument. Analysis of data and presentation of results will come in later publications.

1.1 Key formulations from the research grant contract

The contract for the research grant with the Research Council of Norway may serve as an introduction to the ROSE project. The following text is direct quote from the contract:

The lack of relevance of the S&T curriculum is probably one of the greatest barriers for good learning as well as for interest in the subject. The ROSE project has the ambition to provide theoretical insight into factors that relate to the relevance of the contents as well as the contexts of S&T curricula. The final outcome of the project will be perspectives and empirical findings that can provide a base for informed discussions on how to improve curricula and enhance the interest in S&T in a way that

- respects cultural diversity and gender equity
- promotes personal and social relevance
- empowers the learner for democratic participation and citizenship

ROSE objectives

1. Develop theoretical perspectives sensitive to the diversity of backgrounds (cultural, social, gender, etc.) of pupils for discussion of priorities relating to S&T education.
2. Develop an instrument to collect data on students' (age 15/16) experiences, interests, priorities, images and perceptions that are of relevance for their learning of S&T and their attitudes towards the subjects.
3. Collect, analyse and discuss data from a wide range of countries and cultural contexts, using the instruments referred to above.
4. Develop policy recommendations for the improvement of curricula, textbooks and classroom activities based on the findings above.
5. Raise issues relating to the relevance and importance of science in public debate and in scientific and educational fora.

The ROSE group has a set of **common commitments**. These core commitments can briefly be described like this:

1. Basic literacy in S&T is crucial for the individual's autonomy and quality of life, for national development as well as for meaningful democratic participation citizenship in all societies.

2. The teaching and learning of S&T takes place in particular social contexts. This context (cultural, political, religious, linguistic context, dominating world-view, etc.) will rightfully influence what the society values as important knowledge and skills. This wider context has to be taken into account when curricula are made.
3. Children come to school with different life experiences, they have different interests and plans for their life and they have different values and priorities. These different backgrounds are important determinants for their learning. Besides, they have to be respected in their own right. Only by doing so, can S&T education become meaningful and relevant to them as individuals.
4. Children also have more or less well-founded images about the nature and purpose of S&T; and they have different perceptions of how people in these areas are as persons. Such perceptions about the 'body language' of S&T are likely to colour their attitudes to the subjects and their willingness to enter S&T areas of study and work.

1.2 The chronology and emergence of ROSE

As indicated, the ROSE project grew out of the SAS-study (e.g. Sjøberg, 2002), which may be seen as a pilot study of ROSE. Based on the results and the experiences gained with SAS, the project organizer developed a project description that was sent to the Research Council of Norway in 2000. As part of the preparation, he also contacted a wide range of potential research partners for the planned project. These were colleagues from previous cooperation and S&T educators in associations like IOSTE (International Organization for Science and Technology Education), ESERA (European Science Education Research Association), GASAT (Gender And Science And Technology) and NARST (National Association for Research in Science Teaching). The nearly unanimous response to the plans and drafts was positive. Letters of support were attached to the application for funding.

The research proposal was sent for international review, which resulted in positive response to fund the project as a 'free project'. (In this category, less than 20% of the applications get funding.)

The funding was, however, much less than applied for, and plans had to be adjusted. Grants for a full time PhD researcher was the main part of the grant. This position was advertised, and among the 10 applicants, one was selected. This was Camilla Schreiner, educated as a data engineer, later as cand.scient. in geophysics, and with experience from science teaching. She started working in September 2001, which also marks the beginning of the project.

During the last part of 2001, invitations for participation were circulated through personal contacts as well as on the mailing lists of IOSTE, ESERA and NARST. The project was also described in UNESCO's *Connect*. Interested partners (institutions as well as individual researchers) contacted the ROSE team, and conditions for participation were clarified. The basis for participation was the (revised) project description and a Handbook for participation. This means that participants to a certain degree have a common understanding of aims, rationale and purpose of ROSE.

It became evident early in the project that additional funding was required, also to support participation from developing countries, arranging working seminars, releasing time

available for the research coordinator, etc. This situation developed positively, and ROSE now has funding from the following sources until the end of 2006:

- The Research Council of Norway
- The Norwegian Ministry of Education
- The Norwegian Board of Education
- The University of Oslo
- The Norwegian Centre for Science Education

This funding enabled us to hire Kristján Ketill Stefánsson on part-time from March 2004. Kristján comes from Iceland, he wrote his Bachelors' dissertation based on ROSE, and he will base his Master thesis on the international data from ROSE. He handles the incoming data files (checking coding, quality, etc.), reports, articles, etc. He is also responsible for the maintenance of the ROSE home page.

The ROSE coordinator has, since 2001, had extensive correspondence with about 150 researchers from more than 60 countries. About 15 countries have received financial support for their data collection. At the time of writing, about 28 countries have collected and coded data, about 10 more are expected to finish by the end of 2004. (An overview of the ROSE participants is given in Appendix F.) Some are likely to submit files later. These countries will not be part of the initial international analysis, but may be included in later articles and they will take part joint research.

2 BACKGROUND, RATIONALE AND CHALLENGES

In this chapter, we start by pointing to the growing importance of S&T in modern societies. We describe the paradox that in spite of the primacy of S&T, many young people lose their interest for S&T in schools and further studies. Whereas most research in S&T education is concerned with the cognitive sides of teaching and learning, we argue for the importance of looking into the motivational and attitudinal aspects of the issue.

We stress the importance of cross-cultural comparisons. The emerging globalization and internationalization implies, however, two rather opposite tendencies. On the one hand a pressure to universalize, harmonize and to become alike. On the other hand we also see a growing concern for local and national identity. Learning theorists also stress the importance of contextualising, 'situating' and localizing curricula and learning.

Comparative studies in education function in such a context. Large-scale comparative studies like TIMSS and PISA provide governments and ministries with tools to cope with issues of performance and achievement. But these studies may also provide a pressure to standardize curricula and learning outcomes. Our intention with ROSE is closer to the second point above: We want to open up for variation and difference, based on a belief that "S&T education for all" should primarily prepare the young people to meet the challenges in their own life and environment. We would also add that adolescence is not just a preparation for later life, but is an important part of life itself! Students at school should therefore experience this period as interesting, joyful and stimulating in itself.

By focussing on attitudinal factors and on cultural difference and variation, we hope that the ROSE study can provide information that *compliments* the standards, benchmarks and indicators that often are the result of the other studies. The following will enlarge on some of these aspects.

2.1 S&T as a key element in present societies

Science and technology are currently playing en increasing role in all realms of life; in the private sphere, as citizens, as consumers and in work situations. S&T-issues are often involved in decisions at the personal as well as the wider social and political level. As inhabitants in democratic societies, we are continuously being asked to take a stance on socio-scientific issues. Sound democratic judgment requires rationality and knowledge as well as a background of values and ideals.

In a situation like this, the public knowledge about and perceptions of the different aspects of S&T becomes an important concern for any democratic society. It may be seen as a paradox that in spite of the increasing importance of S&T, schools in many countries are facing problems like lack of students' interest. It is a paradox that subjects that are supposed to describe the real and concrete world are considered to be abstract and irrelevant. It is also problematic that while S&T has profound consequences for their future lives, many young people seem to develop hostile or ambivalent attitudes to and perceptions of S&T.

We are convinced that S&T in schools have the *potential* to appeal to the minds of young people, and to give them knowledge and skills that are meaningful for their lives and

their ability to shape and influence their future. But reforms in S&T contents as well teaching and learning methods may be required.

2.1.1 An international concern

In most countries, education in science and (to a varying degree) technology[1] are key element of schooling, and is to an increasing degree taught from the early years of schooling. High quality S&T education is seen as important training for citizenship as well for preparation for work in a world dominated by globalisation, new technologies and competitive knowledge-based industries. Hence, "Science for all", "Scientific and technological literacy" and "Public Understanding of Science" have become slogans in the public and educational debate.

Educational research, opinion polls, public surveys as well as educational statistics for choices and recruitment, however, indicate that S&T in many countries are facing serious problems. Lack of interest in S&T, at least as school subjects and tertiary studies and a meagre understanding of the contents and methods of S&T as well as their role in society and culture are among the problems.

Many projects are launched, nationally as well as internationally, to meet the challenges. These initiatives try to counteract the observed trends and meet the emerging problems. Industrial organisations (like CEFIC for the chemical industry in Europe) as well as major professional scientific interests (like NASA, CERN and ESA) also engage actively in the promotion of science literacy and the improvement of interests in and recruitment to S&T. Research councils at national as well as international level allocate funds to support the improvement of interests in S&T, with the underlying objective to increase the recruitment and to improve the public image.

The European Union (EU) has put the issue of S&T education as a key concern in their Science and Society Action Plan[2] which is part of the ambitious 6th Frame Programme for research and development (FP6). A special *High Level Group* to look into the issue of "Increasing Human Resources for Science and Technology" was appointed in 2003 by the EU commissioner for research, Philippe Busquin and headed by Professor Jose Mariano Gago, the former minister of science and technology in Portugal. Based on a broad consultation process with industry, research and professional organizations as well as with Ministries of education a report has been produced and discussed among stakeholders from the same groups. This report (EU, 2004) will be the basis to launch further initiatives to promote the interest in S&T studies and careers in Europe.

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[1] In the following, no clear distinction is made between science and technology. The school subject is usually labelled 'science' (or is subdivided in the separate science disciplines), but the names vary between countries and between levels in the schools. In Norway the subject is called 'science and the environment' (Natur- og miljøfag), in Denmark and Sweden 'science and technology' (Denmark: 'Natur og teknik', Sweden: 'Naturorientering och teknik'). In some countries technology is a separate subject, in other countries it is integrated with science. In some contexts, this distinction is important. Although the T does not appear in the ROSE acronym, we also have technology in mind, as will become clear from the ROSE questionnaire and the following text.

[2] Documents, calls, initiatives, etc. relating to the Science and Society Action Plan are available at http://europa.eu.int/comm/research/science-society

Similarly, the OECD (Organization for Economic Cooperation and Development) has become increasingly concerned about the importance of S&T in schools, higher education and in the public sphere. The OECD PISA-study will be briefly described in the following text, but the OECD interest in the issue also has a wider perspective than the monitoring of conceptual understanding at school level. Other OECD initiatives are concerned with the lack of interest is S&T studies, which they consider as a high priority issue. A major initiative by OECD to shed light on these issues is planned for 2004-2006[3].

The high-level political interest in these issues is well spelled out in the recent report from the National Science Foundation to the US President.

> *If the trends identified in Indicators 2004 continue undeterred, three things will happen. The number of jobs in the U.S. economy that require science and engineering training will grow; the number of U.S. citizens prepared for those jobs will, at best, be level; and the availability of people from other countries who have science and engineering training will decline, either because of limits to entry imposed by U.S. national security restrictions or because of intense global competition for people with these skills. The United States has always depended on the inventiveness of its people in order to compete in the world marketplace. Now, preparation of the S&E workforce is a vital arena for national competitiveness. (NSB, 2004a)*

Statements like this leave no doubt that the recruitment to the S&T sector is a key factor in the global competitiveness (and for what is called 'national security').

Given this importance of S&T, it is easy to understand why there are many initiatives to improve the situation. Too often, however, expensive initiatives are launched without a well-developed analysis of the problems and without an underlying philosophy than can support, give direction and profile to the initiatives. Action often dominates over reflection and careful analysis.

The overall purpose of the ROSE project is to contribute to informed and critical reflection about the current challenges as well as to collect and analyse empirical evidence that shed light on the issues. We hope to stimulate an informed discussion and possibly to suggest policy measures and feasible changes and improvements in S&T teaching, mainly in schools, but also in the informal sector. The project therefore has theoretical as well as practical concerns. It should also be noted that ROSE is not confined to Europe or OECD countries, but has a major emphasis on developing countries as well.

2.1.2 Results from research: negative as well as positive

In spite of the now well known issues of unsatisfactory recruitment to scientific studies and careers and low interest in school science in many industrialized countries, we find no unambiguous trend in falling interests in science in general. In most countries, popular science magazines and TV programs about new medical developments, environmental issues, new inventions and technologies and new scientific discoveries have increasing public appeal. Sales rates on books in science and technology have not decreased, science centres

[3] Details will appear under OECDs Global Science Forum at http://www.oecd.org/department/)

and museums attract large numbers of visitors, etc. Neither do the Eurobarometer surveys[4], monitoring the public opinion in European countries on diverse issues, report any fall in the public interests or confidence in science:

> ***General trends:*** *Europeans have high expectations about science and technology. The overall view of science (i.e. the balance between its positive impact and harmful consequences) also remains positive. (EU, 2001)*

Other international studies[5] provide similar results. In summary, there is little evidence of falling public interest in S&T in the population at large in most countries, but that many, mainly highly industrialized OECD-countries, experience a fall in the recruitment to S&T subjects, studies and occupation. The problem seems to be the interest in school S&T, not in S&T as such. Many young people want to be informed about S&T - but they avoid these areas at school and as studies.

This rephrasing of the term "falling interest in S&T" is important. We are basically talking about an issue of recruitment to the S&T sectors. There are, however, wide-spread concerns about many aspects of people's relationship to S&T, like the role of scientists, the rapid pace of development, the possible lack of ethical concern in science and industry, etc., Other issues are mentioned in the first point in the Highlights of the Science & Engineering Indicators:

> *Although Americans express strong support for science and technology (S&T), they are not very well informed about these subjects. Many in the scientific community are concerned that lack of knowledge about S&T may adversely affect the level of government support for research, the number of young people choosing S&T careers, and the public's resistance to miracle cures, get-rich-quick schemes, and other scams. (NSB, 2004b)*

Below are some examples, based on Eurobarometer (EU, 2001): (The numbers are aggregates of results from the then 15 member states in the EU, and there are large variations between countries - and between women and men.)

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[4] Since 1973, the European Commission has been monitoring the evolution of public opinion in the Member States, thus helping the preparation of texts, decision-making and the evaluation of its work. Surveys and studies address major topics concerning European citizenship: enlargement, social situation, health, culture, information technology, environment, the Euro, defence, etc. Several studies relate to public perceptions of S&T http://europa.eu.int/comm/public_opinion/index_en.htm A new study is planned for 2005, also with US, Japan and others are participants.

[5] A key institution for such studies is the International Center for the Advancement of Scientific Literacy (ICASL) in USA (home page http://www.icasl.org/). Supported by NSF (The National Science Foundation), they publish surveys that compare the adult population in for instance the US, Japan and Europe on a range of different questions. Comprehensive reviews of this and other research in the field are given in regular reports like the *Science and Engineering Indicators* (see e.g. NSB 2004).

- "Science is changing our ways of life too quickly."
  Agree: 61.3%
- "Scientists' knowledge gives them a power which makes them dangerous."
  Agree: 63.2%
- "The authorities ought to formally oblige scientists to observe ethical rules."
  Agree: 80.3%
- "Scientists ought to keep us better informed about the possible hazards of certain scientific or technological advances."
  Agree: 89.0 %
- "Scientists ought to communicate their scientific knowledge better."
  Agree: 86 %
- "Industry ought to be better regulated."
  Agree: 82 %

2.1.3 Internalization and globalization: the positive side

We live in an era characterized by increasing contact between cultures, by intense travelling, information flow through mass media and electronic media like the internet, etc. We also experience migration and mobility of the workforce at an increasingly higher speed. Many of those who move are highly skilled people who have education and competencies that are easily transferable and highly valued on a global market. Scientists, engineers, doctors, etc. have the possibility to move rather freely to places where they are in demand.

It also becomes attractive to study abroad. In the US, the majority of PhD students in many S&T-related fields come from outside the US (NSB, 2002), often with the support from US grants. This benefits the host country, but may also constitute a 'brain drain' from the country where students come from. It may be claimed, however, that it is also, at least in the long run, positive for the 'donor' country.

The mobility of students and an educated workforce is considered positive from a whole range of perspectives. It may lead to cross-cultural tolerance and understanding. Organizations like the European Union has many support schemes to encourage this sort of mobility, mainly between member countries, but also from the outside. Also the unskilled labour force moves and migrates, often out of pure material necessity. They move to places where they can find work, and they often take up jobs that the nationals in that country do not want because of low wages and hard working conditions.

In a globalized and competitive economy, it becomes important that people's knowledge, skills and competencies are easily comparable and transferable. It becomes essential that exams, certificates and diplomas are understood and recognized across borders. It is also important for national education systems to match international standards of quality, and to find ways to monitor this quality. The so-called *Bologna process*[6] in Europe is one of many examples of these moves towards common standards in higher education: The move towards a common system of quantifying teaching/learning units (ECTS: European

[6] For details, see http://www.coe.int/T/E/Cultural_Co-operation/education/Higher_education/Activities/Bologna_Process/

Credit Transfer System), a common system of degrees and diplomas and a common system for the use of grades are key elements in this process.

Seen in this way, *globalization implies a pressure to universalize and harmonize the contents of education*, at least on the tertiary level. Countries and international institutions become concerned with developing common tools and indicators for comparisons, including educational outcomes. Key words are *benchmarks* and *indicators*. The OECD, EU and other international agents spend large sums to facilitate these comparisons. Also UNESCO is involved in defining the underlying conceptual framework for valid comparisons, like the ISCED[7] codes.

One can hardly object to the idea of finding common measures to describe educational outcomes. The data provided in such a way provide important input for national governments to judge the quality of their own system and to develop their education systems in an informed way. They also facilitate mobility for students and people with higher education.

But the possibly negative sides of the pressure for globalization are also apparent:

2.1.4 Global standards versus local adaptation

As noted, globalization in education often involves a pressure to universalize and harmonize, and to strive towards common contents, curricula, testing methods, indicators and benchmarks.

But current educational theory and research also carries the opposite message: There is a stress on putting S&T in meaningful and relevant contexts. Many curriculum initiatives have this as the main idea. As examples one can mention the many Salters' science projects in the UK, and the PLON project in the Netherlands. Some countries (like Lesotho, Swaziland and others) use the word to 'localize' the curriculum. In fact, one may argue that a key concern of the STS-movement (Science, Technology and Society) is to put S&T in meaningful social contexts, which often are of a local nature.

The driving force behind this development is in part related to *affective* arguments, that stress the need for learning to be 'situated', and that meaningful contexts become paramount. Other arguments stress the importance of learning as preparation for real life situations. After all, most young people will *not* become scientists or engineers and will *not* work on an international labour market. Most young people in most parts of the world will live and work close to their home, or at least in their home country. For the majority, the prime concern will be to develop knowledge and competencies that enable them to meet the challenges in their own surroundings.

In the colonial times, many developing countries had to use school systems, curricula and textbooks derived from the colonial power. To the extent that the curricula had a context, it was often that of the colonial north. Children in Africa were taught about animals and flowers to be found in England. Although colonialism in this form belongs to the past, many African countries still continue these traditions. They also import curricula, textbooks and exam papers produced in the previous colonial power. They often send their

[7] The International Standard Classification of Education (ISCED) was designed by UNESCO in the early 1970's to serve "as an instrument suitable for assembling, compiling and presenting statistics of education both within individual countries and internationally".

exam papers to be marked overseas. In many countries, educational authorities equate 'quality' with the contents and requirements found in this tradition. They do not want what they consider to be 'watered-down' S&T is their schools.

We hope that data and perspectives from ROSE may provide a different kind of voice in this ongoing debate over priorities.

2.1.5 International and cross-cultural comparisons

International comparisons in education make it possible to see one's own national priorities and choices with new eyes. They may lead to a better understanding of one's own national peculiarities, and they may open up for an awareness of alternatives.

There are already many international comparative studies relating to S&T subjects and other areas of the curriculum, and there is a broad spectrum of possible approaches to such issues.

At one end of this spectrum there are many small-scale studies of comparative nature that involve philosophically and politically oriented discussions about curricula. These discussions often raise fundamental questions about the nature of science, the nature and purpose of science education, the role of the language of instruction, etc. These discussions often address issues like the above mentioned asserted universality and culture-independence of science. They often address the political, economical and cultural domination of western cultures over other cultures. Several critical perspectives can be found, among these a cultural critique, feminists' critiques and a political or ideological critique relating to the purpose of education in science. These debates are of a fundamental nature, but are often of rather philosophical nature and with little reference to empirical evidence from the learners. The debates are often of a scholarly and intellectual character confined to academic journals. The concrete impact of such studies on educational policy and practice is in most countries often negligible.

On the other end of the spectrum are large-scale empirical investigations of students' scholastic achievements. These well funded studies are often professional from a methodological and psychometric point of view. They are strong on the theoretical as well as the empirical side, but have other concerns and research agendas than those indicated above. Some of these studies are run by large international associations set up for that purpose, the most renowned being IEA (International Association for the Evaluation of Educational Achievement). From the early 1970s, IEA has administered several large-scale international studies addressing science: FISS (the First International Science Study), SISS (the Second International Science Study) and recently, TIMSS (the Third International Mathematics and Science Study). TIMSS collected data in 1995 (and TIMSS-repeat in 1999). TIMSS continues under the same acronym, with T meaning Trends. A new round of data collection took place in 2003, and the results are expected to be published in December 2004[8].

Results from the many IEA studies have been used extensively by national governments as well as international bodies like the OECD. In early 1990s, OECD decided to initiate their own study, and to run this through the governments of the member countries. This study was called PISA (Programme for International Student Assessment). The target

[8] Reports from all IEA studies are available at IEA's home page at http://www.iea.nl/ TIMSS Reports and national links are found on TIMSS web page at http://timss.bc.edu/

population is 15 year old students, and the testing consists of three components, covering mother tongue reading literacy, mathematics literacy and scientific literacy. The testing is conducted every third year, with the focus alternating between the three components. The first round of data collection took place in 2000, with reading literacy as focus. The second round in 2003, had the focus on mathematics, and results will be released late in 2004. In 2006 the focus will be on science. PISA has produced a series of background documents, international as well as national reports[9].

TIMSS and PISA are elaborate and rigorous in their research design, sampling requirements, statistical and other procedures. Although they mainly address the learning outcomes, they also describe a whole range of other issues related to schools. Information from these studies is of prime importance for the policy makers at the national as well as international level.

The underlying rationale and hypotheses mainly emerge from the needs of industrialized countries as seen by national governments and policy-makers. Hence, participation is largely limited to countries with well-developed economies, although there are exceptions. (OECD is by its membership confined to rather wealthy nations.) The number of non-western participants is increasing in TIMSS 2003 as well as PISA 2003, partly through external funding.

These studies provide the governments with valuable information about the performance of their national education system measured against jointly defined standards. TIMSS and PISA results receive huge public attention in all countries, and they are presented with large headlines in many leading newspapers. Results are often presented with 'winners' and 'losers' and detailed ranking lists. Results become key concerns in political elections, like in Germany in 2003. The collection of press coverage of PISA-debate in Germany is available at http://www.ipn.uni-kiel.de/projekte/pisa/ It has more than 700 entries from the main German newspapers and journals for the two months after the release of PISA results. Many governments legitimize educational reforms and initiatives by reference to the results. It seems reasonable to expect that educational policy will be 'PISA-driven' in the years to come. The intended as well as the unintended consequences of these studies are enormous, and they are of course both loved and hated by everyone concerned with education.

International comparisons of pupils' S&T achievement may increase the pressure to conform to perceived 'international' standards that are in fact developed only in certain countries.

Although the approaches and operational definitions are different for the different comparative projects, the focus is on understanding the *contents* of science, mainly concepts, laws, models and theories. TIMSS tries to assess achievement relative to the curricula in each participating country. PISA, in contrast, has the ambition to define and assess more general *competencies* that are considered to be important in the present (and future) society. To an increasing degree, such studies also try to measure the understanding of the *processes* and ways of thinking that characterize science. They do, however, only to a limited degree, measure *attitudinal* aspect of students' relationship to S&T.

[9] PISA details and reports are available from the PISA site at http://www.pisa.oecd.org/.

The many comparative studies of "Public Understanding of S&T" like the Eurobarometer (e.g. EU, 2001) and similar studies in other parts of the world[10] may have the same normalizing effect. The target population for these studies is the entire adult population in the participating countries. Indirectly, such studies spell out what is 'officially' seen to constitute valuable knowledge. These public surveys often include rather simple questions supposed to measure 'scientific literacy'. In practice, this is done through a yes-or-no answer to simple factual statements. ("The interior of the earth is very hot", "All radioactivity is created by humans", etc.). These surveys also try to measure to what degree some aspects of the processes of science are well understood, like the concept of 'a fair test' and 'control of variables'.

There are no explicit intentions of such initiatives to standardize curricula and what counts as valuable public knowledge, but they may have such effects. Indirectly, they provide norms and ideals for other countries.

The above description indicates two extreme approaches to comparative studies. These extremes have different research agendas, purposes and perspectives: On the one hand studies motivated by a concern about national quality in international perspectives, and factors that can explain the observed differences. On the other hand we have the cross-cultural, ideological and political critique of science education and curricular priorities. Here the concern is about the role, function and relevance of schooling and the possible biases of curricula and teaching.

Both concerns are equally important, but the latter is often not the immediate concern of ministries of education. Publications in this latter category are often of a philosophical and ideological nature, while the empirical underpinning of arguments is often weak.

An intention of the ROSE-study is to bridge this gap between the two sorts of comparative studies. We want to contribute to the debate about curriculum priorities by providing empirical evidence on dimensions *different* from those measured by TIMSS and PISA. The intention is not to *compete* with the studies, but to provide an *additional* and *different* voice. The ROSE project group consists of people with experience and scholarship in the two traditions mentioned above; the psychometric as well as in the critical sociological and philosophical tradition. We also benefit from cooperation and discussions with the Norwegian TIMSS and PISA teams, who are in the same university department.

2.1.6 Science: Universal, objective and culture-free?

Underlying many debates on the S&T curriculum are questions like: Is science universal, objective and culture-free? If not, how deep and in what ways is science impregnated by or imbedded in the cultural context, be it in terms of language and culture, religious beliefs, gender, social class, economical system, etc.? Similar questions may be raised about the nature and character of technology.

Such questions have several dimensions, and they draw on many academic disciplines. They are of great concern for philosophers and sociologists of science, for educators and politicians - and of course for teachers and learners of science. It is far beyond the scope for this publication, and indeed for ROSE as a project, to go in any detail on such

[10] For a comprehensive overview of such studies, see (NSB, 2004b).

issues, where there are thousands of books and scholars and a wide range of positions. We will also argue that we do not need to take a common and firm stance on these philosophical issues. We do, however, reject the position of science as culture-free, objective and neutral. This version of positivism is, however, a stance that most scholars in the field today reject, so it is hardly a controversial. (Such a stance, does, however, survive in many textbooks and curricula.)

What are the possible *educational* implications of these fundamental questions for the *teaching of S&T in schools?* One may envisage a spectrum of educational positions on these issues: At one extreme is the position that considers S&T as unproblematic and taken for granted, and hence to teach according to what is perceived to be common, universal truths and laws. This solution is to some extent not very different to the prevailing situation in many countries: Science curricula and textbooks from different countries have striking similarities. Contents, structure, examples, illustrations, etc. give the impressions that science as well as its applications is universal and independent of culture or social context. Some see this similarity of science curricula as evidence of the universality and culture-independence of science; others interpret this situation as an example of unjust export of the culture, values and priorities of certain societies at the expense of others. Critics consider the homogeneity of the S&T curriculum as evidence that a particular and dominating world-view is being imposed on other countries.

The other extreme position is a rejection of common international standards in favour of defining national, local (or even personal) goals and contents, based on indigenous knowledge systems. Although only few such examples of curricula are actually developed and implemented, this position is often (in a somewhat weaker form) argued by some science educators.

The two above positions are meant to be analytical extremes on a spectrum of possibilities, and several middle positions are possible. One may, to a varying degree, take into account local knowledge and beliefs in a particular S&T curriculum, but still defend a more or less objectivist and philosophically realist stance regarding the nature of scientific knowledge.

The ROSE project brings together people who hold different positions on these issues. The project can certainly not expect to reach consensus on such issues. The project may, however, enable us to spell out more clearly some arguments for different positions. It may also make us able to suggest what kind of empirical data one would need to further the discussions and to argue for different educational consequences.

2.1.7 The primacy of the affective

Much of the actual contents of S&T in schools are soon forgotten by the students. But it is likely that the attitudinal outcomes have a more lasting effect. Students who develop an interest for science at school are likely to pursue such interests later in life. And pupils who learn to hate science and mathematics at school are likely to avoid mathematics and science - and to retain this feeling all through their life.

Affective factors mean a lot for how students choose their future. Attitudes and interests are important determinants for the choice of school subjects and for the recruitment to S&T studies and careers. But we find it even more important to stress not only this

'instrumental' side of the issue. The affective dimension of schooling, learning and growing up is *not* just a means to an end; it is an important aim in itself.

The many students (and teachers) who spend a considerable part of their everyday life at schools would naturally argue that school *is* life, and not merely a preparation for it. School satisfaction is thereby closely connected to quality of life, and everyday pleasure and joy is in itself one purpose of schooling. Teachers' job satisfaction is strongly influenced by how positive response the students give to their work, and teachers evaluate their success of their teaching partly in terms of whether they were able to engage the students (Ramsden, 1998). According to Ramsden (ibid.), many teachers consider students' attitudes and interests and how to make the students feel more positive about their science lessons as the most pressing area of research in science education. Teachers can, when planning their teaching in ways that motivate the students, make direct use of knowledge about their interests and concerns.

If we look at the aims and objectives as they are formulated in curricula in most countries, we often find that they stress attitudinal aspects in the general as well as in the S&T part. It is an aim of schooling to stimulate the interest in subject-matter, to install a lasting eager and curiosity to learn more. Life-long learning is only possible if schools have managed to stimulate lasting interests and positive attitudes to learning. Investing in attitudes is investing in the future.

Attitudes to S&T are also often stated as learning outcomes in themselves. This aspect is often trivialized to mean 'positive' attitudes, which often is taken to mean 'accepting' attitudes. We do not think that the aim of S&T education is to develop 'positive' attitudes in this narrow meaning. We rather think that students should develop an attitude of critical reflection against S&T issues. This may mean that they embrace and support some sorts of science and some sorts of technology, and oppose and discourage other. (Hence, it may be impossible to use a term or a construct like "positive attitude to S&T" in general.)

Scientific attitudes are also considered important outcomes from S&T in schools. This is, however, *not* the same as attitudes *to* science. Scientific attitudes imply certain ways of thinking and certain ways approaching problems. There is a long debate about what constitutes scientific methods (or wider: The Nature of Science) but key elements would at least be respect for evidence, for valid reasoning, etc. It also implies an attitude of wanting to find explanations that are secular and do not refer to authority. It should also include an element of humility, and openness to accept that one may be wrong and that current explanations may need to be revised. Such attitudes or habits of mind are central when some people and projects use the term 'scientific culture'.

Another important affective dimension is an *appreciation* of Nature in itself and of S&T as human constructs or achievements. Even persons who choose not to become scientists or engineers should be given the possibility to value Nature and the knowledge about it, and to appreciate how humans have constructed their knowledge about its working - and how they have managed to cope with their challenges to create better living conditions. The future non-science voters should be given an emotional as well as cognitive experience that enables them to put value on S&T for its cultural as well as material importance. This is important for people, and it is a good 'investment' for science.

Another affective dimension is related to a feeling of *empowerment*. It is important that S&T education (and schooling in general) helps to develop a feeling that one may influence the development on the personal as well as on a wider local, national and even

global level. Only by having such attitudes can people change their own life and the life of others. And only if they believe that they, individually and as groups, can make a difference, will they become active participants in society and change the world to the better.

These affective aspects do play an important role as aims in many S&T curricula worldwide. But it seems to be rather universal that this is forgotten when it comes to exams, assessment and grading. Most exams in S&T (and other school subjects) put the emphasis on testing the grasp of the factual or cognitive contents - the concepts, laws and theories. This is also the case with the large-scale comparative studies TIMSS and PISA. Our point is that attitudes should be more in focus for our concern about the different school subjects - including S&T. They are, however, more difficult to define, operationalize and measure. They are even more difficult to rank and grade in 'quality', which often is the main purpose of an exam!

We hope that ROSE can assist in describing a few of the many affective dimensions in S&T in a way that can stimulate debate and reflection.

2.2 ROSE: The Relevance of Science Education

In the above part of this chapter, we have elaborated on some of our and others' ideological and political thinking about science, society, schooling and research in science education. All these matters can obviously not be directly measured in a questionnaire, and can consequently not explain what the ROSE questionnaire is aiming at addressing. We have rather outlined some of our initial thinking and concerns prior to the foundation of the project. In the following we will try to approach more concretely the underlying ideas of the project and the questionnaire.

2.2.1 *Relevance* as a key word

The word *relevance* is chosen in the project title of ROSE. The obvious follow-up questions are then: *Relevant for whom? Relevant for what?* Relevant for students who are aiming for S&T studies and careers? Relevant for student careers in general? Relevant for promoting economical growth? Relevant for qualified citizenship? Relevant for high TIMSS/PISA test scores? Relevant for more enjoyable science lessons and everyday life in schools? Relevant for sustainable development? Relevant for handling everyday tasks? Relevant for creating concerned, empowered and autonomous individuals?

We are fully aware that our use of the term *relevance* simply begs for a definition or at least some sort of clarification. Our main perspective is *relevant from the angle of the learners - what the young people themselves express as their concerns.* Students often blame school science to play a small role in their everyday lives. As we all know, youth are not miniature scientists with an urge and desire for revealing the hidden laws of Nature. Their desires are naturally directed towards themselves - their own interests, their worries and their lives, as well as some facets of the society and the environment surrounding them. We are aiming at achieving a better understanding of a series of aspects that are related to young people's relationship with and emotions towards S&T: their interests, perceptions, experiences, attitudes, plans and priorities.

We argue that the only way to successful science teaching goes through knowing something about the views and perceptions of the learners. Only by taking departure in *their*

view can science education recruit more scientists, foster qualified citizenship or promote sustainable development. Only by meeting the learners at *their* premises can science teaching contribute in developing young people into concerned, empowered and autonomous individuals.

Our use of the term 'relevance' is actually more an umbrella term for a wide spectrum of factors that broadly speaking belong to the affective domain. In most highly developed countries, young people are less than before willing to engage in learning that they do not feel is motivating, meaningful and relevant. In a situation like this, it becomes important to get to know the perspectives of the learners. What do they like, what do they dislike? What are their hopes and values and what are their fears? What kind of future would they like to strive for?

Such questions fall outside the usual domain of research in S&T education, which mainly is concerned with conceptual understanding of the subject matter. The emotional or affective dimension of S&T education is much less focused in S&T education research - although it certainly does exist, and we will draw on this in the ROSE project. We can also get inspiration and insight into these aspects from current research in areas of sociology and youth research. We will return to this issue and elaborate a little on it later in this publication.

By getting to know more about what students think and feel about S&T, we may be in a better position to think critically and constructively about alternatives and improvements. The term *relevance* is chosen to indicate these dimensions. We could have chosen other words, like meaningful, motivating, interesting, engaging, important, etc. *Relevance* should therefore not be interpreted in a narrow or precise sense, and we will not try to provide any operational definition of the term. It should rather be understood as an indication of an important dimension that underlies the project. Besides, we found that ROSE was a nice and suitable acronym, and that it opens for metaphors, analogies and mental images! (We did not find a place for T for Technology in the acronym, but we do not limit ourselves to a narrow definition of science.)

2.2.2 Previous research on S&T-related attitudes and interest

According to Gable and Wolf (1993) are *interests* reflecting preferences for particular work activities while *attitudes* are feelings towards some object. Although psychologists have put much effort in identifying and defining these two interrelated constructs, the boundary between the concepts is still blurry, as neither of the two constructs are unidimensional (Gardner, 1996; Ramsden, 1998). In the following we will not make a clear distinction between interests and attitudes. Clarifying the meaning of the numerous terms in the whole complex and interconnected field of curiosity, interests, intrinsic/extrinsic motivation, attitudes, views, etc. is also seen beyond the scope of this publication.

Although the main focus of research in S&T education has been on conceptual understanding, there has always been research into the attitudinal factors relating to S&T. Reviews of the research in this field have been published (Gardner, 1975; Ormerod & Duckworth, 1975; Osborne, Simon & Collins, 2003; Schibeci, 1984; Simpson, Koballa, Oliver & Crawley, 1994). The German Institute for Science Education, IPN, arranged an international conference on Interest in Science and Technology Education in 1984. The proceedings contain a review of studies on empirical as well as theoretical and

methodological issues related to the measurement of attitudinal factors (Lehrke, Hoffmann & Gardner, 1985). This conference on interest in science was followed by a second, where the focus was on gender issues (Hoffmann, Krapp, Renninger & Baumert, 1998). In parallel to these international events, IPN has also had a series of research projects on the interest in various aspects of the different sciences under the umbrella of "IPN–Interessestudien". These studies are confined to German students, and most of the reports are published in German. (Duit & Mayer, 1999; Sievers, 1999)[11]. IPN has specialists in the natural sciences, in psychology as well as in psychometrics, and the above mentioned studies develop all these sides of the issue at some detail.

To an increasing degree public surveys also include *attitudes* and *values* related to science and technology. It is seen to important to understand the attitudes that people have to certain aspects of S&T, to what degree they are positive to public spending on S&T, whether or not they think S&T should be better regulated, whether they trust scientists, what attitudes they have to modern biotechnology, etc.

Students' dissatisfaction with science is not a new occurrence. Ramsden (1998) summarized some major review papers covering research findings from late 1960s and up to early 1980s, and concluded that there is little doubt that young peoples' attitudes to science have in general been unfavourable through several decades. The recent work of Osborne, Simon and Collins (2003) confirms that this disenchantment has endured also through the last two decades. Paragraph 4.2.3 gives a further review of the literature on interest in science and technology.

2.2.3 Building on the SAS-study

The ROSE project is a further development of the project SAS: "Science and Scientists". The SAS-study involved 30 researchers from 21 countries. Some 9 300 students at the age of 13 answered a questionnaire developed by Svein Sjøberg in cooperation with Jane Mulemwa from Uganda and Jayshree Mehta from India. The SAS team elaborated on research that had been done before; see e.g. Sjøberg and Imsen 1987.

The SAS-study started with a curiosity about children's interests in science and their attitudes to science and scientists. The project was met with great interest from researchers all over the world, and provided a wealth of interesting information. Findings based on the SAS-study have been presented in the project report (Sjøberg, 2000, 2002), in several international meetings, conferences and conference proceedings, as a chapter in a book (Millar, Leach & Osborne, 2001), in three Norwegian master theses (Henanger, 2004; Myrland, 1997; Sinnes, 1998), in addition to national studies in participating countries. In spite of many interesting results, the SAS-study had several weaknesses. Many of these stem from the fact that the study was intended to be only a modest exploratory study with a small number of participants. The underlying hypotheses were not clear enough, the logistics for data collection was not clearly developed, the funding was meagre, etc.

The SAS-study may be considered to be pilot study for the ROSE-project. We build on the experiences, results as well as on the wide network of partners that were involved in SAS. The target population in ROSE is 15-year-olds. The shift of age cohort from 13 to 15 does not imply a longitudinal design. It is rather based on the recognition that at the age of

[11] See more publications at http://www.ipn.uni-kiel.de/aktuell/publikationen.html

about 15 students are more mature and hence more likely to have done more conscious reflections on their interests, priorities and attitudes to and comprehensions of science-related issues and schooling. 15-year-olds are likely to give more consistent responses to the questions and thereby enhance the reliability of the data. This is also the age when students in most countries are at the end of the compulsory school, and many students have developed some ideas about their plans and priorities for their future. It is also the age when many educational and curricular choices are taken.

Although we have drawn on our experiences from SAS and similar studies, we base the development of the ROSE instrument on the literature review of comparable research from S&T education, inputs from our research partners as well as from the many public surveys already mentioned.

2.3 Modernity - some theoretical perspectives

In this chapter we have mainly pointed out challenges facing science education in *Western* or materially highly developed societies. The circumstances and the obstacles in other cultures may naturally be very different from the ones described here. But as many of the above described challenges facing S&T education are confined to Western late modern societies, we are lead to ask: Can these changes be connected to modernization of societies? Can sociological perspectives on modernization of societies be suitable for deepening our understanding of the current situation as well as of the results from the forthcoming data analysis?

We are not basing this study on one specific theoretical framework. We do not think that there is *one* set of theories that is able to explain neither the complex conditions of science education in Western societies nor the results of our data comparisons across diverse cultures. In this chapter we will draw on literature from sociology and youth research that outlines aspects of late modern societies and the late modern youth mentality. The background for including such perspective in this publication is that we wish to try out the idea that some of the challenges facing science education in Western societies are raised by late modernity.

No social philosophical interpretation of the present is total; different thinkers emphasize different aspects of society and social life. Other views, theories or explanations may illuminate other aspects or the same aspects from another angle. Several theorists and researchers have contributed to our own understanding. Our main sources are authors of reports from youth research, as well as contemporary social philosophers and researchers as Giddens, Beck, Ziehe, Inglehart, Furlong and Cartmel, and some Nordic writers (e.g. Illeris, Ulriksen and Frønes). These are widely referred to and applied in literature on late modernity. We do not aim to make a comprehensive review of their writings. Rather, we wish to outline some perspectives concerning motivational tendencies and personal value orientations of late modern youth that we consider as relevant for our concern about views of science and science education.

We will in following try to tap into the 'spirit of the age' among young people in late modern societies by picking some perspectives that we find productive and fruitful for our purpose. Our focus is mainly on the social life and mentality, and not so much on politics, economy and culture. Most schools of thoughts, however, see all these facets of society as closely interrelated. This means that people's ways of thinking and understanding is

dependent on the cultural, political and economic characteristics of the society. From this follows that one cannot understand the development in people's mentality without taking into account the development in these other issues. But since we aim to *describe* the late modern mentality, rather than to *understand the societal development*, we argue that these delimited portrayals of late modern societies may be appropriate.

Since we have our background in the fields of science and science education, we are not qualified for going into elaborated discussions on different traditions and beliefs within the field of sociology. Possible tensions and conflicts between the various thinkers, and different nuances in the meanings they put in various terms and concepts will not be considered here. Neither will we go far into descriptions of the past, although we acknowledge that many of the following aspects are interesting and relevant primarily when seen in *contrast* to the past. Maybe some perspectives of the past can be seen from between our lines.

2.3.1 Late modernity

Today's modern societies have developed through various characteristic eras - from hunting and gathering society to agrarian society, then from agrarian society to industrial society, and later from industrial society to the current (Giddens, 2001). The periods are characterized by particular social, cultural and societal trends. Social change is not only a change of economic basis, principal industries and prevailing works and trades, but also a matter of cultural perceptions, social patterns and ways of thinking and understanding (Frønes & Brusdal, 2001).

Modernity and *modernization* are terms connected to cultural, economic and political development in Western societies through at least the last two hundred years (Fornäs, 1995)[12]. Modernity is a state or type of society, but it is also seen as a stage of societal development. Our focus will be on the late post-war period, which we will refer to as *late modernity*. When we in the following refer to 'late modern societies', we refer to societies affected by the various processes associated with modernization - to societies in the state or condition of modernity. The term should not be confused with more value-laden meanings of the term like 'up-to-date', 'leading edge', 'avant-garde', 'innovative', etc. As antonyms to *modern* we use *traditional, non-modern* or *pre-modern*. This should not be confused with everyday meanings as 'out-dated' or 'old-fashioned'. The expressions are simply sociological terms on societal development.

Modernization is divided into sub-phases as late modern and post-modern, and into high modernity, second modernity, reflexive modernity, etc. Post-modernism is associated with chaos, pluralism and scepticism towards traditional values. Post-modernism dismiss universal principles, predictability and objective and empirical ideas, and dwell on alternative ways of thinking. This idea is debated. Some argue that we are living in post-modern societies *after* the modern era. Others counter that we are not yet *beyond* the modern, but rather in a late or high phase of modernity; a post-industrial information age.

[12] Specifying and concretizing periodization of modernity is not easy. Different social philosophers give modernity different starting points: the natural scientific revolution (16th/17th century), the enlightenment (18th century), the industrial revolution (late 18th and early 19th century), the modern corporation with separate R&D-departments (early 20th century), and so on... (Mjøset, 2003).

We will not go into this discussion, but simply state that we will regard individual positions within structures as nationality and gender as fruitful variables for explaining different views of science and science education. By this we have defined ourselves out of the post-modernist opinions.

The British sociologist Anthony Giddens characterizes pre-modern societies as a "disappearing world" (2001). Modernization is seen as a process taking its departure in Western societies, but globalizing tendencies and worldwide effects is in the nature of the process (Giddens, 1990). Industrialization of societies is seen as the driving force of modernization. With industrialization follows occupational specialization, bureaucratization, centralization, rising educational levels and beliefs and values that support high rates of economic growth (Ingelhart, 1997). Formation of nation-states, capitalist development, urbanization, democratization and secularization are also processes associated with modernization of societies. Other processes are technologization (increasing role of S&T), larger proportion employed in industry and service vs. agriculture, commercialization, market orientation, rise of mass media, de-traditionalization, fall of 'grand narratives' individualization, and last but not least, globalization. According to Inglehart, also other changes in advanced industrialized societies emerge: less focus on economic growth and more emphasis on the quality of life and democratic political institutions (1997).

2.3.2 Complexity and heterogeneity

In this chapter we shall see that descriptions of the late modern mentality bring some notions of chaos: Individualization makes everyone obliged to "design their own biography" and "live one's own life" (Beck, 2002) in a "runaway world" (Giddens, 1991). And the personal choices must be made without guidelines, authorities or any other trustworthy deliverers of the 'truth' (Ziehe & Stubenrauch, 1993).

Portrayals of the current transient period between the modern and the post-modern may be recognized by decomposition, disruption, heterogeneity, ambivalence, pluralism, fragmentation - and chaos. Interpreting the present in this way is a delicate balance. The present, or *any* present, always appears to be chaotic. Compared to earlier periods, which we feel we can understand, the current period will always be experienced as over-complex and difficult to understand.

Some of the following perspectives are not developed from specific empirical cases, but based on more philosophical and theoretical reasoning on late modernity. Aspects of these descriptions of youth must therefore bee seen more as rhetoric of the late modern society than as description of reality. It is a paradox that most statistics show that young people still tend to follow the footprints of their ancestors, and that their positioning in life is strongly affected by the social and cultural capital of their parents (Bourdieu, 1984; Furlong & Cartmel, 1997). Also their talents and abilities are decisive for which way they can choose ahead. In reality they can choose neither their biography nor their identity as freely as it may seem like here, because some ways forward may be closed due to conditions in the background of the individual.

Nevertheless, we find these descriptions as fruitful and relevant for describing the late modern mentality and how young people *perceive* their possibilities and ways ahead. Or - in the words of Furlong and Cartmel: "Class still has an impact on people's life chances" but

> *processes of diversification within the school and the labour market may obscure underlying class relationships and may provide the* ***impression*** *of greater equality and individualization without actually providing anything of substance - a process which we refer to as the epistemological fallacy of late modernity. (1997:5, boldface added)*

And furthermore:

> *young people may develop the* ***impression*** *that their own route is unique and that the risks they face are to be overcome as individuals rather than as members of a collectivity. (1997:7, boldface added)*

2.3.3 Risk society

Humans have always faced risks of one kind or another, but the risks facing today's citizens are qualitatively different from those threatening previous generations. The German sociologist Ulrich Beck introduced the term *risk society* (Beck, 1992). Risks are the unintended and unpleasant consequences of modernization. Beck sees risks as one of the main outcomes of globalization and technological and economical development. Risks are not the same as destructions, but they threaten with destructions - risks are threats of a potential reality. Risks are made out of the combination of the side-effects of the technological and societal development and our lack of knowledge of the consequences. This global risk society is an epoch in modernity. He would characterize it as a knowledge-, information- and media society succeeding the industrial society.

This post-industrial society is facing new risks of a new nature. Until a few decades ago, people and societies were threatened by risks such as drought, earthquakes, famine, diseases, plagues, etc. But no matter how large and devastating such risks were, they were perceived to be unrelated to human activity. People today are to a large extent exposed to man-made risks as BSE (mad cow disease), ecological hazards, depletion of the ozone layer, global warming, potential dangers from nuclear, chemical and genetic technology, social inequity, overpopulation, etc. These are often diffuse in origin and their consequences are unforeseeable. Beck describes them as super-national and class-unspecific in terms of causing threats that cannot be delimited in time or area, they cross national borders and they hit regardless of age, gender and social status. As the problems originate from the lifestyle of entire populations, we can hardly find persons to blame and it is unclear who is responsible for taking action against the problem. Possible disasters are consequently detached from individual responsibility. But still, there is a widespread public awareness that the risks are dependent on human decisions, priorities and actions (Beck, 1992).

People in late modernity (or *second reflexive modernity*) are facing risks not only at the societal, national or global level, but as well at the level of the individual life. Decisions regarding personal matters represent risks as accidents, illnesses, death, divorce, educational failure, unemployment and poverty. They are all seen as consequences of wrong choices. Beck sees the perception of risks as key the determinant for the individuals' thoughts and actions (Beck, 2000).

2.3.4 Reflexive modernity

New information and communication technologies give people in late modern societies access to large amounts of information, and have thereby experienced the untrustworthiness of scientific discoveries and theories. Technocracy has been undermined - we notice how scientific experts are disagreeing in public on important matters relating to environmental problems or other scientific issues. Consequently yesterday's authorities have lost some of their credibility, and scientists have a weakened function in guiding people in their actions and their choices.

People know that knowledge may be temporary and short-lived. It often becomes outdated. This makes people less convinced about prevailing 'truths' and 'facts', and creates a society that have become more and more self-critical and individuals that have become more and more self-confrontational.

This is what Beck (1992) and Giddens (1991) call *reflexive modernity*. According to Oxford English Dictionary Online[13] is "inclined to, or characterized by, reflection or serious thought; reflective" one meaning of the adjective *reflexive*. Reflexive modernization is connected to the development of *knowledge*. Modern societies are *knowledge* societies in terms of more information being created and available, and people having more knowledge. This brings knowledge-based decisions and actions. Continuous development of *new* knowledge means that decisions and actions are reconsidered and redefined according to new awareness. Society becomes more self-critical and reflective. Beck argues that *reflex* lies in the concept *reflexive modernity* as well. Risk society is a reflex development of the industrial society in the sense that the transition from industrial to risk society occurs unreflectingly and automatically because of the unintended consequences of modernization (Beck, 1999).

People in reflexive society are constantly responding and adjusting to the changing environment. Late modern beliefs and actions have become more reflexive in terms of continuously being subjected to discussion, explanation, mystification and confusion. Individual choices are continuously being elucidated in relation to consequences and alternative possibilities. As we get new information and obtain new knowledge, we consider and reconsider, and choose and re-choose our beliefs and our actions.

2.3.5 Detraditionalization and loss of grand narratives

Common values, interpretations of meaning, and social and cultural structures have been passed down from generation to generation, through established traditions and norms. Such widely shared believes or 'grand narratives' have functioned as unshakeable truths and guidelines.

One of the grand narratives of the past stem from the Age of Enlightenment. People were convinced that the step-by-step progress of science would eventually explain every phenomenon in science, society and the human mind. The coming time would be the age of progress - enlightened by human reason. Science, evidence, knowledge and reason would wipe out injustice and human irrationality for the benefit of knowledge, technology, truth, freedom and welfare for everyone. Secularization and decline of the authority of the Church

[13] Oxford University Press 2004, http://dictionary.oed.com/

followed from the scientific discoveries of e.g. Copernicus, Galileo and Newton and from the focus on happiness and progress rather than religious salvation.

The strong and often uncritical belief in science, rationality, technology and eternal progress often took forms characterized as 'scientism', and often implied a strong belief in technocracy and trust in experts. But in the post World War Two period this trend has gradually been weakened in many societies. Wars, environmental devastations, population growth, etc. bear witness that enlightenment will not prevent irrationality. People with access to information and high level of knowledge and awareness, do not necessarily make choices that ensure a safe and good future. For example, although we know the causes and can sense the problematic consequences of anthropogenic emissions of greenhouse gases, we do not change our actions noticeably, and we are not close to any solution for overcoming the global warming problem. The grand narrative of future *progress* and *growth* (Giddens, 1990) with *more* and *better* of the *same* (Frønes & Brusdal, 2001) is no longer valid. People have realized that life will not become sounder or better. People expect problematic consequences in the wake of all 'progress'. Today's young people may be the first generation for many centuries who do not believe that they can attain a better life than their parents (Heilbroner, 1995; Øia, 1995).

Not only has the belief in science- and knowledge-driven progress fallen, but also the dogmas of authority and tradition. People experience that the experts cannot explain the social and the natural world. People experience knowledge as ambiguous and temporary. People get the idea that scientific knowledge after a time will be invalid and worthless. This leads to falling credibility of authorities and comes together with relativism and pluralism of meaning. Previous authorities have lost trustworthiness - God, scientists, politicians, teachers and parents have a weakened function in guiding young people in their actions and in their choices. Various systems of values, cultures and norms may coexist without being put against each other. Every 'truth' must be enclosed by inverted commas, because truth is perceived to be a relative construct; every person may have her/his own truth, and no truth is truer than another (Skårderud, 1998). Giddens sees this as reflexivity of modernity undermining the certainty of knowledge - even the core domains of natural science are questioned (Giddens, 1991).

The German sociologist and educator Thomas Ziehe sees the weakening of religion's impact on life, changing sexual morality and manners, erosion of traditional generation patterns, role confusion between sexes, decreasing respect for authorities, etc. as contributing to tearing down the meaning of traditions (Ziehe & Stubenrauch, 1993).

2.3.6 Cultural liberation

As described above, the old traditions and authorities have functioned as agreed guidelines for young people's choices. The disturbing consequences of weakened authorities and traditions are diversity and cultural liberation. The skepticism towards traditional values liberates people to "design their own biographies". Ziehe sees young people as liberated from the constraints of geographical locality, social class, relatives, religion, etc. They can choose their own life-world - they are free from conventions and unrestricted of traditional values and norms. Today's young people are facing choices in all facets of life - they have infinite degrees of freedom and can make their choices without interfering traditions and authorities (Ziehe & Stubenrauch, 1993). Who they are, what they believe in, right and wrong, future

occupation, social class, friends and even their own body are all matters of their own choices. (At least this is their *notion* of the cultural liberation (Furlong & Cartmel, 1997)).

Furthermore, it is never too late to change the decision. They can re-educate themselves to another profession, re-choose a lover, re-settle in another geographical area or in another social setting, re-consider their religious belief, re-shape their body, re-develop their identity, etc. This can be seen as an extension and widening of the reflexive modernization: few decisions are perceived as final. They can be reconsidered, and re-decided in light of new achievements in knowledge and insight (Giddens, 1991).

With this freedom follows advantages. Today's youth can benefit from having the chance to form their own lives in correspondence their interests and wishes. But their decisions regarding personal matters represent risks. With the new freedom follows new challenges and problems. The ideologies, traditions, values and norms have to some extent functioned as a safe and supporting framework. The new freedom implies *possibilities* to choose, but also *obligations* to choose, and they must make these choices without trustworthy authorities. And furthermore, when they have made their choices, they are themselves responsible for the outcome. There is nobody there to share the responsibility, and there is only themselves to blame and to handle the consequences if something goes wrong (Furlong & Cartmel, 1997).

Young people's educational choices represent risks, and for some reasons may their choice not lead to successful achievements. For example, the education may not fulfil their expectations or it may be too demanding and hard to go through, which furthermore may lead to drop-out or failure. In addition may societal developments lead to lack of demand for labour at the moment they have finished their studies, leading to anxiety about finding work.

2.3.7 Individualization and identity development

Identity building is a central concern for youth in general, and for youth in late modern societies in particular. According to Coleman and Hendry (1999) and Illeris et al. (2002) have the German-American psychoanalyst Erik H. Erikson and his book "Identity, youth and crisis" from 1968 been influential on our thinking of identity development. He saw human development as going through a series of stages, where the adolescence stage mainly is affected by the task of establishing a coherent identity. Identity is the experience or definition by an individual of one self. Identity is connected to a series of aspects and features, like age, sex, social class, nationality, race, fashion, body, lifestyle, occupation, etc. The identity concept implies that there is some degree of consistency or connection between a person's behaviour, appearance, priorities, attitudes, activities, etc.

A main issue in the analysis of late modern individualization is that the human identity is no longer seen as inherited, given and established. According to Giddens has identity (or *self-identity*) become an inescapable issue in late modern societies. The modern identity is not settled from the moment of birth by social class, family background and sex. We are not what we are born into or what nature has given us, but rather "what we make of ourselves" (Giddens, 1991). Identity development is a task and a project imposed on everyone by late modernity.

The identity may be altered through time, and it changes as a person enters new roles in her/his everyday life. There may be little consistency between the various identities of a person entering roles as a student, daughter/son, friend, patient, sportsperson, consumer,

etc. (Beck, 2002). Identity cannot be perceived as a fixed understanding of a person, but rather as a feature being subjected to continuous development. Identity development is a reflexive project - constructed through reflexive choices and continuously reconsidered, reconstructed and redeveloped in light of new knowledge and new experiences (Giddens, 1991). People have to work out the roles themselves in terms of making decisions in everyday matters as clothing, appearance, leisure activities, friends, beliefs and educational choices. Or, putting it in the words of Giddens:

> *What to do? How to act? Who to be? These are focal questions for everyone living in circumstances of late modernity - and ones which, on some level or another, all of us answer, either discursively or through day-to-day social behaviour. (Giddens, 1991:170)*

Many see the fall of optimism from the Age of Enlightenment as the main initiator of modern individualization. Fall of traditions, authorities and 'truths' lead to the notion of individual autonomy and responsibility in decision-making, as there were no socially generally accepted guiding convictions. The late modern society has developed into a society accentuating individuality and the idea that each person has a unique character and special potentials that may - or may not - be fulfilled (Frønes & Brusdal, 2001). The late modern project of young people is to develop an identity and to fulfill themselves - and the only something is to be unique. *The worst thing in life is to be ordinary*.[14] Being common and ordinary is like being nobody, nothing and nonexistent (Skårderud, 1998).

2.3.8 Creating the young body

The massive focus on body in newspapers, magazines, movies, television and commercials reflects the increasing interest in body and how to make the body look young, healthy and beautiful. More attention has been paid to the attractiveness of girls and women than to boys and men, but this pattern may now be changing. Products for cosmetics are among the largest and fastest growing in many countries, and the potential market is no longer confined to girls and women. The modern body is, according to Giddens (1991), less extrinsically given. Rather than fate, fortune and nature is body appearance, shape and health becoming a reflexive project - something we choose and construct ourselves.

The British sociologist Chris Shilling describes the *individualization* of the body and the notion of *body as a project* (Shilling, 2003). The late modern risk society threatens our body with risks connected to health as well as to appearance and shape. Heart decease, cancer, overweight and wrinkles are increasingly perceived as consequences of our actions and our lifestyle choices. This means that we are increasingly perceived as personally responsible for our health and our appearance. This notion of the self-determined body is accentuated by new possibilities in health clubs, plastic surgery, gene technology, etc.

The identity is to an increasing degree tied to the surface, and body is a central expression of identity and a crucial instrument for building a self. Following the decline in grand narratives and religious and political authorities, there is also a weakening in the status of maturity, adulthood and age. Consumer culture idolizes the young, sculptured and sexualized body and suggests that it is available to everyone (Shilling, 2003). The late modern

[14] ... as the young girl Angela repeats in the movie "American Beauty"

ideal is youthfulness, smooth skin and a fit body. A young and slim body carries a symbol of self-control and success (Skårderud, 1998).

A Norwegian study reports that the only area where today's youth show more troublesome traits than youth of some decades ago is when it comes to body. Young people today are significantly more worried about their appearance and their health than before (Bø, 1999). Giddens suggest that in a 'runaway world' - rapidly changing and increasingly out of control. The increasing number of young girls with eating disorders like anorexia nervosa mirror youth's "striving for security in a world of plural, but ambiguous options". The Norwegian psychiatrist Finn Skårderud (1998) sees anorexia as an expression for taking control over ones' life.

2.3.9 Narcissism vs. citizenship

The British sociologist Zygmunt Bauman sees "corrosion of citizenship" as the other side of individualization (Bauman, 2001):

> *if individualization spells trouble for citizenship and citizenship-based politics, it is because the concerns and preoccupations of individuals qua individuals fill the public space, claiming to be its only legitimate occupants - and elbow out everything else from public discourse. The 'public' is colonized to the 'private'; 'public interest' is reduced to curiosity about the private lives of public figures. (Bauman, 2001)*

Can we say that the high level of material welfare in late modern societies liberates people from material worries and leads to more focus non-material idealistic values as societal participation and citizenship? Or does the above described struggle for developing an identity, fulfil oneself and find ones own way ahead lead to a project of self-actualization so demanding that late modern youth show more traits of narcissism (i.e. self-centredness). Is narcissism a rational response when one sees future as a threat? If their major concern and worries are connected to their own identity and their own way ahead, are societal and global developments perceived of little consequence?

Thomas Ziehe sees late modernity as imposing a disruption between the individuals and the past and between the individual and her/his own culture (Ziehe & Stubenrauch, 1993). Late modern youth are culturally and socially liberated and freed from traditions and norms, and they have access to social goods such as education and geographical mobility, regardless of social background. They may have the impression that there are infinite options and degrees of freedom. But youth do not only have the *freedom* to choose - they are *forced* to choose, and they on their own are responsible for the outcome. One may interpret that this gives narcissistic youth with focus on the process of shaping their identity and their life - disconnected from societal matters.

On the other hand, Abraham Maslow's (1968) psychological *hierarchy of needs* and the sociological *post-materialist theory* of Ronald Inglehart (1990) point towards contemporary youth holding a worldview with less materialistic values than previous generations. Maslow drew a pyramid with different levels of human needs. The basic needs are of physiological character (to breathe, drink, eat, sleep, etc.), while the fifth need at the top of the pyramid is self-actualization, which means a desire to live one's life to the fullest. Inglehart's empirical study and findings are perceived as consistent with Maslow's pyramid

(Bell, 1997). Inglehart (1990) found that younger birth cohorts were much likelier to emphasize values such as belonging, self-expression and quality of life than their counterparts some decades earlier. Economic and physical security continues to be valued positively, but their relative priority is smaller in younger than in older age groups. Younger people also show more interest and understanding in societal non-materialistic values - beyond the economical and material profits - like democracy, social and ethical values, care for others, societal participation, national and international politics, environmental protection, etc. Inglehart suggests that the main cause of this shift in value orientation is the emancipating capacity of the high economic welfare in Western societies. He sees a transformation from a materialist to post-materialist society.

The questions above and other related issues outline a running debate about value orientations among late modern people. As *young* people are in a phase of life accentuating identity development and critical choices about future directions, special attention is paid to this cohort. In psychoanalysis the term *narcissism* is used as an individual nervous personality disorder, while in our context it should be understood more as a trait of a culture or a general mentality. Narcissism should be seen as a concern lying much deeper than individual self-admiration and self-centeredness. Narcissism is about worry and concern for values emphasized by individualization: developing a unique identity, constructing a body, fulfilling and developing one's potentials, avoiding dangers and risks - and ensuring future happiness. Narcissism can consequently be perceived as necessary attention and love for oneself and as a credible and acceptable consequence of late modern individualization.

Furthermore, we want to emphasize that there is not necessarily a tension or a conflict between narcissism on the one hand and citizenship on the other. For example, a person may 'burn for' environmental protection. Environmental engagement will then constitute a significant element of the person's identity, and societal participation and green lifestyle may be a consequence.

3 QUESTIONNAIRE DEVELOPMENT

3.1 Methodological considerations

Research instruments, like questionnaires or tests, always need a purpose and a meaning. Questionnaire development must be based on some kind of framework that provides an account for *what* the questionnaire aims at measuring and *how* it shall be done. Such ideas and frameworks are of course closely related to the research aims and questions of the research project itself. Standard textbooks in research methods (Ary, Jacobs & Razavieh, 1996; Cohen, Manion & Morrison, 2000; Robson, 2002) describe the whole range of different research designs and their strengths and weaknesses.

Some research requires precise hypotheses and operational definitions of the concepts that shall be measured. For example, research aiming at understanding the combined effects of anxiety and ability on girls' mathematical performance call for clear definitions of the concepts *anxiety* and *ability* as well as the term *mathematical performance* (Hagtvet, 1991). The research is based on the assumption that there is an interaction of anxiety and ability which have an effect on performance. The more exact and detailed the hypothesis and research questions are, the more precise must the concepts be defined, operationalized and measured. Projects like TIMSS and PISA are also examples of studies with a set of definitions and operationalizations of distinct concepts that the projects aim to measure (see e.g. OECD, 2000a).

Other studies follow a different rationale and have a different design. Many studies are more qualitatively oriented, flexible in design, and open for surprises and new ideas. They do, however, not lend themselves easily to comparisons and to generalizations.

ROSE may be said to fall in the middle between these two research designs.

3.1.1 The explorative nature of ROSE

ROSE is quantitatively and statistically oriented, but tries to combine this with the openness mentioned above. Rather than confirming or falsifying certain precisely predefined hypothesis, the ROSE project has an exploratory nature by aiming at *opening up for the unexpected*. The general underlying assumption of the ROSE project is that there are interesting cultural differences and similarities in students' interests, priorities, future wishes, experiences, etc. which are of relevance for teaching and learning of science at school. ROSE is not aiming at assessing *all* such relevant concepts. Neither are we trying to measure *every* possible facets of each concept. As described above, the aim of the ROSE project is to explore some affective qualities of science teaching and learning in order to provoke some thoughts and stimulate some discussions about science curricula in various cultural and societal contexts.

As the study aims at *exploring* and bringing *new* perspectives and theories to a cross-cultural context of science education, it aims to generate new ideas and views - rather than verifying or falsifying a set of explicitly predefined hypothesis or theories. ROSE is based on a set of shared views, perspectives and value positions. These were more or less clarified as a set of core commitments from the beginning, and have been further developed through the process. But there is not a very specific conceptual or theoretical framework on

which this study is based, there is no fixed set of precisely defined research questions, and the partners in the project do not in detail have the same approach or theoretical perspective on the study. Partners in the ROSE study may bring a variety of theoretical approaches, like cross-cultural perspectives, sociology, youth research, development theories, comparative education, curriculum theory, political science in education, learning psychology, feminist theory, etc. By providing data that can be analyzed from several different perspectives with several different purposes, the project is designed for welcoming diverse theoretical perspectives and for a corresponding diversity in research questions.

ROSE aims at generating new hypothesis and developing new theoretical perspectives on cultural background and students' perception of science education. Primary data, data collected from different cultures for a comparative purpose, are hard and expensive to collect (Ember & Ember, 2001). Therefore there are not many previous research results or theories applicable for the cross-cultural perspective of ROSE, and not many theories to test and refine. Ploughing new fields calls for an exploratory study opening up for the unexpected.

As mentioned, our review of the literature indicates that there does not seem to exist any research instrument that pertains to measure the sort of attitudinal aspects of students' relationship to science that the ROSE project wants to assess. This means that we needed to develop this instrument ourselves, as an important element of the project. In the following, we will go in some detail on this process.

3.1.2 Issues to be considered

Problems associated with measuring affective characteristics as interests, attitudes, etc. are widely known and documented both outside and within the community of science education researchers (e.g. Bennett, 2001; Gable & Wolf, 1993; Gardner, 1975, 1985, 1996; Mueller, 1986; Oppenheim, 1992). Some problems can only be dealt with in detail after the data collection, like data analysis and interpretations. Some aspects of the validity of the instrument and the reliability of the data can also only be fully dealt with after the data is collected. There are, however, several crucial matters concerning the methodology that we have considered prior to and during the development of the questionnaire. These include

- clarifying the rationale and the aims of the study and agreeing on a set of common beliefs or assumptions
- exchanging ideas with the persons of concern (students, teachers and researchers)
- reviewing relevant literature
- specifying the underlying ideas and hypothesis
- defining the issues and subjects to be addressed
- designing and developing the instrument (reproduced in Appendix A)
- specifying the target population and sampling procedures
- planning and preparing the data collection and coding
- piloting the questionnaire
- addressing validity and reliability issues

The above points do not follow each other in a linear or sequential order, but have to be discussed and refined as the research develops and matures. Some of the initial points have already been discussed. In the remaining part of this publication, we will elaborate on some of the other aspects that have preceded the data collection and analysis. Some of the points can only be finally discussed during the analysis, when data are collected.

3.1.3 The choice: Closed questions

The ROSE instrument is a questionnaire mostly consisting of closed, pre-structured questions that by their format offer the respondents fixed alternative responses. The respondents give their answers by choosing the alternative appropriate to their view.

Data collected by open questions in which the voice of the students are allowed to come through, e.g. interviews, essay writings, open-ended questions, etc., would have been more sensitive to the richness in the perspectives of the students. But the amount of time, funding and rigour required for collecting and coding free-response data from a wide range of languages and cultures would have been beyond the limits of the project. Open-ended questions are also demanding to answer as they require far more time and thought than closed questions. They also require a certain level of writing skills. A questionnaire with many open-ended questions may receive low response rates and weak reliability of the coding. Only one question in the ROSE questionnaire is open-ended (question I, see paragraph 4.8 and Appendix A), offering the students a number of lines where they can give their ideas in their own words.

We see, however, the need for follow-up studies with other methods than the ROSE instrument. In order to both validate the questionnaire and deepening our understanding of some issues, we wish to pursue some of the questionnaire topics for example by conducting interviews and/or focus group discussions. ROSE partners in many countries are collecting data on issues raised in ROSE by other, more qualitatively oriented methods.

Advantages with closed questions are that they require relatively low costs as the data are rapidly collected and coded. Besides, the coding requires a minimum of inference on coders. They also give tidy data which are easy to compare. Because they do not require any extended writing, they are also quickly and easily answered (Oppenheim, 1992). There are several drawbacks with closed questions: loss of spontaneity and expressiveness, we get no knowledge about the respondents' thoughts of their own accord, we may introduce a bias by 'forcing' the respondents to choose between alternatives or by making them focus on alternatives that might not have occurred to them. One may also possibly lose responses if the respondents become irritated because they don't feel that the questions express their own ideas (ibid.).

Closed questions are, as mentioned, easy to administer, code and analyze. Collection of large amounts of data is simple and relatively cheap. But the quality of the data one gets is of course limited by the quality of the instrument. You only get answers to the questions you ask. Therefore, a closed and ready-made questionnaire requires a lot of time and effort spent on instrument development. We will in the following share some of our concerns from this process.

3.1.4 Item design: Simplicity - and not much repetition!

We have tried to follow well accepted rules from the research methodology literature on designing a good questionnaire: asking short questions, using simple wording, not assuming too much knowledge, avoiding double negatives, avoiding leading questions, avoiding loaded or emotional terms, avoiding 'socially correct' answers, sensitive topics, proverbs, double-barrelled questions (containing several questions but allowing only one answer), etc. (Oppenheim, 1992).

Some of these issues are particularly important in the case of ROSE, since this instrument will be used in very different cultures, translated to other languages, and used by students who may answer in another language than their mother tongue.

We have also tried to avoid tedious repetitions of nearly similar questions, although more items might have increased the statistical reliability of the composite variables or constructs (see chapter 6). This *statistical* imperative had to be balanced against the possible *personal* frustration and irritation by the respondent over having to answer the same question again and again. Duplication of the questions may even make the respondents feel that somebody is trying to lure them into a trap of contradicting themselves.

3.1.5 Response scale: Likert-type with four categories

All items follow the same basic structure or logic. A statement is presented, and the students are asked to give their response by ticking the appropriate box in a fixed scale. We use Likert scales with four categories for all items. The responses go from 'small' to 'large': Disagree–Agree, Not interested–Very interested, Not important–Very important and Never–Often.

We have chosen Likert scales in favour of other attitude scales as e.g. Thurstone scales, Semantic Differential scales, etc. Compared to Thurstone scales, Likert scales are easy to construct and easy to give response and scores to. As the instrument must be translated to many different languages, a simple Likert scale has obvious advantages. Likert scales are also often found to provide data with relatively high reliability (Gable & Wolf, 1993; Oppenheim, 1992).

The issue of the preferred number of responses on a Likert scale is discussed in many standard textbooks on research methodology, and the recommendations vary: In a five-categorized (or other uneven numbers) Likert scale there is a middle box representing a neutral category. However, the meaning of the middle category has turned out to be complicated to interpret (Oppenheim, 1992). Respondents do not necessarily regard the middle category as the neutral midpoint between the two extremes. They are likely to choose the middle box for various reasons, for example for indicating lack of knowledge, lack of understanding, indifference, lack of motivation for taking a stance towards the topic or refusing to answer (Gable & Wolf, 1993). Many studies find that people tend do tick the middle neutral box; maybe because the most convenient option is not to take any stance. This high number of ticks in the neutral box is leading to what is called *ordinal bias* with 'too high' scores in the middle box (Oppenheim, 1992). This may cause complexities in the data analysis, as the neutral middle point often differs markedly from the regression line in correlation analysis. In fact, we do not know exactly where the attitudes turn from slightly positive to slightly negative in Likert scales; in contrast to Thurstone scales with a true neutral point (Ary & al., 1996).

After lengthy discussions and review of literature, we have chosen to leave out the neutral middle point as well as the "Do not know" category[15]. Without these categories, the respondents are in a way 'forced' to take a stance. This can of course be debated, and one can argue that people should have the right to remain neutral to an issue. However, in the introduction of each question we reminded the students that they might refrain from ticking any boxes if they did not want to or know what to answer.

There is some evidence that the reliability of the scale increases with increasing number of response categories. In addition, few steps on a scale will fail to discriminate between respondents. On the other hand, the more categories, the more effort is required to choose an answer. Too many categories can lead to confusion and frustration among the respondents (Gable & Wolf, 1993). We consider it important to make the questions straightforward and undemanding to answer. As a result of these and other considerations, we decided to use four categories on the Likert scales, and to stick to this throughout the whole instrument.

It is common practice to score the scale by assigning numerical values to the response categories, for example 1–4 from left to right, and to regard the Likert scales as a quasi-interval scale. In an interval scale the origin is arbitrary, but the distances between each of the categories are supposed to be equal sized intervals. Data in an interval scale may be manipulated by addition and subtraction and analyzed with a whole range of standard statistical methods (Ary & al., 1996). However, when handling the scores as data in an interval scale, we presuppose that the distance from category 1 to category 2 is identical to the distance from category 2 to category 3, etc. Issues like these are debated in the research methodology literature, but is seems to be a wide acceptance to use Likert scales as we are indicating here.

We decided to have headings above *only* the extremes in the Likert scales. In this way we avoided the task of making good and balanced titles. Is also simplified the translations of the titles to other languages and avoided ambiguity in meanings. In discussions and interviews with some respondents (see paragraph 3.2.2), they did not point out the lack of such headings as problematic. We are more inclined to believe that the respondents imagined the space between the extreme boxes as a continuous scale, with the untitled boxes dividing the scale into three equal sized intervals[16].

3.1.6 Three major challenges

Every questionnaire developer is facing several challenges. Numerous decisions have to be made, priorities have to be balanced, and compromises between competing concerns are frequent. Below (in paragraph 3.2) we will give some details on how the questionnaire was developed into its final form. But before we get to this, we will mention three major

[15] In choosing a 4-point Likert scale, we use the same format as questions of similar nature in the PISA Student Questionnaire, see e.g. http://www.pisa.oecd.org/docs/context_quest_2003.htm. Also our coding system is similar to that used by PISA.

[16] We also note that a popular way of judging the 'quality' of movies, etc. in mass media often is by showing a dice with 1 to 6, ranging from the worst to the best. The exact meaning of the number on the dice is never 'explained' to the reader, as it appears to be self evident.

challenges which had major influence on the evolution of the questionnaire and great impact on the final product. ROSE is burdened with three central features which in themselves may be perceived as self-contradictions:

1. *Exploring while wearing blinkers:*
   On the one hand ROSE aims to explore and capture diversity, but on the other hand the instrument for data collection is a fixed-choice questionnaire.
2. *Comparing the incomparable:*
   On the one hand ROSE will compare science-related issues in different cultures, but on the other hand different terms, concepts and connotations convey different meanings in different cultures, and cannot therefore easily be compared.
3. *Cooperation without a common aim:*
   The questionnaire is developed in a cross-cultural collaborative process - involving actors who might bring in their own theoretical background, research agendas, political aims, etc.

We regard the following description of the challenges as important for setting the scene for the process of developing the questionnaire. It is not meant as a justification or defence for something, but rather as an achievement in courage, open discussions and collaborative work:

1. Exploring while wearing blinkers

This challenge is related to the conflict between our ambition to be open and to *explore the unknown* - but by collecting data with a ready-made closed questionnaire. Wearing blinkers reduce your sight and horizon, and the questionnaire is by definition restricting what you can possibly see. The obvious weakness of closed questionnaires is that you only get answers to questions you actually have asked. It goes without saying that the element of discovery is small when all questions and possible answers are fixed in advance. As ROSE aims to *open up for diversity* and *capture the range of variations* in students' interests, priorities, experiences, etc., one might think that the ideal method for data collection would allow the students to express their own ideas with their own words.

The ROSE questionnaire includes only one open-ended question (question I, see paragraph 4.8). This is one means for exploring the concerns held by the students. But apart from this question, the study is constrained by the disadvantages connected to fixed questionnaires.

We have tried to meet these inevitable limitations through the process of developing the questionnaire. We have hade an effort to maximize the span captured by the questionnaire items. For example, in question A, C and E we request the students to indicate how interested they were in learning about a variety of topics. In this part of the questionnaire there are several topics that many science educators would consider to be far outside the bounds of appropriate S&T curricula. We are aware that the inclusion of such items may seem strange, but we have included such items in order to be as open as possible to the view of the students.

The active participation of scholars from a wide range of cultures through the process of instrument development has hopefully also enabled us to maximize the variety that we wish to capture and describe. The various stages and approaches throughout the

questionnaire development (interviewing students, piloting, etc., see paragraph 3.2) has also helped us to be open for the variety that we are aiming at.

2. Comparing the incomparable

The second challenge concerns the complexity of comparing across very different cultural and material settings. Questions that are meaningful in one culture may seem strange or even incomprehensible in other cultures. We have tried to avoid the most obvious of such examples. This problem raises issues of validity of the questions. Another challenge is related to the reliability of item scores, and even more so to composite variables and constructs.

Diversity in ethnicity, religion, culture and tradition as well as political, economical and social conditions convey different values, worldviews, beliefs, fantasies, taboos, etc., and different moral, ethical and aesthetical qualities. It is a demanding task to construct a questionnaire that can travel across so many boundaries. Questionnaire items related to for example homosexuality would be straightforward to ask in some countries, controversial in others, and simply impossible or unthinkable in some countries. And even when getting answers, the answers would be difficult to compare and interpret, because they may carry different meanings in different cultures. Likewise, questions regarding suntan, lotions, health and nutrition, beauty and slimming, etc. would carry different connotations in different societies. This calls for humility as well as local knowledge in the interpretations of the results.

On a more technical level, the way different items cluster is likely to be different in different cultures. This means that care should be taken when we group items to form a composite variable and give the variable a label. One should bear in mind that high reliability of a construct or score is not a property of the test instrument itself, but of the *data* that are gathered. Data collected with the same instrument may result in different indices in different cultures.

High validity should be the prime concern of all research. High validity (of an item, group of items or a whole instrument) simply means that we measure what we intend to measure. If one and the same question measures different theoretical constructs in different cultures, one must be cautious with comparing the scores and when commenting on observed differences. This does not mean that the scores cannot be compared, but the differences should be treated with caution and interpretations of the results should be carefully done by drawing on the context of the cultures.

We have tried to agree on questionnaire items which are appropriate to most kinds of societies and cultures. It is, however, virtually impossible to make items with identical meaning and value in all participating countries. Varying social, economic, political, cultural and physical conditions will lead do different meaning, connotations and relevance between the countries.

The Norwegian ROSE team is, of course, most likely to see science, youth and schooling through Norwegian glasses. We have therefore been reliant on collaboration with researchers from other countries - both with respect to the selection and the wording of each item. Cross-cultural collaboration has consequently been a prerequisite for developing the questionnaire, and the established international network has been crucial for promoting the required cultural balance. We also stress the need of national analysis and interpretations.

We will try to facilitate this through joint workshops, seminars and exchange of findings and views during the analysis.

3. Cooperation without a common aim

The ROSE project invited partners for participation in a project that had some pre-specified aims, a rationale and some core commitments. This has given the project the necessary direction and basic ideas from the outset. Nevertheless, the research partners come from a variety of backgrounds, and they carry with them their own perspectives, theoretical approaches and research interests, often emerging from national or local educational settings and challenges. This poses some problems, but it is also the strength of the project. The diversity enables partners to learn from each other. This wide range of relevant backgrounds, approaches and perspectives has been a challenge in the development of the questionnaire.

A complete consensus among a group of S&T educators from all continents on all issues relating to the questionnaire structure, length and content is virtually impossible. We have appreciated and considered every single input from our partners, but in the end it was the Norwegian ROSE team that took the final decisions. We still want to stress that it is a product of international cooperation, and we know that the research partners have a kind of ownership of the final product.

3.1.7 Translation: Language and meanings

The ROSE instrument is (and will be) translated into many other languages, and used in many different countries and cultures. The master version is developed in English, and the working language in the international advisory group was English. As organizers of the study we did, however, work out the Norwegian and English versions in a kind of symbiosis: Changes in wording in one version was discussed in the context of the other language. These two languages are not too different, although Norwegian is closer to German than to English. Nevertheless, we became aware of several difficulties even in this relatively simple process of translation. The translation will of course be much more difficult when translating into more foreign languages.

This report is not the place to go in details on general problems of translations from one language to another. (Neither are we competent to go deeply into such discussions!) But let us take one example on how the meaning of a word can be problematic by considering the key word 'science':

In English, the term 'science' is more or less synonymous to 'natural science'. All encyclopaedias confirm this association, also as the official basic meaning. In daily use, there is no need to add 'natural'. If you think of something else, you have to be explicit, like saying 'social science', 'political science', etc. It is also typical that the name of the school subject is the same word, simply 'science' (when not divided into its sub-disciplines like biology, chemistry, physics, etc.).

In German, (natural) science must be translated to 'Naturwissenschaft', while 'Wissenschaft' alone is the general term for systematically organized knowledge. The same is the case for other European languages, like for instance all Nordic languages. The Norwegian term for 'science' as an *academic discipline* is 'naturvitenskap', while the term for the corresponding *school subject* is 'naturfag'. (The same is the case in e.g. German and Danish.) Moreover, the Norwegian word 'naturfag' has embedded a strong connotation to 'natur'

(nature), and is often, even by many teachers, mainly understood as 'nature study', in reality (a kind of) biology[17].

Therefore, when students are asked questions about attitudes to 'science', the meaning of this question may indeed be different in different languages.

These different meanings of *science* and *scientists* can cause severe misunderstandings, for instance when the European Union wants to have 'more scientists' and when they launch initiatives to "Improve the Recruitment to Science and Technology!" Are they mainly thinking of (natural) science, or do they include e.g. human and social sciences? Even official documents are weak or imprecise on such issues.

When 'science' and 'scientists' are translated to other, more 'remote' languages, the problems become even more accentuated. For example, 'science' 'school science' and 'nature' can be translated to Japanese in several ways, and none of these correspond directly to the English concepts (Kawasaki, 1990; Ogawa, 1998). Ogawa clarifies the issue like this:

> *In short, the western concepts, Nature, Science, and School Science are translated into Japanese as Shizen, Kagaku, and Rika respectively. However, when translation happens, a different connotation related to original Japanese word is inevitably permeated into the western original concept and the resultant concept become to be quite different one from the original. And important point is that most of Japanese people (including science educators) have never been aware of this. And they believe that for example, Nature is equivalent to Shizen, or School Science in western countries is equivalent to Japanese Rika programs, which they are not. (Ogawa, personal communication, August 2004)*

Such things translation issues are likely to happen in almost all of the regions.

We have chosen one example to illustrate the point that translations may be difficult and possibly misleading. We could have chosen other words as examples. The matter gets even more complicated when you move from single words or concept to full statements. In particular, when we ask questions about attitudes, perceptions, emotions, there is reason to believe that the difficulties are even greater. Moreover, in some countries, it may not be considered as appropriate or correct to ask questions of such a personal nature.

These problems are not at all unique to our research. Each item in the ROSE questionnaire is intended to be very simple and rather short. We have avoided multiple clauses and double negative statements, etc. The problems are more difficult to handle in studies where the students are asked questions connected to a lengthy texts or narrative.

[17] 'Naturfag' in Norwegian schools is an integrated science course which, according to the national curriculum, includes biology, chemistry and physics. Nevertheless, a teacher wrote "I teach 'naturfag' (i.e. science), but I do not teach physics."

TIMSS and PISA have made strict procedures for ensuring translation equivalence.[18] They also acknowledge that:

> *translation errors are known to be a major cause for items to function poorly in international tests. They are much more frequent than other problems, such as clearly identified discrepancies due to cultural biases or curricular differences. (OECD, 2000b)*

The ROSE researchers are requested to report on problems related to translations and the student's understanding of the questions in the Data collection report (see paragraph 5.2 and Appendix E). We have also asked the translators to strive to convey the meaning of the statements, and if necessary to rewrite the statement in order to achieve this aim. There is no way of avoiding all such obstacles. It is therefore important to interpret comparative findings by making use of thorough knowledge of cultures and languages.

3.2 Developing the questionnaire

In order to ensure that the questionnaire would do the job it was intended to do, the instrument was developed through a lengthy process of discussion, thinking, writing, trying out, improving and trying out again.

The development and validation of the questionnaire started in the autumn 2001, and took place in several steps through more than one year. Through the whole process we had frequent discussions with students, teachers, ROSE partners and scholars from various academic fields. It would be too lengthy to go into detail on every step of the process and on every consideration, discussion and decision we made. The following is a rough review of the main steps towards the final version of the questionnaire.

The important issues of *validity* and *reliability* will be addressed in a separate chapter (no. 6), although they were of course discussed all the way through the process of instrument development.

3.2.1 Workshop with ROSE Advisory Group

As described above the ROSE project is in many ways a continuation of the SAS-project, and the ROSE questionnaire is a further development of the instrument applied in SAS.

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[18] *PISA 2000 Technical Report* describes different translation procedures:
- *Double translation* procedure: i.e., two independent translations from the source language, and reconciliation by a third person.
- *Back translation* procedure: (most frequently used) translating the source version of the test (generally English language) into the national languages, then translating them back to and comparing them with the source language to identify possible discrepancies
- PISA 2000 used *double translation from two different languages* procedure: two parallel source versions (in English and French), and recommending that each country develop two independent versions in their instruction language (one from each source language), then reconcile them into one national version (quotes from OECD, 2000b)

In October 2001 we hosted a four-days working seminar near Oslo in Norway. The goals for the seminar were to initiate the process of the questionnaire development and to elaborate on procedures for logistics and data collection. We also discussed relevant empirical research and theoretical perspectives, and how ideas and objectives of the ROSE study can build on these.

By open and special invitations, the ROSE Advisory Group was established to serve as main partners in the development of the ROSE instrument. The personal composition of the group should preferably balance regional coverage with the limited financial resources of the project. The group was constituted of: Dir. Vivien M. Talisayon (The Philippines), Dr. Jane Mulemwa (Uganda), Dr. Debbie Corrigan (Australia), Dir. Jayshree Mehta (India), Professor Edgar Jenkins (England), Dir. Vasilis Koulaidis (Greece), Dr. Ved Goel (The Commonwealth), PISA project leader Marit Kjærnsli, (Norway), Professor and TIMSS-coordinator Svein Lie (Norway), Dr. Marianne Ødegaard (Norway) and Cand.scient Astrid Sinnes (Norway). Professor Glen Aikenhead (Canada) and Professor Masakata Ogawa (Japan) approved to join the Advisory group as well, but they were unable to attend the workshop.

This means that scholars from all continents were gathered in the workshop. Through joint sessions and group work we elaborated on the questionnaire and the thinking behind it. The product of the workshop was a draft questionnaire with some SAS questions maintained and some deleted and with suggestions of introducing new ideas of questions. The seminar was followed up by cooperation by e-mail.

3.2.2 Preliminary studies in Norway

Western (and Norwegian) youth culture is widely described in literature and youth research reports, but since little is done on the connection between youth culture and science education, we found it important to hear the voice of the people with their everyday life in schools. In January and February 2002 we conducted some preliminary studies with Norwegian students and teachers. The purpose of the studies was to brainstorm, to open our minds and to come up with ideas for concepts in contemporary (Western) youth culture which could be of relevance to ROSE.

For practical and financial purposes, these studies had to be conducted in Norway, although from a cross-cultural point of view it is not fair to carry out such studies in *one* country. Hopefully, later data analysis will show that some ideas introduced to the questionnaire through these studies of Western youth will improve our understanding of youth in Non-Western countries as well.

The preliminary studies involved four means for triggering free associations:

Test survey

We conducted a mini survey by developing a short questionnaire and had it answered by a sample of 94 15-16 years old students at grade 10. The students were not probabilistically sampled; hence the sample was not representative for the Norwegian population.

A rough report of some findings on what the students were interested in learning about can be that the boys gave high scores to atom bombs, dynamite, biological warfare, petrol engines, computers and space-related topics. The girls, on the other hand, were mostly interested in medical vaccination, solarium, life on other planets, astrology and healing as well as space-related topics. Neither girls nor boys were interested in topics of everyday

relevance like for example *where the water in my tap comes from*. When asked about their interest in various professions, the highest scores were given to film production, web design, architecture and journalism, while agronomy and science teaching were at the bottom.

Discussion groups with students

We arranged discussions within two different groups of students which knew each other from before. There were five students in each group. The students discussed scientific topics that they enjoyed and were enthusiastic about, while we introduced new topics to their discussion and directed their talk towards their interests.

It was striking how the one group (consisting of five girls) kept on coming back to topics with components of wonder and mystique, and the way ordinary textbook topics were turned around to the magic angle. For example, one girl said

> *Yes, learning about the atoms was fun, because **afterwards** we talked about what was - or was not - in the **empty spaces** - I mean in the spaces **between** the nuclei and each electron...*

They also discussed topics like ghosts and other supernatural phenomena, twin-research on the influence from inheritance vs. environment on personality development, etc. It provoked our thoughts that although these five girls claimed that they did not like science at school, virtually all the topics we introduced to their discussion were converted into a context they were enthusiastic about.

The other group (consisting of three girls and two boys) raised questions like how *everything* goes in circulation, why the dinosaurs died out, what happens if one jumps out of a spaceship, fairytales about the star constellations, etc. But they also appreciated the fact-supply they had from science at school, because a situation may occur when it is 'useful to know', for example in a quiz or in a discussion. The same day they had learned about enzymes in saliva, which was of use - because 'now I know'.

Written lists of topics

Through cooperation with science teachers at grade 10, students in four school classes were requested to write a list of science-related topics they found interesting. Most of the suggested topics were included in the first draft version of the questionnaire.

Conversations with science teachers

We talked with six science teachers about boredom and enthusiasm among the students, and about their encouraging and discouraging experiences with teaching science in upper secondary school. We also asked them in what way they wished their science teaching to prepare and equip young people for their young and adult lives. We will leave this matter here; as such issues will bring us into discussions far beyond the scope of this paper...

3.2.3 First international trial

In April 2002 we had implemented the responses and ideas from the preliminary studies into the questionnaire version from the workshop. The size of this first draft questionnaire was more than the double of what it should be, but it was nevertheless distributed to the ROSE

Advisory Group and to all researchers that had expressed interest for participating in the ROSE project.

Although the partners were asked to indicate which items they suggested to be deleted, the most important purpose of the trial was to ensure that the questionnaire was broad enough to capture cultural diversity. We specifically asked for suggestions for items that could reflect particular circumstances of *their* culture. They were also invited, if time and resources could allow it, to conduct some kind of preliminary studies with students and/or teachers in their own country.

We received a considerable number of responses from a wide range of countries, and some countries had even piloted the questionnaire. Many items were, not surprisingly, censored since they in some cultures were too peculiar, controversial and/or provocative. Other arguments for excluding items were that the topic was unknown for youth in the country, that the item was unclear or had double meaning, that the topic was covered by other items, etc.

The variety of the recommendations and suggestions was huge, and some drew us in very different directions. Again we were confronted with the challenge of aiming at comparing youth from different cultures. For example, to the question about the students' future job (question B), one partner commented that

> *For young people in my country it is an impossible dream to have the chance to choose the job they want. They will not understand the question, and their answers will be randomly ticked.*

We also met opposition to the wide range of the subjects of questionnaire and to items addressing topics that traditionally are not included in science curricula:

> *This is not directly connected with science, and the data can be difficult to relate to science curriculum*

3.2.4 Piloting

At the same time as the first draft questionnaire was on the international check, the questionnaire was translated into Norwegian and piloted in five Norwegian school classes. The purpose of the pilot test was threefold: Firstly it was to gain experiences on procedural matters and practicalities on organizing the survey, like establishing contact with coordinators at schools, instructing them in carrying out the survey, the duration of the test run, collecting the questionnaires, coding data in the codebook, etc. Secondly we wanted to catch some spontaneous and unrestrained reactions from students and teachers to the questions and to understand what meaning and understanding they put in the various items. Thirdly we were interested in doing some analysis of the data and evaluate some statistical features in the material.

Some 130 students answered the questionnaire. We requested them to indicate the items that they did not understand and to give praise and (more important) blame wherever they felt like it. Furthermore, we arranged a discussion in a group of eight students about their attitudes to and understandings of the questions. Some critique of the questionnaire was very explicitly pronounced, both in the feedback from the students and from the teachers: It

was lengthy and the students were annoyed when they got the feeling that they were asked the same questions over and over again.

We coded the data in SPSS and carried out some statistical analysis. Issues like design, measurement, analysis as well as some results from the analysis were discussed with scholars in psychometrics at our faculty.

Altogether this pilot test gave important input to the next revising of the questionnaire.

3.2.5 GRASSMATE meeting

In June 2002 we had the opportunity to meet the supervisors in the GRASSMATE group in Bergen in Norway. GRASSMATE (Graduate Program in Science, Mathematics and Technology education) is a Norwegian–Sub-Saharan project aiming at developing research competence in Africa. The supervisors of the approximately 20 PhD-students on the GRASSMATE programme were scholars in science education from Norway and several African countries.

We jointly elaborated on the questionnaire items, and received some useful comments. Particularly emphasis was put on discussing the cultural balance and different values and worldviews in different cultures.

3.2.6 Second international trial

In August 2002, after taking into account the input from the first trial, the pilot test and the GRASSMATE meeting, a second draft version of the questionnaire was distributed to the ROSE Advisory Group and other project partners. We asked for feedback on cultural and gender balance, advices on where the questionnaire could be shortened and suggestions for simpler and clearer English language and wording. We received responses from Russia, Finland, Uganda, Denmark, Sweden, Norway, The Philippines, Korea, USA, United Kingdom, Canada, Greece, South Africa and Ghana.

Again we experienced diverse responses and that comments from some nations could contradict comments from others. For example, we had a lengthy discussion about whether or not to include classification questions on the socioeconomic background of the students: Since the number of books in the home has shown to be a good proxy for socio-economic capital (see paragraph 4.1), we employed this question for tapping the socioeconomic status of the students' parents:

> *How many books are there in your home? There are usually 40 books per metre of shelving.*

Some countries requested more questions about the socioeconomic status (SES) of the students' parents, and referred to the TIMSS and PISA studies which include several questions for measuring SES (for example parental education and profession, how often the family eats the main meal together, number of cars, bathrooms, etc. in the home, whether they have works of arts in the house, etc.). At the same time as some nations suggested more classification questions of this kind, another country gave the following comment to the question about the number of books:

You may not find bookshelves even where you may find books in developing countries - the books may be kept in boxes or cupboards instead.

This example illustrates some of the complexity of cross-cultural comparisons and the challenge of aiming at cultural balance in a questionnaire that is intended for use on a global scale. Furthermore, most of the partners indicated that the questionnaire was too long, but on the other hand there were lots of suggestions for new items for the revised version. Equally interesting was it to note that some partners characterized the questionnaire by having

a western and middle-class orientation

while others indicated that it had a

bias favoring developing countries

as well as an

ideological orientation towards 'alternatives' at the expense of 'proper science'

3.2.7 Interviews

While the questionnaire was on its second trail, we undertook individual interviews with two Norwegian students after they had answered the questionnaire. The purpose of the interviews was to detect difficult sentences, concepts and wordings and to validate the items by considering whether their understandings of the items matched our intention behind them.

The outcomes of the interviews lead to some minor item modifications.

3.2.8 Third and last international trial

In September 2002 the last draft was distributed to the ROSE Advisory Group and to all international ROSE partners. This time we only asked for smaller suggestions for item adjustments and for comments on the two (new) open-ended questions at the end of the questionnaire. Again we got valuable input from many international scholars.

A last discussion took place in mid-October, when Professor Edgar Jenkins paid a visit to Norway. The ROSE questionnaire was finalized in the beginning of November 2002.

Through the whole process of developing the questionnaire, we have aimed at ensuring that nothing was unjustifiably emphasized at the expense of something else. We acknowledge that we can impossibly have fully succeeded in developing a questionnaire which travels equally well in all cultures. The forthcoming experiences, feedback, analysis and results will inevitable reveal weaknesses in the questionnaire. But we have tried to produce a satisfactory whole by taking all the inputs into consideration and by trying to balance them. We have made several compromises - primarily directed by the aims and the objectives of the project.

4 THE ROSE INSTRUMENT: RATIONALE AND UNDERLYING ASSUMPTIONS

Except for public surveys like the Eurobarometer (EU, 2001) and NSB (2004b)[19], there has not been reported development of research instruments that may in a cross-cultural context. To our knowledge, ROSE and its predecessor SAS are the first attempts to develop instruments that may be used across countries and cultures in this domain.

In the following we will address issues of why we are asking the questions we do and how we intend to use the responses. Parts of this text are based on the text in the *ROSE Handbook* that was made available to all participants as part of their preparations (and their decision to take part in the study.) The ROSE questionnaire is reproduced in Appendix A. Letters in brackets indicate the question and item of interest as they appear in the ROSE questionnaire.

4.1 Student background questions (cover sheet and J)

There are many extra-curricula and out-of-school factors that influence students' relationship to science and science education. Among such factors are: sex, age, nationality, home language vs. language of instruction, parents' education and occupation, urban/rural environment, peer culture, etc.

The cover sheet of the ROSE questionnaire contains three classification questions: sex, age and nationality. These are the only background variables that will be applied in the report of the *international* comparisons. We suggested for the international partners that they, if applicable for contrasting groups in their *national* analysis, could add some complementary questions (e.g. about region, type of school, mother tongue, etc.).

Previous research has identified a noticeable relationship between educational achievement and the economic, social and cultural capital of the students' parents. These results are explained with the notion that parents of higher socioeconomic status (SES) are more involved in the education of their children than parents with low SES, and thereby stimulating more positive attitudes and motivation to learn, better homework conditions, higher achievement, etc. (Ho Sui-Chu & Williams, 1996; OECD, 2000a; Turmo, 2003).

The socioeconomic background of the students may be interesting and relevant also in ROSE, although we are not primarily interested in students' achievement. Therefore, at the end of the questionnaire, we included one question about how many books there are in the home of the students:

> *How many books are there in your home? There are usually 40 books per metre of shelving. Do not include magazines.*

[19] Most of the Public surveys on Public understanding of science (and also attitudes to science) are based on questionnaires developed rather long time ago in the US (e.g. Miller 1983, 1996). At present, there are plans for a revised Eurobarometer survey to be used also in many non-European countries. Data collection will take pace in 2005.

This question has seven response categories: *None, 1–10 books, 11–50 books, 51–100 books, 101–250 books, 251–500 books and More than 500 books.* The reason for placing the question at the end of the questionnaire was that some students might feel uncomfortable with being asked about private home conditions. By placing this question towards the end, we hoped that the student after answering other questions would feel more comfortable, and that we thereby had a better chance of getting responses to the question.

This question is a true copy of the corresponding question in the PISA 2000 questionnaire. PISA does in addition ask a number of questions about parental education and occupation, home possessions, etc.[20] For obvious reasons (see for example the discussion in 3.2.6) such questions would be impossible to interpret when we compare across the different cultures represented in ROSE. We regard it as virtually impossible to ask questions about home and family background that can provide meaningful comparisons across all cultures. Moreover, in several countries, there are considerable legal and formal rules against asking such questions. Nevertheless, because of the contemporary research interest in SES, we decided to include *one* question addressing this issue. As the number of books in the home has turned out to be a good proxy for the SES of the students' parents (Lie, Kjærnsli & Brekke, 1997), the choice of the question fell on this. All participating countries were nevertheless free to add more SES questions at the end of the questionnaire for national classifications of respondents and for opening the possibility to link ROSE data to for example TIMSS or PISA. (Some participating countries have added such variables. Details are given in each national data collection report which can be found on the ROSE web site.)

4.2 "What I want to learn about" (ACE)

As indicated in paragraph 2.1.2, the many international surveys as well as other indicators (like press coverage, magazine circulation, visitors to science centres, etc.) do not indicate any general decrease of interest in S&T among the population in most countries. The term 'falling interest in S&T' should rather be rephrased to be 'falling interest for S&T subjects at school and as studies'. In this group of items, we want to explore possible new ways of thinking about the S&T contents, mainly in a school setting - but also with wider ramifications for the informal sector.

One underlying hypothesis in this question is that many young people, although they do not plan to have a scientific career, find various aspects of science interesting. This

[20] Some examples of PISA SES questions: how often the parents discuss books, films or TV programmes with the student, how often the parents listen to classical music with the students, how often the student has participated in an opera, ballet, or classical symphony concert, how many books of poetry s/he has in the home, whether s/he has a quiet place to study, a dishwasher, a room for her/him self, how many calculators, televisions, cellular phones, cars, bathrooms, etc. s/he has at home, etc.

ACE question will give empirical evidence on what topics various groups of students[21] are interested in learning about. This insight can inform our discussions on how S&T curricula can be constructed in order to meet the interests of different groups of learners. We want to emphasize that our prime concern behind this ACE question is that we think science lessons should *engage* the students. Asking the students how interested they are in various topics is one approach for getting in touch with science lessons' potential for engagement. But engagement does not refer simply to enthusiasm, entertainment and fun. It is also important to trigger concern, provoke creative thinking and stimulate individual growth.

As research in science education report growing unfavourable attitudes towards science at school, we argue that there are several sensible reasons to justify further research on students' interests in science. Above we have described the rationale and some underlying thoughts for tapping into some affective dimensions of science education. Here we will touch into some different purposes of asking about *interests* in particular.

4.2.1 *Interests* and purposes of science education

Aikenhead (2003) refers to 'Personal-curiosity science' as when "students' hearts and minds are captured" and the students themselves decide school science topics from their idiosyncratic interests and desires. We do not argue that science curricula should be determined merely from student 'opinion polls' on what they find interesting. But on the other hand, we see several arguments taking their voice into account, for example:

The welfare of late modern societies is in a large extent based on scientific and technological development, and our future welfare is seen as reliant on bright and creative scientists and engineers that can promote future productivity and innovation. Personal interest is a key factor behind modern youth's educational choices. One means for higher enrolment in S&T education is to enhance the ability of school science to enliven, enrich and inspire the students.

Science education is also seen as a crucial means for preventing alienation and for empowering individuals for qualified participation in democracy. Scientific and technological developments have shaped our societies, and play key roles in our culture and our worldview. Besides, science and technology are closely linked to many controversial societal issues raising public debate and concern. A more interesting school science can lead to more motivation, engagement and participation.

Another argument for promoting interesting science lessons is for facilitating personal growth. Schooling can contribute to developing the spiritual, moral, emotional, philosophical, etc. dimensions of the students. In this formation of the *whole* person are individual emotional satisfaction, personal well-being, autonomy, self-concept, security and

[21] When we in the following use the term 'group of respondents', 'group of students', etc. we allude to various ways of classifying the students into categories. The most obvious variables for stratifying the samples are by the classification questions sex, gender, nationality or number of books in the home. But in fact there are countless ways of grouping the respondents, as they may be divided with respect to any question whatever, for example by high or low interest in a topic (ACE), by how often they have done something out of school (H), by how concerned they are about the environmental problems (D) or by issues they would like to do research on (I).

self-confidence words of honour. Interests and engagement are prerequisites for personal involvement and development.

And a last example: Students would value to feel that their everyday life at school is interesting. School *is* life, and not a *preparation* for it! School satisfaction (as job satisfaction) is thereby closely connected to quality of life, and interesting lessons is in itself a purpose of schooling.

4.2.2 Contents vs. teaching methods and pedagogy

There are several factors influencing the potential of science education to motivate and inspire the students. Two key issues are *what* is taught (the content) and *how* it is taught (the teaching method or pedagogy). By asking about young peoples' interests in various topics, we only address the *what*-question. The value of this question will be in identifying subject matter that appeals to (different groups of) students: What sort of topics are they interested in learning about? Do we find universal patterns? How does culture and gender come into play? What seems particular for students with similar cultural backgrounds? How does the interest in one particular topic vary when it is exemplified through different contexts? Does it make sense to talk about different interest profiles for different groups of students (e.g. for students with positive/negative attitudes to science at school, with optimistic/pessimistic images of the future of the environment and the world, with various wishes for their future job, etc.)?

There is great variety of teaching methods or learning activities, ranging from traditional 'chalk and talk' to project work, internet search, excursions, experiments, group work, discussions, role play, drama, storyline, etc. These different methods serve various educational purposes and have different capacities of motivating students and of attracting their interests. As all teachers know, the teaching method or the pedagogy does indeed make a difference (e.g. Cerini, Murray & Reiss, 2003; Ødegaard, 2000; Osborne & Collins, 2001; Reiss, 2000).

This indicates the limitations of this ACE question: We only address the issue of *what* to teach, not *how* to teach. The above limitation should be kept in mind also when interpreting the results. Furthermore, we must be aware that this question somehow taps into to what extent various topics hold *immediate attraction* for the students, but we cannot interpret whether a teacher actually will succeed or fail with teaching the topic. Teaching 'interesting' topics gives no guarantee that the teaching will be successful - but it is certainly better than choosing issues deemed by the students to be boring at the outset.

4.2.3 Previous research on interest

Research literature on interests, despite the wide methodological diversity, provides some clear findings which seem to be valid across a number of educational systems and cultures. In spite of various attempts to explain differences in attitudes towards science in terms of various categorizing variables, it has invariably been found that sex is the most powerful variable for explaining it. (Age is also a significant variable, as students tend to loose interest over time. But since ROSE only collects data from one age-cohort, it is not a relevant variable for this study.)

Topics of interest

Many students find school science boring and irrelevant for their lives[22]. When science is addressed as a single subject, boys are more positive to science than girls, but when divided into sub-disciplines the pattern is altered. Girls are blaming physics for being impersonal and boring, but they respond more positively than boys to biology. In chemistry the gender differences are less pronounced, but there is a pattern indicating that boys are more likely to report interests in the subject. Among those who find school science interesting, it seems like their motivation often is extrinsic or instrumental, e.g. for passing an examination or for their further career education.

The recent English study Student Review of the Science Curriculum (Cerini & al., 2003), was a web-based survey collecting data from ca. 1500 14-19 years old students at English schools. One conclusion of the study was that the students would have preferred a science curriculum including more contemporary socio-scientific controversial issues as well as more philosophical and ethical matters. In general, the students showed high interest in topics suitable for discussion and deliberations, while fact-oriented topics had less appeal. When the students were asked explicitly about teaching methods they found most enjoyable, "Having a discussion/debate in class" received high scores.

These findings of young people's interests in socio-scientific issues is supported by, among others, the focus group study of Osborne and Collins (2000; 2001) and by a study of Jarman and McClune (2002). Osborne and Collins found that as English students were acquainted with the many political and ethical controversies connected to science and society (matters of environment, gene technology, population growth, etc.) they questioned the emphasis school science put on facts and consensual knowledge. Some students found it "strange that school science maintains a hermetic seal between itself and contemporary society" (Osborne & Collins, 2001). In the latter study, Jarman and McClune explored how teachers used newspapers in the Northern Irish secondary science classrooms. One finding was the very positive responses the students gave towards using newspapers and to contemporary upcoming scientific developments. Osborne and Collins' students blamed science for not giving space for creativity, imagination, discussion and self-expression, and the authors interpreted that grand philosophical questions about who, what and where we are have appeal as they help the students to find out about self, identity and their role in the universe.

In general it seems like topics within human biology are found interesting. Osborne and Collins report that the students attached particular interest to human biology (how to maintain a healthy body through diet and exercise, effects of drugs, cures for diseases, etc.). The students in a longitudinal study of Reiss (2000) expressed that they did not find the science relevant for their lives, but among the 'most useful' topics they reckoned they had learned in science at school were sex education, drug use and differences in boys' and girls' behaviour. Topics of interests in chemistry may be 'mixing chemicals', 'smells and colours' and 'elements of danger' (Osborne & Collins, 2001), while physics can offer appealing issues about space and aspects of the unexplored and unknown (ibid.). Osborne and Collins found

[22] Much the same picture is presented by Flutter and Rudduck (2004) referring to the entire enterprise of schooling. Students experience that school in general is a 'world apart' - lacking relevance for their lives outside school.

that girls did not share the boys' interest in the physics related to cars and flight, but that they expressed some interest in light and electricity. Both sexes found that in general, topics like the periodic table and other intangible and microscopic entities were pointless and far away from their concerns. In Reiss' study, the many negative comments concerning chemistry lead the author to conclude that although some students may find some intellectual satisfaction in learning about for example molecular masses, the students in his study found it neither intelligible nor relevant for their lives.

Matter of context

A finding in the SAS study (Sjøberg, 2000, 2002) is how the subject matter attraction vary with varying contexts. For example Sjøberg found that 'music' attracted much more interests than 'acoustics and sounds', and correspondingly was 'the rainbow and sunsets' much more interesting than 'light and optics'. This can also be illustrated with an formulation from a student in the above mentioned Student Review of the Science Curriculum:

> *learning how chemicals are used in industry is very boring - chemicals in the body and used in drugs are more interesting and relevant (Cerini & al., 2003)*

A study of Häussler & Hoffmann (2000) showed that the *context* was superior to the *content* in terms of being the decisive factor for the students' interests in physics. They designed questionnaire items where the one and the same subject matter (e.g. acoustics, optics, energy, etc.) was repeated through five different contexts. These five contents were predefined as 'practical' (promote practical competence for everyday use), 'socio-economic' (physics in society), 'emotional' (triggering affective dimensions like astonishment, beauty, etc.), 'intellectual' (physics as a challenging scientific enterprise, but with little value for application and use in life) and 'qualifying' (preparation for careers in physics). Data was collected in 1984-89 from a sample of ca. 6500 German students. The study found that in the 'practical' context anything that had to do with the human body was attracting interests and that handling everyday equipment was favoured among the younger students. Older students were positive to the topics in the 'socio-economic' context. In the 'emotional' context, girls and boys gave different responses depending on what 'emotion' the items evoked. The interest dropped sharply when the subject matters were presented in the 'intellectual' context, while in the 'qualifying' context there was some interest in topics related to medicine.

International comparisons

When it comes to international research on students interests in science we have not found many reports to draw on. The SAS study (Sjøberg, 2000, 2002) revealed a considerable divergence among the students from different countries in what they were interested in learning about. Sjøberg found remarkably low overall interests in Japan and that in general students from developing countries seemed to be far more interested than students from the more economically developed countries. The SAS-study also found a strongly gendered pattern of interest, in particular in the richer countries. For example, did learning about "The car and how it works" attract the interest of boys, while "What to eat to be healthy" received high scores from the girls. In some countries the gender differences were quite remarkable. The gender differences in developing countries were less pronounced.

TIMSS and PISA are mainly measuring students' performance and knowledge. Neither of the studies have any questions about interests or what they would like to learn about, but in order to examine relationships between achievement and attitudes, questions are included for measuring the students' attitudes towards science as a school subject. The findings of TIMSS (Martin & al., 1999) can be perceived as consistent with the cross-national profile found in SAS, with most positive attitudes in Malaysia, The Philippines, Tunisia, Jordan and South Africa, and with the least positive attitudes in Japan and Korea. Next after these two latter countries, the least positive attitudes were found in Canada, Italy, New Zealand, Australia, Chinese Taipei and Hong Kong.

4.2.4 The items in question ACE

Below the heading "A. What I want to learn about", the following instructions are given:

> ***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.)*

The question is an inventory of possible topics to learn about, each with a 4-point Likert scale from 'Disagree' to 'Agree'. The extreme categories in the Likert scale are labelled 'Not interested and 'Very interested'. It is a rather lengthy question with totally 108 items. To avoid fatigue from the students, the items were grouped into three questions: question A, C and E.

The underlying structure in this pool of items is somehow similar to the questionnaire applied in the above described study of Häussler & Hoffmann (2000). The structure is a two-dimensional system in which most of the items can be classified by *content* (subject matter areas) and *context*.

The list below contains the main subject matter areas from which we have chosen the items. The subjects are not mutually exclusive, but here they occur as they often do in science curricula and textbooks. This is by no means a comprehensive list of all possible subjects from the natural sciences, neither are they on the same level of detail and specification:

- Astrophysics, universe (U)
- Earth/geo science (G)
- Human biology (H)
- Zoology, animals (A)
- Botany, plants (P)
- Chemicals (C)
- Light, colors, radiation (L)
- Sounds (S)
- Energy and electricity (E)
- Technology (T)

Most of the subjects were incorporated in items that were supposed, more or less explicitly, to carry a connotation of the following contexts (again the list is not all-inclusive of possible contexts, neither are the contexts mutually exclusive):

- Environmental protection (W)
- Practical use, everyday relevance (R)
- Hullabaloo, spectacular phenomena, horror (Z)
- Human biology (H):
  - Health (Q)
  - Fitness (F)
  - Issues of particular relevance for youth (Y)
- Mystery, philosophy, wonder, quasi-science, belief-oriented (M)
- Beauty, aesthetical aspects (B)
- Science, Technology and Society, Nature of Science, etc. (X)
  (often undefined in terms of subject)

(The characters in brackets are abbreviations for the various entries. They correspond to the codes for each item in Table 1.)

Some of these contexts have been derived from our reading of sociological theories about late modernity, identity, youth culture, etc., others from our review of research in science education and others, again, have arisen from the preliminary studies with Norwegian students and teachers (described in paragraph 3.2.2).

The classification by content and contexts could have been done in many ways, and the above lists are only our attempt to make a structure. As neither the contexts nor the subject matter areas are mutually exclusive, the items may be connected to more than one subject as well as to more than one context. Furthermore, the distinction between context and content may be unclear or non-existent, as some matters can be regarded as a subject *and* as a context. There is no doubt that results from exploratory factor analysis and other forthcoming data analysis will not give support for exactly this structure, but rather suggest other ways of grouping the items. And furthermore, we will find that items clustering together in one culture may cluster very differently in another. The classification scheme suggested here cannot be (and was not during the questionnaire development) applied strictly, but it can rather function as a kind of guiding principle and a device for assisting our thinking.

At one stage in the process of developing the questionnaire this ACE question had ca. 450 item suggestions, and virtually all subject matters were covered in all contexts. It goes without saying that an attempt to construct items for all subjects in all contexts leads to some rather contrived and far-fetched items. At the end of the process of questionnaire development (described in paragraph 3.2) we were left with 108 items. This number included some new item suggestions from ROSE partners (some of these did not fit into our two dimensions). Parts of the two-dimensional structure behind the items were inevitably lost through this process, but hopefully we gained some well-founded items that will be valid in many cultures.

Some of the items may seem controversial and unusual in an S&T educational context, e.g. items regarding ghosts, horoscopes, mind-reading, clashes between science and

religion, etc. These items may be addressing topics far outside the traditional science curricula. We do *not* argue that such items should be legitimate parts of the S&T curriculum! These questions are developed in order to capture span and diversity in responses, and some of them intend to respond to some traits of late modern youth. We wish to postpone discussions about subject inclusions in curricula to subsequent the data analysis.

Table 1 is an outline of how we at the outset classified the items.

A1:	*U*	**A2:**	*C*	**A3:**	*G*	**A4:**	*G*	**A5:**	*G*	**A6:**	-
A7:	*H*	**A8:**	*H*	**A9:**	*HY*	**A10:**	*HY*	**A11:**	*H*	**A12:**	*A*
A13:	*A*	**A14:**	*AZ*	**A15:**	*P*	**A16:**	-	**A17:**	*C*	**A18:**	*LHQ*
A19:	*LM*	**A20:**	*LA*	**A21:**	*S*	**A22:**	*UZ*	**A23:**	*UZ*	**A24:**	*GZ*
A25:	*GZ*	**A26:**	*HQZ*	**A27:**	*AZ*	**A28:**	*PZ*	**A29:**	*CHZ*	**A30:**	*CZ*
A31:	*CZ*	**A32:**	*CHZ*	**A33:**	*EHZ*	**A34:**	*UM*	**A35:**	*UM*	**A36:**	*LH*
A37:	*HF*	**A38:**	*HF*	**A39:**	*CHF*	**A40:**	*HF*	**A41:**	*HF*	**A42:**	*LHF*
A43:	*SH*	**A44:**	*UT*	**A45:**	*UT*	**A46:**	*LHQ*	**A47:**	*CT*	**A48:**	*CT*
C1:	*CR*	**C2:**	*LT*	**C3:**	*LT*	**C4:**	*ST*	**C5:**	*T*	**C6:**	*T*
C7:	*T*	**C8:**	*UM*	**C9:**	*UMH*	**C10:**	*UM*	**C11:**	*HM*	**C12:**	*HQM*
C13:	*HM*	**C14:**	*M*	**C15:**	*HM*	**C16:**	*LUB*	**C17:**	*LGB*	**C18:**	*GB*
E1:	*PB*	**E2:**	*LGB*	**E3:**	*GW*	**E4:**	*GW*	**E5:**	*GW*	**E6:**	*TW*
E7:	*HQ*	**E8:**	*HQ*	**E9:**	*HQY*	**E10:**	*HQ*	**E11:**	*HQ*	**E12:**	*HY*
E13:	*HY*	**E14:**	*HY*	**E15:**	*HY*	**E16:**	*AW*	**E17:**	*PR*	**E18:**	*PHQ*
E19:	*PW*	**E20:**	*EW*	**E21:**	*EW*	**E22:**	*CR*	**E23:**	*HY*	**E24:**	*AR*
E25:	*PR*	**E26:**	*CR*	**E27:**	*ER*	**E28:**	*TR*	**E29:**	*UX*	**E30:**	*EX*
E31:	*HYX*	**E32:**	*HQ*	**E33:**	*WX*	**E34:**	*MX*	**E35:**	*RHX*	**E36:**	*X*
E37:	*X*	**E38:**	*XZ*	**E39:**	*MX*	**E40:**	*X*	**E41:**	*X*	**E42:**	*X*

Table 1: Item numbers (bold) and intended connections to contents and contexts (italics). Abbreviations: U: Universe; G: Geo science; A: Animals; P: Plants; C: Chemicals, L: Light, etc.; S: Sounds; E: Energy; T: Technology; Z: Hullabaloo; H: Human biology, Q: Health; F: Fitness; Y: Young body; M: Mystery; B: Beauty; W: Environmental protection; R: Everyday relevance, X: STS, NOS, etc. A few items are only given a dash, as they were not categorized in these contents and contexts.

4.2.5 Research questions

Data from these items may illuminate questions like:

- How does the context versus the content influence the interests of the student?
- What kind of interests seem to be shared or universal, and what seems to be influenced by their cultural background?
- When dividing the items into categories of e.g. narcissistic and post-materialistic values, can the debate outlined above (see paragraph 2.3.9) deepen our understanding of the scores?
- How do girls' scores in contexts and contents differ from boys', and how can we characterize different interest profiles for different groups of students?

- Which contents and contexts may consequently be the most effective for engaging particular groups of students?

There are of course countless possibilities for seeing the scores in this question in connection with scores in other parts of the questionnaire, and one example may be analysing question ACE together with question D:

- How do the interests of students empowered for environmental protection (see paragraph 4.4) differ from interests among students lacking concern for the environmental problems?

4.3 "My future job" (B)

This question provides information about the future priorities and motivations of the students. This is in itself interesting information, and allows for comparisons across cultures and between various groups of students. Results from the SAS study indicated that interesting patterns emerged through factor analysis.

4.3.1 Youth and job priorities

Educational choices in late modern societies are not only based on rational arguments about income and possibilities in the labour market. Decisions about education and profession are central elements in identity development. Education is seen as a means of self-actualization and for fulfilling and developing personal talents and abilities.

According to Illeris and Ulriksen is *personal interest* the main vehicle behind youth's educational and occupational choices. Young people in modern societies require to be occupied with something they 'die for' doing. Feelings of *urge*, *desire*, *enjoyment* and *pleasure* are esteemed qualities of education. Monotony and tediousness cheats their identity, and is consequently something to be avoided. *Independence*, *flexibility*, *communication* and *creativity* are key words for their future job expectations (Illeris & al., 2002; Ulriksen, 2003). *Leisure* and *friends* is the most important and meaningful parts of their lives (while studies show that older cohorts appreciate the nuclear family and work) (Sjödin, 2001). This means that they are to a limited degree willing to sacrifice their extra-curricular activities in favour of school and homework.

A Danish study of youth's educational choices found three different motivational tendencies behind their choices, which were labelled strategies of 'conquer', 'rescue' and 'immerse'. The 'conquer' strategy is motivated by globalization - the students wish to join the global labour market. Social and environmental problems arouse a more idealistic 'rescue' strategy, while the strategy of 'immerse' had focus on personal development through life (Zeuner & Linde, 1997). The respondents in the survey were students at that had chosen mathematical, scientific and technological subjects in upper secondary school. The study found that about half of the students were closest to the 'immerse' strategy when they make their educational choices, while the other students were equally divided in the two other strategies. Inspired by C.P. Snow's "Two Cultures", they label the humanistic and social sciences "approach for personal development" while the natural sciences are called "approach for exact knowledge". The study found that most of the students were closest to the "personal development" approach.

Section 2.3 above described how young people whish to develop their abilities, to fulfill themselves and to live their lives to the fullest. They are concerned about their way ahead and the choices that must be made. One may interpret that this mentality of modern youth is reflected in the educational choices of young people in the study described here. These students were enrolled in upper secondary with weight on mathematics, science and technology. They wished to 'immerse' themselves in the study, and that the achieved knowledge should give room for 'personal development'.

4.3.2 The items in question B

Below the heading "B. My future job" the following instructions are given:

> ***How important are the following issues for your potential future occupation or job?***
> *(Give your answer with a tick on each line. If you do not understand, leave the line blank.)*

This is followed by 26 statements, each with a 4-point Likert scale from 'Not important' to 'Very important'

This question contains items meant to describe their priorities in the following dimensions of their future work:

- Self-actualization (B9, B13, B15, B16, B25)
- Work creatively (B8, B10, B11)
- Leisure priorities (B12, B17, B23)
- Care for surroundings (B1-B4)
- Power and glory (B20, B21, B22, B24)
- Dynamism and excitement (B5 (negatively worded), B18, B19, B26)
- Fix; use hands and tools (B6, B7)

4.3.3 Research questions

Referring to the chapter above about late modernity, narcissism and citizenship (section 2.3), one clear subject that can be illuminated through this question is:

- Is there a 'modern profile' in this question? Can scores in some of these items reveal more concern about self-actualization among youth from modern societies than among youth from non-modern societies?

If this is the case, if we find a modern pattern in their answers, an interesting follow up question would be: How are these items correlated with items in other parts of the questionnaire? For example:

- What items in ACE ("What I want to learn about") seem closer connected to the items for "self-actualization" than others?
- What is the relationship between the items for 'self-actualization' in B and the items for 'empowerment' in D (see paragraph 4.2.4)?

- How are scores on items for 'self-actualization' related to scores for attitudes science classes and to S&T in general (question F and G)?
- Can we find a pattern between scores on 'self-actualization' and the categories for why they want to do the research on particular subjects in question I?

4.4 "Me and the environmental challenges" (D)[23]

Empowering students to deal responsibly with the environmental issue should be an important goal of education. As science educators we need to develop knowledge and awareness of what challenges we are facing in our efforts to make students equipped to meet the environmental problems. Research in science education have taught us a lot about students' conceptual understandings (and 'misconceptions' or 'alternative conceptions') of science contents, but less about their attitudes, priorities and decision-making regarding environmental matters. This part of the questionnaire will deepen our understanding how youth relate to some environmental issues, and we will interpret the results against perspectives from sociology and youth research.

4.4.1 Science education for environmental empowerment

What exactly does *empowerment* mean in connection with environmental education? In our use of the phrase, empowerment is a prerequisite for action and includes content-specific knowledge and cognitive skills, motivational patterns and personal value orientations. An empowered person feels capable to take appropriate action to achieve what s/he aims for, and combines his/her cognitive recourses (knowledge and skills) with affective recourses (motivation, attitudes, hope and visions). Key resources for empowerment are self-efficacy, assertiveness and ability to evaluate alternatives and make appropriate choices. Environmentally empowered persons feel that they can make a difference in the world, both by daily, personal choices related to lifestyle and by influencing democratic decision processes.

We assume that in order to be empowered to meet the environmental problems, a person must:

- be motivated for action towards the problems
- have hope and visions for the future
- have a general feeling that s/he can influence the future development
- be interested and engaged in the environmental issue
- think that environmental protection is important for society

S/he must also have sufficient knowledge about the science of the environment, about possible adequate actions in terms of personal lifestyle, technical solutions and political measures and about possible channels of influence through politics, organizations, etc. But as

[23] This text is mainly based on a journal article submitted to Studies in Science Education for print in the 2005 issue. The authors are Camilla Schreiner, Ellen K. Henriksen and Pål J. Kirkeby Hansen.

ROSE does not assess this knowledge component of empowerment, we will not pursue this any further.

Various arguments for empowering students for environmental protection will often (and naturally) be connected to actions for preserving the natural world. Motivation for environmental protection may be based on an anthropocentric worldview (that we must take care of our globe in order to ensure safe conditions for humanity) or a more eco-centric worldview (that nature *per se* has a value that we are obligated to protect). Another argument touches into aspects of personal well-being. Removing the combat from the level of the individuals will make them put a distance between themselves and the problem. Depriving a person of the chance to fight the serious problems s/he realizes are coming, may lead to feelings of alienation, powerlessness and meaninglessness.

In the following we will outline some perspectives from sociology that describe some aspects of late modern societies. We will also include some findings from youth research on young people's images of the future and their feeling of empowerment (or lack of such) for influencing the environmental development.

4.4.2 Previous research on 'empowerment'

Environmental protection and risks

Diversity in humans' indigenous traditions, religious and spiritual approaches and various philosophical directions may lead to a variety of views of nature and the environment, and consequently to diverse motivations and attitudes for environmental protection (Cooper & Palmer, 1998).

> *For some, the environment is primarily something to be appreciated and preserved. For others, it is a resource to be managed and developed, a problem to be avoided or overcome, or simply somewhere to live in and get to know. (Jenkins, 2003)*

People in Western societies may have different approaches to nature, e.g. quasi-religious, eco-centric and anthropocentric approaches. However, the predominant factor motivating for environmental *protection* in Western societies is the perception of *risks*. The experience of risk is an important factor explaining people's engagement in environmental protection, and to a smaller extent the value of nature *per se* (Skjåk & Bøyum, 1993).

Images of the future

Beliefs about what the future brings will contribute to the meanings one gives to the present (Bell, 1997). By knowing the images and visions young people hold of the future, we can better understand their motivation, choices and actions. Images of the future are consequently of interest to science and environmental educators (Hicks, 1996a; Palmer, 1998).

One area of futures research is predictions of how the political, individual, environmental, etc. facets of *societies* are likely to develop. Our focus is rather on the *images* young people hold of the future, and how individuals' ideas about the future influence the way they act in the present.

Future views vary with the angle one takes. Images of one's personal future are different from images of the future of the nation or the globe, and short-term images are different from long span future perspectives. The images will also vary between visions of one's *preferred* future, what one regards as the most *probable* future and what futures one conceives as *possible* (Hicks & Holden, 1995). The focus of this overview will be on studies of *youth's long term global future images*, i.e. images young people hold of the future of the globe for the coming 20-50 years.

If a person's alternatives for *preferred* futures are not contained in her/his images of the *possible* futures, the consequence may be disempowerment, hopelessness and the feeling that one is without power to influence the development in the preferred direction. The most negative combination of future images is consequently when such influence pessimism occurs together with pessimistic images of the *probable* future (Polak, 1961:17).

Views of the future are inevitably influenced both by the personal background of the individual and by contemporary societal events and developments. A person's attitudes, values and priorities, as well as his/her knowledge and experiences, contribute to shaping her/his images of the future. But future images also mirror social, economic, political, environmental and other challenges facing society. This means that future images will change from one epoch to another and that people in different societies will hold different and often characteristic types of images.

Fred Polak (1961) was concerned with images of the future of the globe held by citizens in Western societies. His study disclosed how future images show traits of self-fulfilling prophecies in the sense that images of the future seem to precede or accompany the rise and fall of cultures. This relationship between societal development and future images held by the citizens can be connected to individual actions: A person's actions in the present are affected by her/his images of the future, since one acts in accordance with what one believes will come. People either try to adapt to what they see coming, or try to act in a way that promotes the future they prefer (Bell, 1998). As Kenneth Boulding voices in the foreword of Polak's work (1961): "The image of the future ... is the key to all choice-oriented behavior. ... The individual's image of the future is likewise the most significant determinant of his personal behavior."

From this angle, future images can be seen as a key driving force in the evolution of societies. The actions of citizens in the present are often directed towards the future they wish for, unless this preferred future is incompatible with the future they see as possible. In the latter case, if one fears the future and does not have the feeling that one can change it to the better, one may choose a here-and-now attitude (Hicks & Holden, 1995) and live for today at the expense of tomorrow (Polak, 1961).

Through recent centuries Western future images have been characterized by utopian optimism, while pessimism and helplessness dominate the futures images in the last decades. Heilbroner (1995) found that from roughly 300 years ago until the second half of the twentieth century, people in the West thought the future would be superior to the present. "The spirit of the time was not one of doubt", and the future would bring

> *unimaginable possibilities for improving the human condition at all levels ... an era in which we look to the future with confidence, because men and women believe that forces will be working there for their betterment, both as individuals and as a collectivity (Heilbroner, 1995)*

But as he approaches our current period, he finds that in advanced industrial and capitalistic nations the visions of the future have been noticeably altered towards darker and more pessimistic images.

Alvin Toffler (1974) disclosed a discrepancy between personal and global images of the future held by US youth. Since then, numerous studies of youth in Western societies have confirmed his finding of personal optimism and global pessimism - the further the images are from the personal level, the darker and more hopeless they get.

Young people's images of their personal futures are optimistic and full of hope. With focus on education, nuclear family, occupation and leisure, they feel able to design and create their own good and happy personal future. Their goals are a good education and job, a safe personal economy, a loving nuclear family, a good home and leisure for friends and traveling. When it comes to the future of the nation with national problems like drug abuse, crime, unemployment, sexism, racism and local pollution, they show a large degree of pessimism, but they also expect some improvements. But when they view the future of the globe, they seem to have somewhat apocalyptic expectations. War, ecological catastrophes, overpopulation and famine are their main global fears, and they expect continuation or worsening of the global problems in the future (Brunstad, 2002; Eckersley, 1987; Gidley & Inayatullah, 2002 (eds); Head, 1997; Hicks & Holden, 1995; Rubin, 2002).

Several studies find increasing pessimism with increasing age and that girls in general hold more pessimistic future images than boys (Eckersley, 1999, 2002; Hicks, 1996b). The socio-economic status of the parents and whether the school is located in an urban or a rural area do not seem to influence young people's future images significantly.

Some years ago, global future pessimism was often directed towards a third world war and the nuclear arms race between the United States and the Soviet Union, but more recent studies find a rising environmental concern (Hicks, 1996b; Hicks & Holden, 1995). (It should be mentioned here that this shift is also produced by the researchers, since early studies were not designed to capture environmental issues. For example, the questionnaire applied in the study of Ornauer & al. (1976) was developed around 1966, and at that time they did not find it relevant to include questions for tapping the public concern for the environment.) Among the various environmental problems, including litter, acid rain, polluted air and drinking water, etc., it is global issues like ozone depletion, deforestation and global warming that mostly worry (Henley Centre, 1991).

It seems that there is a close relationship between future images and attitudes towards science and technology. Eckersley (1999) found that those who were optimistic about the future also tended to be positive to the role of science and technology in society. Other studies have found a corresponding connection between future images and people's attitude to scientific and technological development (Hicks & Holden, 1995).

Can S&T solve the environmental problems?

The level of technological development in a country is a crucial factor for explaining the expectations people have of further development in science and technology. Sicinski (1976) found that people in developed countries are less confident with future achievements of science than people in less developed countries. The SAS study investigated 13- year-old students' attitudes to and views of science and technology (Sjøberg, 2000, 2002), and found

that students in developing countries have far more positive images of scientists and their potential for helping people than students in developed countries.

Several studies find that many young people in Western societies regard the benefits of science and technology to be more important than the drawbacks (Eckersley, 1987; Hicks & Holden, 1995), but there is something in the nature of the drawbacks that seems to worry people. While benefits are specific and evident, the costs are diffuse and invisible, and lead to lurking fears of some sneaking consequences (Eckersley, 1987). Science and technology "seem to have a life of their own which the ordinary citizen feels she can neither understand nor control" (Hicks & Holden, 1995).

When it comes to the capacity of science and technology to solve the environmental problems in particular, a number of studies find that young people do not believe much in the power of science and technology (Henley Centre, 1991; Hicks & Holden, 1995). Boys have more faith than girls in science and technology as problem-solvers (Eckersley, 1999; Schreiner & Sjøberg, 2003).

Interests, concern and engagement

One means of personally influencing societal development is participation in organisations and public elections. Through the last decades, young people in most Western countries are showing low interest in joining political and environmental organisations, and many Western countries notice a trend of decreasing voting participation, especially among young people. Øia (1995) interprets that possessing a belief in future progress is an important factor for motivation for political engagement and actions directed towards societal problems. As long as young people do not believe in future progress, they find no use in taking any kind of action (including political action) against the problems. The 'status' or 'image' of young persons active in environmental protection should not hinder participation in organizations. Young people who are concerned about the environment are not perceived by their peers as having a particularly radical, political or controversial attitude. On the contrary, it is regarded as simply a common-sense reaction to the present situation (Henley Centre, 1991). Øia (1995) found that active 'green' youth and youth working for other global concerns (e.g. Amnesty International) achieved high popularity and respect from their contemporaries.

On the one hand, many studies find that environment is a key concern for most young people and that they believe that within their own lifetime, the climate in their society will change due to global warming (Hansen, 1993; Henley Centre, 1991). But although they see environmental protection as an important goal for society (Schreiner & Sjøberg, 2003), some longitudinal studies find falling concern during the last one or two decades. Hellevik and Høie (1999) found that during the 1990s the Norwegian public became less concerned about environmental problems and less willing to give up some goods for the sake of the environment. In 1989, 61 % claimed that we are approaching an ecological catastrophe and that it is too late to stop it, whereas only 34 % gave the same answer in 1997. They found a decline in concern for all the environmental challenges listed in the survey - for global problems (global warming and depletion of the ozone layer) as well as for local air pollution, acid rain, growing waste disposals, etc. Similar decrease in concern is found in Engineering Indicators 2002 (NSB, 2002). The study reports that the percentage of people agreeing that "protection of the environment should be given priority, even at the risk of

curbing economic growth" has declined from 70 percent in 2000 to 57 percent in 2001, the lowest percentage recorded since this question was first asked in 1984.

The reason for this decreasing concern is unclear. There has been concrete and obvious progress towards solving or improving all the above listed environmental problems except for the problem of global warming. Consequently, a public notice of betterment can explain some of the fall in worry, but the fall in public concern about the man-made greenhouse effect can hardly be explained by a general public perception that the problem is solved.

Also, some preliminary results from our analyses of the Norwegian ROSE data (Schreiner & Sjøberg, 2003) confirm that the students are concerned about the environment, but when it comes to *learning* about environmental protection at school, they show rather low interest. For example, they take much more interest in health issues (predominantly the girls) and technology (boys). In the SAS study of Sjøberg (2000; 2002) on what 13-year-olds would like to learn about in school science lessons, environmental topics like "the pollution and dangers of traffic" and "how we can protect air, water and the environment" scored below average interest among students in most Western countries. However, moderate or low interest in learning about various ways of protecting the environment *at school* does not necessarily imply lack of general concern.

Today's young people do not blame previous generations for causing the environmental problems, because they realize that they did not know the consequences of their actions. But they themselves do not have this excuse, and wish to take actions against the problems (Henley Centre, 1991). However, many studies conclude, maybe not surprisingly, that young people do think they personally can have an effect on the future on their own life and to some extent also on the national development, but that global problems are outside their influence (Brunstad, 2002; Head, 1997; Henley Centre, 1991; Hicks & Holden, 1995; Rubin, 2002). For example, Head (1997) found that only two of ten among her 13-year-old Australian respondents said that it would have any effect if they tried to influence the global environmental development, while half of the students believed that they themselves personally could influence the local environment. One third of the students thought that there was little or nothing they could do in order to prevent their global fears from happening.

Narcissism vs. environmental protection

While older generations might conceive the environmental problems as 'new', today's young people do not know a childhood free from environmental risks; the environmental risks are conversely a kind of inborn or natural part of their everyday life (Øia, 1995). The environmental challenges are an accepted state of the world. According to the literature reviewed above, today's youth do not believe that the global problems can be solved, and they cannot see how their individual contribution can make any difference. But as far as we can see, this does not imply that they are unconcerned and unengaged in the environmental matters. Young people take the problems seriously, but the environmental issue is complex, and they do not feel empowered for coping with it.

Environmental devastation plays the role as one of the main perceived global future threats, and many young people do not believe that they can influence it towards the better. Some researchers interpret these results in terms of characteristics of the so-called 'here-and-

now' generation or the 'me'-generation - a generation mainly aiming at realizing and fulfilling themselves. When they do not experience that they can influence or cope with the future of a doomed world, they try to achieve a less complicated life through regression into a short-sighted day-to-day perspective on their own lives (Brunstad, 2002; Hicks & Holden, 1995). (See our paragraph 2.3.9 above about narcissism vs. citizenship.)

Future *hopes* are linked to qualities crucial to personal well-being, especially meaning and purpose of life (Eckersley, 2002). Brunstad (1998) sees a connection between global threats and personal well-being. His study shows ecological catastrophes, war, famine and overpopulation to be the main global future fears held by young people. Except from some vague suggestions of altered consuming, his Norwegian informants had no ideas of how to counteract these fears.

The young girls show more pessimistic images than the boys, and are more inclined to give up some material goods for the sake of the environment. The young boys show more a let-go-attitude. Girls are closer to an eco-centric worldview, for example by meaning that animals have the same value as humans. The boy's worldview is more anthropocentric (Skogen, 1996).

4.4.3 The items in question D

Below the heading "D. Me and the environmental challenges", the following instructions are given:

> ***To what extent do you agree with the following statements about problems with the environment (pollution of air and water, overuse of resources, global changes of the climate, etc.)?***
> *(Give your answer with a tick on each line. If you do not understand, leave the line blank.)*

This is followed by 18 statements, each with a 4-point Likert scale from 'Disagree' to 'Agree'.

We have chosen the challenges of the environment, since this is a *global* challenge. We are well aware that other issues may be more urgent in some parts of the world, like e.g. AIDS/HIV. But since the importance of this issue (and most others) varies so strongly from one country to another, we decided to concentrate on problems of the environment. The issue of environmental protection is closely connected to the realm of S&T, consequently the data analysis and the discussion of the results can be related to implications for science curriculum.

This question seeks to explore to what extent the students feel empowered to cope with the environmental problems (see our definition of this concept in section 4.4.1). We are asking questions (negatively or positively stated) about whether they:

- have hope and visions for the future (D2, D7, D14)
- are motivated for action (D1, D5) - or do they think that somebody else should solve the problems (D4, D11, D13)? (D5 may also tap into the post-materialist theory of Inglehart (1990) described above)
- have a general feeling that they can influence the development (D6, D12)
- think that it is important for society (D3, D8, D9, D10)

By making use of a group of items in the ACE question (E3, E4, E5, E6, E19, E20, E21), we may as well draw inferences about their interests in learning about the issue.

The development of most of the items D1-D14 is inspired by literature on alienation, powerlessness, meaninglessness and normlessness (e.g. Seeman, 1972) and measurement scales reviewed in Measures of Social Psychological Attitudes (Robinson, Shaver & Wrightsman, 1991).

The last four items in this question (D15-D18) are developed for making inferences about students' quasi religious view on nature and protection of nature as a goal in itself (D15, D17, D18) and of nature as sacred (D16). These items are adapted from an international survey on values and environment (Skjåk & Bøyum, 1993). The survey was conducted in 1993 in 19 countries.

4.4.4 Research questions

Responses in this item battery will give information about some cultural values of the students as well as about their empowerment for environmental action. This may be valuable for detecting some basic structures behind their attitudes towards environmental issues, as well as for deepening our understanding of responses given in other parts of the questionnaire.

Some examples of issues to be illuminated by data from this question are:

- How can we characterize differences in views on environmental protection between different groups of learners?
- Are scores on 'empowerment' in late modern societies differing from the scores in non-modern societies? In what way?
- How are scores on 'empowerment' related to scores in other parts of the questionnaire?
    - Do empowered youth seem more concerned about societal matters than youth lacking concern for the environmental issues?
    - Do students with low scores on 'empowerment' show more narcissistic traits than students with higher scores? How are for example empowerment-scores related to items on 'self-actualization' in ACE ("What I want to learn about") and B ("My future job")?

4.5 "My science classes" (F)

Under this heading, the following instructions are given:

> ***To what extent do you agree with the following statements about the science that you may have had at school?***
> *(Give your answer with a tick on each line. If you do not understand, leave the line blank.)*

This is followed by 16 statements, each with a 4-point Likert scale from 'Disagree" to "Agree". The following rationale for the items is extracts from the *ROSE Handbook*:

This question provides information about different aspects of the students' perception of their science classes, like their motivation for science at school, their self-

confidence in their own abilities in science at school, what they get out of science at school, their perceptions of the necessity of science education, etc. We know that aspects like self-confidence, attitudes, interest and motivation are key factors associated with learning. The responses will make it possible to describe what students in different countries actually think they have learned from their science classes.

(The terms "school science" and "science at school" in this question refer to the education in science (biology, physics, chemistry, geology, geophysics, astronomy, etc.) and technology that the students get at school. Each nation was requested to substitute this term with the proper name of the corresponding *school subject* in their country, and not to science in a more general sense.)

4.6 "My opinions about science and technology" (G)

Under this heading, the following instructions are given:

> ***To what extent do you agree with the following statements?***
> *(Give your answer with a tick on each row. If you do not understand, leave the line blank.)*

This is followed by 16 statements, each with a 4-point Likert scale from 'Disagree' to 'Agree'. The public surveys of EU (2001) and NSB (2004b) have provided a useful background for the development of this question. The following text is quotes from the ROSE Handbook with underlying ideas for the items:

This question probes different aspects of how the students perceive the role and function of science and technology in society. We explore their possible trust or distrust, their interests and support, etc. Many of the questions are copies of questions used in large scale public surveys like the Eurobarometer[24] and similar surveys in other parts of the world. The responses are interesting in themselves, and may also be compared with the corresponding replies by the adult population in many countries. We may also explore how the responses on these items are related to responses on many other questions in the ROSE questionnaire.

4.7 "My out-of-school experiences" (H)

Under this heading, the following instructions are given:

> ***How often have you done this outside school?***
> *(Give your answer with a tick on each line. If you do not understand, leave the line blank.)*

This is followed by 61 activities or experiences, each with a 4-point Likert scale from 'Never' to 'Often'. The ideas behind these items are (as described in the ROSE Handbook):

This question provides information about students' experiences out-of-school; activities that may have bearing on their interests in S&T and that may provide important experiences for the learning of science at school. Responses to this question will give

[24] See e.g. http://europa.eu.int/comm/public_opinion/

teachers, curriculum makers and textbook writers a description of what kind of S&T-related experiences youth bring to school, and how these vary between girls and boys and between diverse cultures.

Meaningful teaching should build on the learners' experiences, and this question can provide such insights. It may for instance shed light on whether the dominating form of science teaching (or textbooks) favours certain groups of students at the expense of others. Responses to this question can also be analysed and seen in relationship to answers to other questions, for instance ACE ("What I want to learn about").

4.8 "Myself as a scientist" (I)

Under this heading, the following instructions are given:

> *Assume that you are grown up and work as a scientist. You are free to do research that you find important and interesting. Write some sentences about what you would like to do as a researcher and why.*

This is followed by the text:

> *I would like to . . . . . .* [three empty lines available for writing]
> *Because . . . . . .* [five empty lines]

This is the only open-ended question, and the students are invited to express opinions with their own words. The question has two parts. The first asks about *what* they would like to work on, the other asks for *reasons* for this particular choice. The first part may be analysed in terms of a classification by problem area or subject-matter. (e.g. medicine, space exploration, computer technology, etc.), while the second part may be analysed in terms of personal motivation and values (e.g. helping others, personal interest or curiosity, seeking money and success, etc.)

Some of the advantages connected to data collection by essay-writing can be found in open-ended questions in questionnaires. Here the respondents are to a larger extent freed from the constraints of the closed scale items. Rather than responding to a pre-structured questionnaire item, they can argue and express their own ideas and perspectives, and thereby give the data some new dimensions.

But analyzing open-ended questions is time-consuming and it requires international co-operation to make the categories. Open-ended questions also require that persons in all participating countries evaluate and code the written texts. A coder in each county must classify the responses into the various categories given in a code scheme for this particular question. The categorizing and coding of writings are necessarily associated with individual interpretations done by each coder, as they inevitably interpret from the point of view of their own culture, gender and personality. This entails fallible human judgments and leads to some inter-coder inconsistency. This variance in categorizing open-ended questions will weaken both the reliability of the coded data and the validity of the question.

Some of the richness in the responses is of course lost when they are coded. We will therefore use the responses to this question in two ways:

- As full quotes to *illustrate* what we find to be *typical* responses
- Coded results for quantitative comparisons, also across countries.
  For this purpose we need a system of coding that can be used in all countries.

For the coding, we developed two coding schemes, and the categories are reproduced in Appendix C and D.

The coding consists of the student identification number (for later merging of the data files) and a count of the total number of words in the two parts of the response. The two parts of the question are then coded separately. None of the categories are mutually exclusive. In cases where students gave multiple topics that they wanted to do research on, and more than one reason for their choice, all the mentioned aspects were coded. All mentioned categories were coded "1", while the categories that did not occur remained empty.

Here are the details of the coding:

"I would like to ..." is a question about the area of concern; of the field or subject matter. The categories are:

Biology: human, body
Biology: deceases, medicine, cure
Biology: microbiology, gene technology
Biology: animals, plants, nature
Biology: other
Technology: computers, electronic, new tech, etc.
Technology: motors, buildings, roads, car, transport, etc.
Technology: weapon
Technology: other or in general
Environment
Earth, weather, climate
Chemistry; atoms, reactions, etc.
Physics; electricity, heat, etc.
Space; stars and planets, black holes, space travel, etc.
Psychology, human behaviour
Invent things
Do experiments, work on laboratory
Paranormal, philosophical, mysterious, wonder, etc.
Social and economic sciences
Do not want to do research
Other

"Because ..." is a question about underlying reasons or motivation for the choice. The coding categories are the following:

Curiosity, interests, seems fun, want to, exciting
Related to the profession I want
Important in general or for society/humanity
Help (people, animals, etc.)
Get rich, popular, famous
Other

A final string variable was added for comments, if necessary.

This coding scheme may of course be questioned. We used Norwegian and English data as the basis for the development of the above scheme. We started off with more categories, but simplified and reduced them based on an analysis of a high number of responses. We checked the reliability of the coding by letting two independent markers code a series of common response schemes. We found that the above scheme functioned satisfactory and had the simplicity that we found necessary to communicate to researches in other countries.

The responses to this question may be analysed in terms of differences between girls and boys, between different cultures, etc. The results may also be explored for possible relationship with other questions, e.g. "My future job", "My opinions about science and technology", "What I want to learn about", etc. Maybe can sociological theories about modern youth mentality (described in section 2.3) deepen our understanding of scores in categories for self-actualisation or narcissism vs. societal engagement and concern.

5 INSTRUCTIONS TO PARTICIPANTS

In a comparative research project like ROSE, it is of course of paramount importance to have clear procedures on details of data collection. The *level* of detail and rigour may of course be discussed. Projects like TIMSS and PISA have well developed procedures and systems for ensuring excellent quality of the data. This way of organizing the data collection may be seen as a natural consequence of the aims and ambitions of the studies. Besides they have the funds needed for such thoroughness.

ROSE is operating on another scale. It is a low cost undertaking based on cooperation between interested researchers in diverse cultures. The researchers are not receiving any payments for their work, so their involvement must enter into their present employment. Besides, the outcomes of the project will not be any kind of fine-tuned 'ranking' according to given criteria for quality. Our aim is to explore cultural differences and similarities and to stimulate discussions on important issues. Given these considerations and constraints, we are nevertheless interested in collecting high quality data from representative samples.

5.1 Data collection and coding

We developed, in cooperation with research partners, a *ROSE Handbook* that was made available to all partners from the website. The document was meant as a handbook for researchers who want to participate in the ROSE study. It described some underlying ideas behind the ROSE project, the 'logistics' and the practical details of taking part in the study, the rationale behind the ROSE instrument and the process of the questionnaire development.

See Appendix B about issues like translation of the questionnaire, definition of target population, sampling instructions, coding and cleaning of the data, etc. The appendix is an extract from the part of the ROSE Handbook describing instructions and guidelines for how to organize and carry out the survey.

5.1.1 Code books

We developed an empty data file for the coding of the responses in the closed questions A-H. Responses in the open question I needed interpretations before coding. For practical reasons this question was coded separately in another empty data file containing the pre-defined categories (see Appendix D). Both data files were made available in two formats: SPSS (Statistical Programme for the Social Sciences) and Microsoft Excel.

With these two files followed corresponding code books with necessary details and explanations about the data entry. These are reproduced in Appendix C and D.

5.1.2 Data cleaning

Since only the coded files (and not the questionnaires) were returned to the ROSE organizers, the partners were encouraged to ensure that the data was properly cleaned for mistakes. In the instructions to the participants, we had provided some advice on how to

check the quality of the data before submitting the file to the ROSE organizers. As we received data files in Norway, we did our own quality check and cleaning of the files before they were merged into the common international data file. The details are as follows. This procedure was developed and performed by Kristján Ketill Stefánsson.

A standard SPSS syntax file recoded and standardized the national data. This syntax file was further developed for handling particular adjustments and/or mistakes for each nation. The national syntax files will also function as logs with records of all corrections and changes in each national data file.

The national student background questions were deleted as well as the page break variables. Furthermore, the data were checked for coding errors and illegal values. All illegal values were recoded to the missing value code 9. For uncovering patterns in the data that most likely were caused by mistakes, we conducted frequency and crosstab tests. Some of the files required special attention, e.g. by lacking or having extra variables; containing variables with different data format; etc.

In addition, when a new file was added, we performed some checks on the total file to see how well the new country file 'behaved' on a selection of variables compared with other countries. Some emerging problems were resolved by correspondence with the national organizer. In some cases, we discovered problems that led to a postponement of the inclusion of the file until a proper explanation was available.

Details on some of these issues will be presented in a later report on results. For each nation, the original data file and the national syntax file are saved and available for later viewing.

5.2 Data collection reports

All partners were requested to write a report describing in detail the process of national data collection. For this information to be complete and comparable, we developed a 'template' with headings and questions to be addressed. (The Norwegian report is given in Appendix D as an example.) When we received the responses, these were uploaded on the ROSE web site.

The data collection report has the following headings:

ROSE team

- name of contact person
- name of co-workers
- occupation
- name of institution

School system and science teaching

- number of years with compulsory school
- schools with grouping of students according to ability, gender, language, region, special needs, etc.
- how science teaching is arranged at various grades (e.g. one common science subject or different subjects like physics, chemistry, biology, etc.)

Translation

- description of the process
- at what time the translation was done
- any particular difficulties?

National questions

- additional questions for background of the home (parents education or occupation, etc.)
- additional survey questions

Piloting

- pilot testing of the questionnaire, if any
- experiences, feedback and results

Official permission

- permission needed from authorities
- restrictions and difficulties, if any

Population

- demarcation of the target population (the population to be represented)
- accessible population

Sample and participation

- how the sample was drawn, random sampling?
- response rate, percentage of positive responses
- how good does the sample represent the target population?
- possible weaknesses connected to the sample

Data collection in schools

- how the contact with schools was established
- how the questionnaire was duplicated
- how the questionnaire was distributed
- persons involved in conducting the survey at schools
- what instructions the persons got
- practical problems, if any
- at what time the data was collected

Feedback and experiences

- reactions from the students, if any
- reactions from the persons who collected the data
- ROSE team's general feeling of how well the survey was conducted

Coding (also of the open-ended I question)

- how the coding was done
- who coded the questionnaire

- problems with the coding, if any
- how flippant or incomplete responses were handled
- proofreading and checking of the coding, if any
- at what time the coded file was finalized

5.3 Electronic collaboration

As described earlier, we arranged in the beginning of the project period some international *in person* gatherings. (Such workshops and seminars will also be arranged through the forthcoming period with data analysis and interpretations of the findings.) However, the main channel for communication and collaboration has been electronic through e-mailing and access to web-pages.

The participants have shared ideas and reflected on their own and others work through discussions on e-mail. When new documents (the questionnaire, hand book, code books, etc.) were finalized, we uploaded them to the ROSE web site, and as the project proceeded and reached new stages, we informed the group by e-mail about completions, status and news. The ROSE partners have returned their files (data files, reports on organizing the survey, papers, presentations, etc.) as attachments in e-mails. (Files may of course also be sent by snail-mail on diskettes, but so far we have only received e-mails.)

The uploading of the national files to the ROSE web site has been done by Kristján Ketill Stefánsson.

6 ISSUES OF DATA AND QUESTIONNAIRE QUALITY

A key concern connected to any research and research instrument is about the quality of the data, the results and the interpretations. In the previous text, we have touched upon these issues several times, but here we will be more precise. Key (and interrelated) issues in this chapter are:

- *Validity*: Do we actually address (or measure) the issues that we want to and claim that we are addressing?
- *Reliability*: Do we measure in a consistent, reliable and accurate way?
- *Credibility* (or trustworthiness): Does the study make sense; will people believe and have trust in the results?

It is important to keep in mind that the above concepts are not objective concepts; they involve personal judgement, and they can only be discussed in concrete cases where an instrument has been used in a particular setting with a particular population. Besides, high validity, reliability and credibility are not inherent properties of the *instrument*, but of the information that they produce. This is particularly important in the case of ROSE, since the instrument is designed be used in widely different cultures. A detailed discussion of these issues must therefore in principle be done by those who collect, analyze and interpret data in their own particular setting.

Nevertheless, one may still say something about the ROSE instrument in the light of these concerns. Above all, it is important to keep in mind some other characteristics of the ROSE questionnaire:

The ROSE instrument is not a *test*. Neither have we developed measurement scales for some particular theoretical constructs. The ROSE instrument is rather inventories of aspects that we consider important for our purpose. ROSE is aiming at capturing span and diversity. As described earlier, this had some implications for the development of the instrument. Some principles and techniques within the field of psychometrics and test theory have therefore not been applicable for our questionnaire and item development.

As ROSE is not a test, there are no correct answers. This means that there is nothing like 'cheating', in fact some help with language and understanding is considered to be positive. It also implies that there is no need to put time constraints on the students when they answer.

6.1 Validity

According to Shadish, Cook, & Campbell (2002), refers validity to the truth of the inferences drawn from the results, i.e. to what extent the empirical evidence supports the inferences. From this follows that the validity of the measurement depends on the conclusions one draws from it (Oppenheim, 1992). Validity is a key concern in any research. Research that is invalid is by definition of no value.

In the case of ROSE, we have tried to develop an instrument that can be used in different cultural contexts. If it was meant to be used in one country or culture only, the instrument would have been different. The validity of the study must be considered in the

light of its rationale and purpose, and of course on the accounts that emerge from articles and publications.

Validity has many aspects, and is not a simple term. There are many possible ways to consider validity. Cohen et al. (2000) lists 18 different kinds of validity. Validity is not a technical term that can be objectively calculated, as it is always a matter of degree and it implies always some element of personal judgement. Among the 18 kinds of validity, we see the concepts of "face validity" (the superficial appearance of the question), and "cultural validity" (whether the cultural background of the students influences their understanding of the question) as the most applicable. We have tried to address these sorts of validity through the process of instrument development (described in chapter 3). We have asked ourselves and our partners how useful and meaningful the various questions and items are, and we have tried to formulate items which are clear in meaning and simple and unambiguously worded. Through the whole process of questionnaire development we have drawn on input from students, teachers and researchers with a variety of cultural backgrounds and thereby strived for common-sense face validity and cultural.

As recommended by Oppenheim (1992), we have asked ourselves and our partners: Do the items actually measure what they intend to measure? Why are these items selected? How well balanced are these items in terms of content? How pure and one-dimensional are the items? What are presupposed qualifications of the respondents?

The reporting and the analysis can of course take place in several forms. Since each question by itself is meant to be interesting, reporting on single item-level may be of interest. We may for example compare score frequencies or mean values of different groups of students (girls vs. boys, country by country, etc.). This is the way the data often are reported for example in the Eurobarometer surveys (see e.g. EU, 2001) and in the majority of surveys reviewed by the US National Science Board (NSB, 2004b).

But both for overcoming the amount of data and for being able to lift the discussion up from the items to a more general level, the questionnaire items can be grouped into clusters; each cluster constituting one composite variable. When composite variables are constructed, they shall be given appropriate names. The name represents the common factor of the items making up the variable. But because of the above described data-driven method for constructing the composite variables, the items making up the variables may not represent all facets of the corresponding construct. Or in other words: The items forming one composite variable may not be the best possible selection of indicators (items) from the universe of indicators relevant to the name of the variable. It would consequently be a fallacy to consider a composite variable as a construct. They shall rather be reckoned as a purposeful grouping of the items.

Adequate and accurate naming of the composite variables will be crucial for valid interpretations of the findings. This discussion above addresses the validity of the composite variables. The variables ought to be employed with thoughtful caution and the interpretations of and the inferences from the findings must always bring this validity issue into consideration.

Hopefully the forthcoming data analysis will show that the rather thorough and lengthy process of developing the questionnaire described in chapter 3 has ensured sufficient validity in most of the dimensions that the questionnaire intends to assess. The study can thereby provide empirical evidence for valid inferences addressing the aims of ROSE.

6.2 Reliability

There are some weaknesses in the data that may raise questions about the reliability of the data. For example, there are countries that did not draw representative samples for a defined target population (only easily accessible schools participated); some countries could not spend the amount of sheets required by a questionnaire on 13 pages and arranged therefore the questionnaire differently; in some countries the survey language differed from the mother tongue of the students; very low response rates was a problem in some countries, etc. Such matters were due to low financial recourses or other practical obstacles.

In psychometrics, there are a set of often rather precise and technical ways of measuring reliability. This assumes that one sets out to measure more or less clearly defined theoretical *constructs*. A construct is "something that has been systematically put together, usually in the mind, especially a complex theory or concept" [25], or with Pedhazur's and Schmelkin's words (1991): "Constructs ... are theoretical constructions, abstractions, aimed at organizing and making sense of our environment".

One can directly measure how late a student is for the science lesson or how many kilos of sheets s/he has made use of during the science classes. In contrast to these observable quantities, constructs as attitudes, understanding, motivation, achievement, behaviour, intelligence, etc. can not be directly measured. Such abstract properties, or latent variables, must be inferred from observable indicators. The latent variable is consequently *operationalized* (given an operational definition) and a variety of observable indicators are developed. The questionnaire items represent the indicators. In the universe of possible items relevant for the construct, the items are chosen and created in such a way that they jointly make a good representation of the construct. When combined into a common *scale*, these items produce a measure for this construct.

The statistical properties of this scale can be scrutinized through different well accepted procedures. It is important that the scale 'hangs together' - that the data for the items show *internal consistency* so one can interpret that the items measure the same underlying trait. One can assess the internal consistency of the items by examining how well they correlate with each other and with the total score. A usual measure for this internal consistency (or reliability) is Cronbach's alpha, which is calculated on the basis of the correlation coefficients between items in the scale and the total number of items (alpha gets higher the higher number of items one includes in the scale).

It is important to note that ROSE is *not* aiming at measuring theoretically pre-defined constructs in a strict psychometric sense. Contrary to the above described procedure for measuring a construct, item clusters in this study may emerge from the data analyses, and not from a clear explication of the construct. But as mentioned above, may also the ROSE items be merged into composite variables in order to lift the discussion up from the items to a more general level and to achieve a better understanding of the responses. Combinations of theoretical perspectives, our initial ideas during the questionnaire development, exploratory factor analysis and reliability analysis may lead to a structure of various item clusters. As one

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item may have different connotations in different cultures, the items may cluster differently in the different countries.

After the appearance of an item cluster, the corresponding composite variable will be given an appropriate name representing the common factor of the items making up the variable. But we cannot automatically turn our understanding of the name the other way around, saying that the name is a construct, which is best possibly represented by the items in the cluster. Because of the above-described data-driven method for building composite variables, the items making up the variables may not represent all facets of the corresponding construct. The items forming the composite variable may not be the best possible selection of indicators from the universe of indicators relevant to the name of the variable. It would consequently be a fallacy to consider a composite variable as a construct. They should rather be reckoned as a purposeful grouping of the questionnaire items. Adequate and accurate naming of the variables is crucial for valid interpretations for the findings, and thus a decisive step in the data analyses.

6.3 Credibility, trustworthiness

The final key term for the quality of research is its *credibility* or *trustworthiness*. These terms are of course closely related to the terms validity and reliability. Some authors claim that one should go beyond the traditional concern for reliability and validity, and rather ask the question:

> *Is there sufficient detail on the way the evidence is produced for the credibility to be assessed? (Robson, 2002)*

Does the study make sense? Will people believe the results and have trust in them? Will they believe you, trust you and have confidence in your data as well as in your findings and your conclusions? This concept is obviously 'relative' and carries a strong element of individual and subjective judgement. But trust can definitely not be conveyed merely through high values of calculated statistical measures; people will not be convinced by statistical parameters if they do not grasp the meaning of the concepts or if they cannot see how you arrived at your findings.

A prerequisite for high credibility is that you are very clear in explaining what you have done and how it was done. One has to be as exact as possible in describing the necessary details. In experiments in natural science this is a basic requirement; everybody shall in principle be able to replicate the and check the details of the experiment. In social science this is not to the same degree, but at least as an ideal, one should be able to repeat the research in order to check and verify results.

The analysis must always address issues of validity, reliability and credibility. In this publication we have, among other issues, described the exploratory nature of ROSE, our appreciation of cross-cultural diversity and some weaknesses in the data material. From this follows that we have to look for robust findings for avoiding drawing conclusions on scanty evidence. ROSE is collecting data from multiple sources. One may validate the data for example by investigating whether non-representative data from nations with similar culture (e.g. countries in Scandinavia or in Great Britain) show the same profile. Furthermore, one may reason that the data from the various nations *confirm each other*. This method can be seen as one (among other) means for strengthen the credibility of the data.

7 CONCLUSION, STATUS AND FUTURE PLANS

In this report, we have tried to go in some detail on our basic rationale and the details of instrument development. This account (and the reports that we will publish) should provide the basis of a more detailed judgement of the overall quality of the study. To summarize, we have done the following in trying to achieve reasonably high reliability, validity and (hopefully) credibility:

- We have tried to include aspects that shed light on the basic ideas of ROSE
- We have tried to involve experts from a wide variety of cultures from all continents through workshops and later correspondence
- We have used trials and pilot studies performed in many countries
- We have used qualitative and open methods to gather ideas and input from students as well as teachers
- We have received ideas and inputs from research partners in many countries
- We have revised and refined the instrument several times based on all the input we have received (but have, of course, made several decisions and compromises)

As mentioned several times, we are not claiming to measure theoretically defined constructs, although we intend to look at emerging similarities, differences and relationships. The overall purpose of the study is to address a series of aspects that we consider to be important for how students think and feel about S&T at school and in a wider social setting. Based on this ambition, spelled out in the aims and purposes of the project, we have made a selection of what we consider as key aspects to study. These are grouped under the headings (A-I) in the ROSE questionnaire. Under each of these, we have had several dimensions or categories in mind. These were initially grouped conceptually by us as part of our underlying ideas, as they are described in chapter 4. Whether or not these groupings turn out to have satisfactory statistical properties or not is matter that can only be discussed based on the data that are collected. The reliability of emerging composite variables is a property of the data, and not of the instrument itself.

We have tried to keep the cross-cultural aspect as a key concern through the process. It may, however, be that the ROSE instrument is deemed by others to be valid in some cultures and not in others. It is certainly the case that it is easier to develop a valid instrument for use in one culture only. But the purpose of ROSE was to make a cross-culturally suitable instrument, and issues of validity and credibility must be seen in this light.

At the time of writing this report, several papers based on ROSE have already been presented at international conferences. Such papers are continuously put on the ROSE home page. Most of the papers written so far have been national studies, but as ROSE organizers we have also presented some international comparisons. We plan to produce a more comprehensive international report early in 2005. This report will mainly embody rather simple comparisons and has to be followed up by more detailed analysis. (As one may understand, the possibilities for 'asking questions' to the ROSE data are enormous.) We also know that several research partners are working on reports, some also with international comparisons. As mentioned, there are about 10 researchers in different countries who want

to base their thesis on ROSE data, and we do look forward to support and to see the progress of this research.

In November 2004 we will host a ROSE workshop in Oslo, and we also have other plans to organize joint work. The details will depend on the financial possibilities. Currently we only have funding from Norwegian sources for such cooperation, but we are looking for international funding.

Part of the motivation behind ROSE is to support capacity-building and to encourage international cooperation and joint research. Participants in ROSE are encouraged to get engaged in shared research with one or more partners in other countries. Through our network they may get access to data files from other countries for such cooperation.

A final word on the more personal side:

The last three years or so have brought us in contact with about two hundred researchers from around 60 countries. Several thousand mails have been received and sent. This correspondence has of course been time consuming, but it has also been rewarding, academically as well as on a more personal level. We have also had the chance to meet several of our colleagues from all parts of the world at conferences and workshops. The fact that we work on similar issues and that we now have collected comparable data provides us with a fantastic base for discussing important issues and for a joint effort to try to interpret and understand the many challenges that we are facing. This research is often rather hard work - but it also gives us pleasure and personal rewards. Such outcomes of research cooperation are not easy to convey through statistical analysis and regular research reports. But maybe this is what makes us tick?

APPENDIX A THE ROSE QUESTIONNAIRE

At the next pages follows the original ROSE questionnaire in English version on A4 paper size. The questionnaire is available in several other languages at the ROSE web site.

The ROSE questionnaire is copyrighted, but may be used when permission from the project organizers is provided.

R SE
The Relevance of Science Education

This booklet has questions about you, and about your experiences and interests related to science in school and outside school.

There are no correct or incorrect answers, only answers that are right for you.
Please think carefully and give answers that reflect your own thinking.

This questionnaire is being given to students in many different countries. That is why some questions may seem strange to you. If there is a question you do not understand, just leave it blank. If you are in doubt, you may ask the teacher, since this is not a test!

For most questions, you simply put a tick in the appropriate box.

The purpose of this questionnaire is to find out what students in different parts of the world think about science at school as well as in their everyday life. This information may help us to make schools better.

Your answers are anonymous, so please, do not write your name on this questionnaire.

THANK YOU!
Your answers will be a big help.

START HERE:

I am a ☐ **girl** ☐ **boy**

I am _____ years old

I live in _____ (write the name of your country)

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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.)

		Not interested			*Very interested*
1.	Stars, planets and the universe	☐	☐	☐	☐
2.	Chemicals, their properties and how they react	☐	☐	☐	☐
3.	The inside of the earth	☐	☐	☐	☐
4.	How mountains, rivers and oceans develop and change	☐	☐	☐	☐
5.	Clouds, rain and the weather	☐	☐	☐	☐
6.	The origin and evolution of life on earth	☐	☐	☐	☐
7.	How the human body is built and functions	☐	☐	☐	☐
8.	Heredity, and how genes influence how we develop	☐	☐	☐	☐
9.	Sex and reproduction	☐	☐	☐	☐
10.	Birth control and contraception	☐	☐	☐	☐
11.	How babies grow and mature	☐	☐	☐	☐
12.	Cloning of animals	☐	☐	☐	☐
13.	Animals in other parts of the world	☐	☐	☐	☐
14.	Dinosaurs, how they lived and why they died out	☐	☐	☐	☐
15.	How plants grow and reproduce	☐	☐	☐	☐
16.	How people, animals, plants and the environment depend on each other	☐	☐	☐	☐
17.	Atoms and molecules	☐	☐	☐	☐
18.	How radioactivity affects the human body	☐	☐	☐	☐
19.	Light around us that we cannot see (infrared, ultraviolet)	☐	☐	☐	☐
20.	How animals use colours to hide, attract or scare	☐	☐	☐	☐
21.	How different musical instruments produce different sounds	☐	☐	☐	☐
22.	Black holes, supernovas and other spectacular objects in outer space	☐	☐	☐	☐
23.	How meteors, comets or asteroids may cause disasters on earth	☐	☐	☐	☐

		Not interes-ted			*Very interes-ted*
24.	Earthquakes and volcanoes	☐	☐	☐	☐
25.	Tornados, hurricanes and cyclones	☐	☐	☐	☐
26.	Epidemics and diseases causing large losses of life	☐	☐	☐	☐
27.	Brutal, dangerous and threatening animals	☐	☐	☐	☐
28.	Poisonous plants in my area	☐	☐	☐	☐
29.	Deadly poisons and what they do to the human body	☐	☐	☐	☐
30.	How the atom bomb functions	☐	☐	☐	☐
31.	Explosive chemicals	☐	☐	☐	☐
32.	Biological and chemical weapons and what they do to the human body	☐	☐	☐	☐
33.	The effect of strong electric shocks and lightning on the human body	☐	☐	☐	☐
34.	How it feels to be weightless in space	☐	☐	☐	☐
35.	How to find my way and navigate by the stars	☐	☐	☐	☐
36.	How the eye can see light and colours	☐	☐	☐	☐
37.	What to eat to keep healthy and fit	☐	☐	☐	☐
38.	Eating disorders like anorexia or bulimia	☐	☐	☐	☐
39.	The ability of lotions and creams to keep the skin young	☐	☐	☐	☐
40.	How to exercise to keep the body fit and strong	☐	☐	☐	☐
41.	Plastic surgery and cosmetic surgery	☐	☐	☐	☐
42.	How radiation from solariums and the sun might affect the skin	☐	☐	☐	☐
43.	How the ear can hear different sounds	☐	☐	☐	☐
44.	Rockets, satellites and space travel	☐	☐	☐	☐
45.	The use of satellites for communication and other purposes	☐	☐	☐	☐
46.	How X-rays, ultrasound, etc. are used in medicine	☐	☐	☐	☐
47.	How petrol and diesel engines work	☐	☐	☐	☐
48.	How a nuclear power plant functions	☐	☐	☐	☐

B. My future job

How important are the following issues for your potential future occupation or job?
(Give your answer with a tick on each line. If you do not understand, leave the line blank.)

		Not important			*Very important*
1.	Working with people rather than things	☐	☐	☐	☐
2.	Helping other people	☐	☐	☐	☐
3.	Working with animals	☐	☐	☐	☐
4.	Working in the area of environmental protection	☐	☐	☐	☐
5.	Working with something easy and simple	☐	☐	☐	☐
6.	Building or repairing objects using my hands	☐	☐	☐	☐
7.	Working with machines or tools	☐	☐	☐	☐
8.	Working artistically and creatively in art	☐	☐	☐	☐
9.	Using my talents and abilities	☐	☐	☐	☐
10.	Making, designing or inventing something	☐	☐	☐	☐
11.	Coming up with new ideas	☐	☐	☐	☐
12.	Having lots of time for my friends	☐	☐	☐	☐
13.	Making my own decisions	☐	☐	☐	☐
14.	Working independently of other people	☐	☐	☐	☐
15.	Working with something I find important and meaningful	☐	☐	☐	☐
16.	Working with something that fits my attitudes and values	☐	☐	☐	☐
17.	Having lots of time for my family	☐	☐	☐	☐
18.	Working with something that involves a lot of travelling	☐	☐	☐	☐
19.	Working at a place where something new and exciting happens frequently	☐	☐	☐	☐
20.	Earning lots of money	☐	☐	☐	☐
21.	Controlling other people	☐	☐	☐	☐
22.	Becoming famous	☐	☐	☐	☐
23.	Having lots of time for my interests, hobbies and activities	☐	☐	☐	☐
24.	Becoming 'the boss' at my job	☐	☐	☐	☐
25.	Developing or improving my knowledge and abilities	☐	☐	☐	☐
26.	Working as part of a team with many people around me	☐	☐	☐	☐

C. 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.)

		Not interes-ted			*Very interes-ted*
1.	How crude oil is converted to other materials, like plastics and textiles	☐	☐	☐	☐
2.	Optical instruments and how they work (telescope, camera, microscope, etc.)	☐	☐	☐	☐
3.	The use of lasers for technical purposes (CD-players, bar-code readers, etc.)	☐	☐	☐	☐
4.	How cassette tapes, CDs and DVDs store and play sound and music	☐	☐	☐	☐
5.	How things like radios and televisions work	☐	☐	☐	☐
6.	How mobile phones can send and receive messages	☐	☐	☐	☐
7.	How computers work	☐	☐	☐	☐
8.	The possibility of life outside earth	☐	☐	☐	☐
9.	Astrology and horoscopes, and whether the planets can influence human beings	☐	☐	☐	☐
10.	Unsolved mysteries in outer space	☐	☐	☐	☐
11.	Life and death and the human soul	☐	☐	☐	☐
12.	Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are	☐	☐	☐	☐
13.	Why we dream while we are sleeping, and what the dreams may mean	☐	☐	☐	☐
14.	Ghosts and witches, and whether they may exist	☐	☐	☐	☐
15.	Thought transference, mind-reading, sixth sense, intuition, etc.	☐	☐	☐	☐
16.	Why the stars twinkle and the sky is blue	☐	☐	☐	☐
17.	Why we can see the rainbow	☐	☐	☐	☐
18.	Properties of gems and crystals and how these are used for beauty	☐	☐	☐	☐

D. Me and the environmental challenges

To what extent do you agree with the following statements about problems with the environment (pollution of air and water, overuse of resources, global changes of the climate etc.)? (Give your answer with a tick on each line. If you do not understand, leave the line blank.)

		Disagree			*Agree*
1.	Threats to the environment are not my business	☐	☐	☐	☐
2.	Environmental problems make the future of the world look bleak and hopeless	☐	☐	☐	☐
3.	Environmental problems are exaggerated	☐	☐	☐	☐
4.	Science and technology can solve all environmental problems...	☐	☐	☐	☐
5.	I am willing to have environmental problems solved even if this means sacrificing many goods	☐	☐	☐	☐
6.	I can personally influence what happens with the environment ..	☐	☐	☐	☐
7.	We can still find solutions to our environmental problems	☐	☐	☐	☐
8.	People worry too much about environmental problems	☐	☐	☐	☐
9.	Environmental problems can be solved without big changes in our way of living	☐	☐	☐	☐
10.	People should care more about protection of the environment ...	☐	☐	☐	☐
11.	It is the responsibility of the rich countries to solve the environmental problems of the world	☐	☐	☐	☐
12.	I think each of us can make a significant contribution to environmental protection.....	☐	☐	☐	☐
13.	Environmental problems should be left to the experts	☐	☐	☐	☐
14.	I am optimistic about the future	☐	☐	☐	☐
15.	Animals should have the same right to life as people	☐	☐	☐	☐
16.	It is right to use animals in medical experiments if this can save human lives	☐	☐	☐	☐
17.	Nearly all human activity is damaging for the environment	☐	☐	☐	☐
18.	The natural world is sacred and should be left in peace.....	☐	☐	☐	☐

E. 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.)

		Not interested			*Very interested*
1.	Symmetries and patterns in leaves and flowers	☐	☐	☐	☐
2.	How the sunset colours the sky	☐	☐	☐	☐
3.	The ozone layer and how it may be affected by humans	☐	☐	☐	☐
4.	The greenhouse effect and how it may be changed by humans	☐	☐	☐	☐
5.	What can be done to ensure clean air and safe drinking water ..	☐	☐	☐	☐
6.	How technology helps us to handle waste, garbage and sewage	☐	☐	☐	☐
7.	How to control epidemics and diseases	☐	☐	☐	☐
8.	Cancer, what we know and how we can treat it	☐	☐	☐	☐
9.	Sexually transmitted diseases and how to be protected against them	☐	☐	☐	☐
10.	How to perform first-aid and use basic medical equipment	☐	☐	☐	☐
11.	What we know about HIV/AIDS and how to control it	☐	☐	☐	☐
12.	How alcohol and tobacco might affect the body	☐	☐	☐	☐
13.	How different narcotics might affect the body	☐	☐	☐	☐
14.	The possible radiation dangers of mobile phones and computers	☐	☐	☐	☐
15.	How loud sound and noise may damage my hearing	☐	☐	☐	☐
16.	How to protect endangered species of animals	☐	☐	☐	☐
17.	How to improve the harvest in gardens and farms	☐	☐	☐	☐
18.	Medicinal use of plants	☐	☐	☐	☐
19.	Organic and ecological farming without use of pesticides and artificial fertilizers	☐	☐	☐	☐
20.	How energy can be saved or used in a more effective way	☐	☐	☐	☐
21.	New sources of energy from the sun, wind, tides, waves, etc. ...	☐	☐	☐	☐
22.	How different sorts of food are produced, conserved and stored	☐	☐	☐	☐
23.	How my body grows and matures	☐	☐	☐	☐

		Not interes-ted			*Very interes-ted*
24.	Animals in my area	☐	☐	☐	☐
25.	Plants in my area	☐	☐	☐	☐
26.	Detergents, soaps and how they work	☐	☐	☐	☐
27.	Electricity, how it is produced and used in the home	☐	☐	☐	☐
28.	How to use and repair everyday electrical and mechanical equipment	☐	☐	☐	☐
29.	The first landing on the moon and the history of space exploration	☐	☐	☐	☐
30.	How electricity has affected the development of our society	☐	☐	☐	☐
31.	Biological and human aspects of abortion	☐	☐	☐	☐
32.	How gene technology can prevent diseases	☐	☐	☐	☐
33.	Benefits and possible hazards of modern methods of farming	☐	☐	☐	☐
34.	Why religion and science sometimes are in conflict	☐	☐	☐	☐
35.	Risks and benefits of food additives	☐	☐	☐	☐
36.	Why scientists sometimes disagree	☐	☐	☐	☐
37.	Famous scientists and their lives	☐	☐	☐	☐
38.	Big blunders and mistakes in research and inventions	☐	☐	☐	☐
39.	How scientific ideas sometimes challenge religion, authority and tradition	☐	☐	☐	☐
40.	Inventions and discoveries that have changed the world	☐	☐	☐	☐
41.	Very recent inventions and discoveries in science and technology	☐	☐	☐	☐
42.	Phenomena that scientists still cannot explain	☐	☐	☐	☐

F. My science classes

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

(Give your answer with a tick on each line. If you do not understand, leave the line blank.)

		Disagree			*Agree*
1.	School science is a difficult subject	☐	☐	☐	☐
2.	School science is interesting	☐	☐	☐	☐
3.	School science is rather easy for me to learn	☐	☐	☐	☐
4.	School science has opened my eyes to new and exciting jobs	☐	☐	☐	☐
5.	I like school science better than most other subjects	☐	☐	☐	☐
6.	I think everybody should learn science at school	☐	☐	☐	☐
7.	The things that I learn in science at school will be helpful in my everyday life	☐	☐	☐	☐
8.	I think that the science I learn at school will improve my career chances	☐	☐	☐	☐
9.	School science has made me more critical and sceptical.....	☐	☐	☐	☐
10.	School science has increased my curiosity about things we cannot yet explain.....	☐	☐	☐	☐
11.	School science has increased my appreciation of nature.....	☐	☐	☐	☐
12.	School science has shown me the importance of science for our way of living	☐	☐	☐	☐
13.	School science has taught me how to take better care of my health	☐	☐	☐	☐
14.	I would like to become a scientist	☐	☐	☐	☐
15.	I would like to have as much science as possible at school	☐	☐	☐	☐
16.	I would like to get a job in technology.....	☐	☐	☐	☐

G. My opinions about science and technology

To what extent do you agree with the following statements?

(Give your answer with a tick on each row. If you do not understand, leave the line blank.)

		Disagree			*Agree*
1.	Science and technology are important for society	☐	☐	☐	☐
2.	Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.	☐	☐	☐	☐
3.	Thanks to science and technology, there will be greater opportunities for future generations	☐	☐	☐	☐
4.	Science and technology make our lives healthier, easier and more comfortable	☐	☐	☐	☐
5.	New technologies will make work more interesting	☐	☐	☐	☐
6.	The benefits of science are greater than the harmful effects it could have	☐	☐	☐	☐
7.	Science and technology will help to eradicate poverty and famine in the world	☐	☐	☐	☐
8.	Science and technology can solve nearly all problems	☐	☐	☐	☐
9.	Science and technology are helping the poor	☐	☐	☐	☐
10.	Science and technology are the cause of the environmental problems	☐	☐	☐	☐
11.	A country needs science and technology to become developed	☐	☐	☐	☐
12.	Science and technology benefit mainly the developed countries	☐	☐	☐	☐
13.	Scientists follow the scientific method that always leads them to correct answers	☐	☐	☐	☐
14.	We should always trust what scientists have to say	☐	☐	☐	☐
15.	Scientists are neutral and objective	☐	☐	☐	☐
16.	Scientific theories develop and change all the time	☐	☐	☐	☐

H. My out-of-school experiences

How often have you done this outside school?

(Give your answer with a tick on each line. If you do not understand, leave the line blank.)

I have ...

		Never			*Often*
1.	tried to find the star constellations in the sky	☐	☐	☐	☐
2.	read my horoscope (telling future from the stars)	☐	☐	☐	☐
3.	read a map to find my way	☐	☐	☐	☐
4.	used a compass to find direction	☐	☐	☐	☐
5.	collected different stones or shells	☐	☐	☐	☐
6.	watched (not on TV) an animal being born	☐	☐	☐	☐
7.	cared for animals on a farm	☐	☐	☐	☐
8.	visited a zoo	☐	☐	☐	☐
9.	visited a science centre or science museum	☐	☐	☐	☐
10.	milked animals like cows, sheep or goats	☐	☐	☐	☐
11.	made dairy products like yoghurt, butter, cheese or ghee	☐	☐	☐	☐
12.	read about nature or science in books or magazines	☐	☐	☐	☐
13.	watched nature programmes on TV or in a cinema	☐	☐	☐	☐
14.	collected edible berries, fruits, mushrooms or plants	☐	☐	☐	☐
15.	participated in hunting	☐	☐	☐	☐
16.	participated in fishing	☐	☐	☐	☐
17.	planted seeds and watched them grow	☐	☐	☐	☐
18.	made compost of grass, leaves or garbage	☐	☐	☐	☐
19.	made an instrument (like a flute or drum) from natural materials	☐	☐	☐	☐
20.	knitted, weaved, etc	☐	☐	☐	☐
21.	put up a tent or shelter	☐	☐	☐	☐
22.	made a fire from charcoal or wood	☐	☐	☐	☐
23.	prepared food over a campfire, open fire or stove burner.....	☐	☐	☐	☐
24.	sorted garbage for recycling or for appropriate disposal	☐	☐	☐	☐
25.	cleaned and bandaged a wound	☐	☐	☐	☐
26.	seen an X-ray of a part of my body	☐	☐	☐	☐

		Never			*Often*
27.	taken medicines to prevent or cure illness or infection	☐	☐	☐	☐
28.	taken herbal medicines or had alternative treatments (acupuncture, homeopathy, yoga, healing, etc.)	☐	☐	☐	☐
29.	been to a hospital as a patient	☐	☐	☐	☐
30.	used binoculars	☐	☐	☐	☐
31.	used a camera	☐	☐	☐	☐
32.	made a bow and arrow, slingshot, catapult or boomerang	☐	☐	☐	☐
33.	used an air gun or rifle	☐	☐	☐	☐
34.	used a water pump or siphon	☐	☐	☐	☐
35.	made a model such as toy plane or boat etc	☐	☐	☐	☐
36.	used a science kit (like for chemistry, optics or electricity)	☐	☐	☐	☐
37.	used a windmill, watermill, waterwheel, etc	☐	☐	☐	☐
38.	recorded on video, DVD or tape recorder	☐	☐	☐	☐
39.	changed or fixed electric bulbs or fuses	☐	☐	☐	☐
40.	connected an electric lead to a plug etc.	☐	☐	☐	☐
41.	used a stopwatch	☐	☐	☐	☐
42.	measured the temperature with a thermometer	☐	☐	☐	☐
43.	used a measuring ruler, tape or stick	☐	☐	☐	☐
44.	used a mobile phone	☐	☐	☐	☐
45.	sent or received an SMS (text message on mobile phone)	☐	☐	☐	☐
46.	searched the internet for information	☐	☐	☐	☐
47.	played computer games	☐	☐	☐	☐
48.	used a dictionary, encyclopaedia, etc. on a computer	☐	☐	☐	☐
49.	downloaded music from the internet	☐	☐	☐	☐
50.	sent or received e-mail	☐	☐	☐	☐
51.	used a word processor on the computer	☐	☐	☐	☐
52.	opened a device (radio, watch, computer, telephone, etc.) to find out how it works	☐	☐	☐	☐

		Never			*Often*
53.	baked bread, pastry, cake, etc	☐	☐	☐	☐
54.	cooked a meal	☐	☐	☐	☐
55.	walked while balancing an object on my head	☐	☐	☐	☐
56.	used a wheelbarrow	☐	☐	☐	☐
57.	used a crowbar (jemmy)	☐	☐	☐	☐
58.	used a rope and pulley for lifting heavy things	☐	☐	☐	☐
59.	mended a bicycle tube	☐	☐	☐	☐
60.	used tools like a saw, screwdriver or hammer	☐	☐	☐	☐
61.	charged a car battery	☐	☐	☐	☐

I. Myself as a scientist

Assume that you are grown up and work as a scientist. You are free to do research that you find important and interesting. Write some sentences about what you would like to do as a researcher and why.

I would like to . . . . . .

. . . . . .

. . . . . .

Because . . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

J. How many books are there in your home?

There are usually about 40 books per metre of shelving. Do not include magazines.
(Please tick only one box.)

None ..... ☐

1-10 books ..... ☐

11-50 books ..... ☐

51-100 books ..... ☐

101-250 books ..... ☐

251-500 books ..... ☐

More than 500 books ..... ☐

APPENDIX B
DATA COLLECTION : INSTRUCTIONS TO PARTICIPANTS

Slightly revised extract from the *ROSE Handbook*. This part of the handbook gave the ROSE partners guidelines on practicalities connected to organizing and carrying through the survey.

ROSE Guidelines and practicalities

This part of the document describes details for ROSE participants on practical matters as well as 'rights' and 'duties' related to the ROSE study. We need to ensure a minimum quality of the data. If data files are to be part of the international analysis, certain requirements need to be met. (Data not meeting requirement may still be used as 'stand-alone' in your national studies and for (careful) comparisons with the international data.)

Translations of the ROSE questionnaire

The 'original' ROSE questionnaire is in English and is provided to participating researchers as formatted rtf-document and/or as a word-file in **A4 paper size**.

For data collection, use the questionnaire in the language of instruction. When there is a need for translation, **please keep *exactly* to the given format** (layout, page breaks etc), and just replace the original English text with your own.

If the text in your language needs more space than the English original, you may need to adjust the margins to avoid changes in page shifts.

The font in the questionnaire is Arial, and the squares for students' responses are also in Arial. If your word processor does not support this font, you may find that the squares are 'translated' to other symbols. Try to avoid this!

If you need to translate the questionnaire to another language, you may contact the ROSE organizers to avoid duplicate translations to the same language. Please aim at making the *meaning* in your language identical to the English items.

National items and questions

We have tried to make an instrument that can be used in a large variety of cultures. (In fact, to give an account of this variety is a key idea behind the project as such!) It may nevertheless be desirable for some nations to include additional national items or even new questions. The need for local adaptation has been balanced against the need to keep data collection and coding as simple as possible. On the first page of the ROSE questionnaire, you may add some questions (max 4) to allow you to ask for background data like region, school district, school type, etc.

At the end of the instrument you may also add your own national items, for instance to give a more local flavour to some of the questions in the questionnaire (like experiences, interests, future plans, etc.) At the end of the questionnaire you may also add more questions to serve as about background variables (about home and family background, urban vs. rural, etc.)

Target population(s)

In principle, the ROSE target population is the cohort of all 15 year old students in the nation, or more precise: the ***grade level*** where most 15-year old students are likely to go. This is, in many countries, the last year students attend lower secondary school, and it often coincides with the end of compulsory schooling. In many countries, this is the last year before streaming according to educational choices or other forms of selection takes place. (These considerations are not equally valid for all countries and educational systems.)

ROSE tries to shed light on the *range* and the *variety* of students' experiences, interests, perceptions, etc. in issues related to S&T. The vast variation in types of countries and cultures has implications for the definition of the *target population*:

Some countries are rather homogeneous and 'mono-cultural'. Here it makes sense to talk about *national averages*, etc. Other participating countries have large variations due to geography, differences in culture or ethnicity, level of economic development, etc. In such cases it may not make sense to calculate national averages. (In fact, one may loose sight of the educationally interesting variety by calculating national means!) In such countries, one may consider to define the target population as a more homogeneous subgroup, for instance a 'state' or a particular administrative or otherwise clearly identifiable unit. As a consequence, in such countries one may prefer to define more than one target population, or one may define identifiable strata in the national population.

Furthermore, the national researcher's economic and human *resources* differ between the participating countries. Based on the local national circumstances, one may define an *accessible* population that is smaller than the whole national student cohort, for example as a cultural or geographic defined group as indicated above.

Whatever choice one makes, care should be taken to be explicit in the definition of the target population. This is important in order to avoid later confusion or unwarranted conclusions to be drawn. If there are questions about how to define a suitable population please discuss them with the organizers.

Sampling

The sample should be drawn so that it represents the target population as defined above. For practical reasons the sampling unit is likely to be the *school class* (and not the single individual). This implies that whole classes are expected to take part in the study. Using whole classes does, however, reduce the variability, and hence the 'effective sample size'. One should therefore as a rule use only one school class from each school to avoid further reduction of the effective sample size.

The sample should be drawn from the class level with the highest proportion of 15-year old students. Within the defined target population, one should identify the existing schools, preferably from available statistical school administration data. In some countries educational or statistical authorities may assist in providing such lists as well as providing a representative sample. From the list of schools, one should draw *at random* a specified number of schools for participation. If school size varies considerably, one may use proportional sampling in order to get a representative sample. This means that before drawing, the school should be given a weight that is proportional to the number of students at the actual class level.

At each school, only one class should take part. Take care to make a representative selection of *type* of school, if these exist (girls' and boys' schools, boarding schools, etc.) The type of school may be one of your nationally defined background variables as indicated above.

One should aim at a *minimum* of 25 participating schools - preferable more. With 'normal' class sizes of about 25, the 25 schools should give ***a minimum of 625 respondents***. (If you plan for 25 schools, be sure to sample a considerably higher number, since you are not likely to get a 100 % response rate!)

If you want to compare sub-groups within your national population, you should go for larger samples than indicated above to ensure that you contrast groups which are sufficiently large.

Preparations take time!

Please be aware that the preparations for the actual data collection may be time-consuming! Data collection should take at the earliest convenience. The international data analysis will start in the beginning of 2003. We have, however, not yet decided on any definite time limit for data collection. The data analysis for the first international report will start in August 2004. Partners who cannot meet this deadline, are welcome to collect and analyze their own data and to take part in later joint analysis.

In most countries you may need official permission to gain access to the schools and students to collect data. In some places you may even need such permissions on a regional level. And you certainly need to get permission at each school, possibly at the 'top' level, but certainly at the classroom teacher level. Some countries even require permission from the students' parents.

These practical and legal constraints vary from country to country, and the best way forward must be determined by each researcher (or group). Do not underestimate the time that this may require. In this planning process, many 'local' decisions are likely to be taken. Please take care to describe these as clearly as possible when data are submitted.

If a letter of recommendations from the ROSE organizers will help you in getting the necessary permission, we will provide this. It is a good idea to start preparing for data collection at the earliest opportunity.

Administration of questionnaire

The ROSE study is *not* a test, and there are no correct answers that can be used for ranking by some pre-determined measure of quality. Hence, there is no need to be extremely strict in the guidelines for administration and data collection. The important thing is that we get reliable and honest data, and that the students understand the questions. They should also be given enough time to complete the questionnaire. Pilot testing in has indicated that *one normal lesson* (about 40 min) is sufficient time, but this may not be enough when there are problems with the language, etc. *Please ensure that the students get time to answer all questions.* The administrator may even explain questions where they are not fully understood. One may even consider the possibility of completing the questionnaire as homework.

The questionnaire should be presented by the normal class teacher, but the researcher may assist and supervise. After the completion and collection of the questionnaire, the researcher or teacher may fill in the necessary school code or other information on the front page for later identification. At a later stage (during data entry), all questionnaires from each country should be given a unique *identification number* for easy retrieval in case of corrections, etc. The open-ended question will be coded separately, so the identification number is essential for merging the two data files.

Coding of data

Each participating researcher (or group) must follow precisely the common guidelines for data entry. We will use SPSS (Statistical Programme for the Social Sciences) as the instrument for analysis, but Excel may be used for data entry if SPSS is not available. Empty data files in SPSS and Excel format will be provided. The corresponding code book with the necessary information for data entry will also be made available.

The first page in the questionnaire contains a few background data about the respondent. Additional information might be added by the researcher (or the teacher administrating the questionnaire). Each national researcher has to decide what background information one needs The ROSE instrument and data file has, as mentioned, set aside 4 extra variables for this purpose to be included at the first page. These may be the name of school, type of school, region, etc.

The coding will be made as easy as possible. Details will be apparent from the code book and will also appear as 'legal' values in the empty data file that is provided. As a general rule, the actual *position* of the respondents' tick will be the value to be entered (a tick in the first box will be entered as '1', a tick in the second box will be coded as '2', etc. and no response will be coded as '9') Each page shift in the questionnaire will be coded with the letter 'x', This will ensure that a possible mistake (e.g. a shift in position) can be easily detected. Details will be given in the code book.

The open question ("Myself as a scientist") at the end needs interpretation before coding, and details will be provided. These data will for practical reasons be coded separately. It is therefore important that each questionnaire is identified by the running number as indicated above.

Cleaning of data

Since only the coded files (and *not* the questionnaires) are returned to the ROSE organizers, it is essential that the data are properly cleaned to avoid mistakes, since these cannot be traced and corrected by the organizers! In any case, we ask you to keep the original questionnaires to be able to trace possible mistakes at a later stage.

There are many ways of cleaning data to ensure quality. If you use SPSS for data entry, you may for instance run frequency tables for all variables to search for values outside the 'legal'

range. Some details and suggestions for data cleaning and proof-reading will be provided in the code book.

Return of data files

When you return data, please provide as detailed information as possible about the definition of population and the selection of the sample. Describe the underlying considerations, whether these are of a practical nature or based on educational or other concerns. You may send us the data file as an attachment to e-mail, or as a diskette. The format may be either SPSS (preferably) or Excel.

"Rights and duties"

ROSE is intended to be a collaborative work, where all researchers contribute and benefit. Participating researchers may conduct their own research on their national material, given the following guidelines:

- All *national* reporting should pay proper credit to the project with suitable references to the ROSE project and its organizers.
- *International* ROSE reporting by the organizers should also pay credit to the ROSE project and the participating researchers who have contributed to the international data file.
- National reporting should take place *only when* the whole international data collection is finalized. (Exceptions may be given to this, for instance when students collect data as part of their teacher training or for essays or degree work.) Please contact the organizers if you are in doubt.
- When the first international ROSE reports have been published, ROSE participants will have access to ROSE data files, and may use this for their own research in cooperation with other ROSE participants. They can get in touch with them through information on the ROSE web site. (Any reporting must of course give credit to the ROSE project and explain the background)
- Copies of all papers based on the ROSE data should be sent to the organizers when published. The electronic version will be placed on the ROSE site.
- The organizers will send all international ROSE reports and papers to all participants when available.
- A ROSE web site is established at http://www.ils.uio.no/forskning/rose/.
  This site will be continually updated, and contains background information, overviews over participating countries and researchers, articles and publications.

Additional qualitative data?

With a standardized questionnaire one may compare responses from large groups and from widely different cultures. But data collected with questionnaires have obvious limitations. It is not always easy to interpret what students have had in mind when they simply tick boxes in a pre-determined questionnaire. This is the limitation of this type of research. We have left only one question open for free response through writing (Question I: "Myself as a scientist"), and details of coding will be described in later communications.

In order to give more nuance to the 'hard data' from the questionnaire, we suggest that one should accompany the ROSE data collection with interviews with some of the students. This may shed light on how they may think when they answer the questionnaire. This sort of information may be of value when drawing conclusions and interpreting results.

Funding

The basic funding for ROSE is from the Research Council of Norway and The University of Oslo. This, however, only covers a full-time researcher, related costs in Norway and very limited international support..

Participating researchers are requested to seek local funding to support their own participation. Researchers in OECD countries are expected to finance their own participation,

while developing countries and not so wealthy countries may need assistance. Some countries may 'sponsor' the participation of other countries.

The ROSE team will assist in this process of seeking funds, for instance by writing letters of support. One should also mention that when the Research Council of Norway decided to fund the ROSE project, this decision was based on judgements given by international referees. Participation in an international research project may enhance the possibility of securing national funding.

By the end of 2002 we also received additional funding from the Norwegian Ministry of Education to support other countries. Priority will be given to support participation of countries with weak economies. If more resources become available, the intention is also to arrange workshops and/or training seminars. We are rather optimistic about such possibilities.

Involving students?

Many of the researchers involved in ROSE are involved in teacher training and/or degree work in science education at Master or PhD-level. It may be a good idea to use participation in ROSE in connection with such work. Many countries (for instance all the Nordic countries) have already indicated that they will do so, at the PhD as well as the Master level. PhD students from 5 different countries have already decided to base their thesis on ROSE. Students may of course be involved in different aspects of the study, in data collection, or through writing essays or thesis work based on the results.

APPENDIX C CODE BOOK QUESTION A-H

The code book for the closed questions A-H:

ROSE Code Book

This document contains data entry file information for **'ROSE data.sav'** in SPSS format and **'ROSE data.xls'** in Microsoft Excel format. If available, we prefer that you use SPSS, since this will be the program to be used for the data analysis. If you have some experience with SPSS, the empty data file is more or less self-explanatory, but the following information may clarify things a bit further.

The following is a list of the variables in the data entry file, and instructions on how to code each variable. Please rename the data file to a name indicating the name of your country, e.g. 'ROSE Norway.sav'.

In the SPSS file, the variables have *names* with a maximum length of eight characters. Most variable names are composed of the question number (capital letters) and the item number. Each variable has a corresponding *label* with the questionnaire item text. The Excel file is the SPSS file converted to Excel format. The format transformation caused some loss of information, e.g. the labels are not sustained in the Excel file. If you have the SPSS software available, we recommend this programme for data entry. For Excel users, we have included an Appendix in this document with complete list of all variables and the corresponding labels. (Notice that one Excel page does not have enough columns available for the whole ROSE questionnaire, therefore variables for question H and J are on page 2 in the spreadsheet.)

Beneath the heading 'Value' in this document, you find the legal values of the variable.
As a general rule, the position of the respondents' tick in one of the four response categories, is the value to be entered: a tick in the first box shall be coded as '1', a tick in the second box shall be coded as '2', etc.

The Likert scales in the ROSE questionnaire have headings only for the extreme categories, while the two middle categories are untitled. In this document, the middle left and the middle right response categories are labelled 'lo [leftmost]' and 'lo [rightmost]' respectively.

When the respondent has given no response or multiple responses to one item, it counts as *missing*, and shall be coded as '9'. You shall also make use of the **missing code '9'** in cases when it is obvious that the respondent has not answered the question seriously, e.g. when the ticks on one page or in one question are all positioned in the rightmost boxes.

For simplicity, the open question (I. *Myself as a scientist*) is excluded from this data entry file. Coding the variables in the file at hand is a rather straightforward punching job, while coding of the open question request consideration of substance. Consequently, the two coding tasks are separated, and the open question will be coded at a later stage. We are currently working on the categories for the open question responses, and a separate code book will be provided in January 2003 (the unique identification number for each questionnaire is crucial for later merging of the two data files!).

Oslo 16. December 2002

Camilla Schreiner Svein Sjøberg

File information for **'ROSE data.sav'**

Variable name

Q_ID questionnaire identification number
Measurement Level: Ordinal

Value: give each questionnaire a unique identification number and write the number at the first page of the questionnaire and enter it in this variable (for easy retrieval in case of corrections, merging data files, etc.)

SEX girl or boy
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	girl
2	boy

AGE years old
Measurement Level: Scale
Missing Value: 9

Value: the age of the student

COUNTRY survey country, the country in which the survey has taken place
Measurement Level: Nominal

Value: the name of the country

VAR1-VAR4 national, if applicable (like region, stratum, name of school, mother tongue, etc.)

X_NXT_PG page brake, finished items on front cover
X1-X11 page brake, finished items on page [#]

Each page shift in the questionnaire should be coded with the letter 'x', since this will ensure that a possible mistake (e.g. a shift in position) can be easily detected.

Value: x

A01-A48 question A. What I want to learn about
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	not interested
2	lo not interested
3	lo very interested
4	very interested

B01-B26 question B. My future job
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	not important
2	lo not important
3	lo very important
4	very important

C01–C18 question C. What I want to learn about
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	not interested
2	lo not interested
3	lo very interested
4	very interested

D01–D18 question D. Me and the environmental challenges
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	disagree
2	lo disagree
3	lo agree
4	agree

E01–E42 question E. What I want to learn about
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	not interested
2	lo not interested
3	lo very interested
4	very interested

F01–F16 question F. My science classes
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	disagree
2	lo disagree
3	lo agree
4	agree

G01–G16 question G. My opinions about science and technology
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	disagree
2	lo disagree
3	lo agree
4	agree

H01–H61 question H. My out-of-school experiences
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	never
2	lo never
3	lo often
4	often

J question J. How many books are there in your home?
Measurement Level: Ordinal
Missing Value: 9

Value	*Label*
1	none
2	1-10 books
3	11-50 books
4	51-100 books
5	101-250 books
6	251-500 books
7	More than 500 books

Appendix: Complete list of variables and labels

In this variable list, the variables are arranged in the same order as in the data entry file. The list is primarily intended for users of Excel. Please note that the labels are truncated at the end of the line (while they are complete in SPSS file)

Var. no.	*Var. name*	*Label*
1.	Q_ID	questionnaire identification number
2.	SEX	girl or boy
3.	AGE	years old
4.	COUNTRY	survey country
5.	VAR1	national, if applicable
6.	VAR2	national, if applicable
7.	VAR3	national, if applicable
8.	VAR4	national, if applicable
9.	X_NXT_PG	page brake, finished items on front cover
10.	A01	A1. Stars, planets and the universe
11.	A02	A2. Chemicals, their properties and how they react
12.	A03	A3. The inside of the earth
13.	A04	A4. How mountains, rivers and oceans develop and change
14.	A05	A5. Clouds, rain and the weather
15.	A06	A6. The origin and evolution of life on earth
16.	A07	A7. How the human body is built and functions
17.	A08	A8. Heredity, and how genes influence how we develop
18.	A09	A9. Sex and reproduction
19.	A10	A10. Birth control and contraception
20.	A11	A11. How babies grow and mature
21.	A12	A12. Cloning of animals
22.	A13	A13. Animals in other parts of the world
23.	A14	A14. Dinosaurs, how they lived and why they died out
24.	A15	A15. How plants grow and reproduce
25.	A16	A16. How people, animals, plants and the environment depend
26.	A17	A17. Atoms and molecules
27.	A18	A18. How radioactivity affects the human body
28.	A19	A19. Light around us that we cannot see (infrared, ultraviol
29.	A20	A20. How animals use colours to hide, attract or scare
30.	A21	A21. How different musical instruments produce different sou
31.	A22	A22. Black holes, supernovas and other spectacular objects i
32.	A23	A23. How meteors, comets or asteroids may cause disasters on
33.	X1	page brake, finished items on page 1
34.	A24	A24. Earthquakes and volcanoes
35.	A25	A25. Tornados, hurricanes and cyclones
36.	A26	A26. Epidemics and diseases causing large losses of life
37.	A27	A27. Brutal, dangerous and threatening animals
38.	A28	A28. Poisonous plants in my area
39.	A29	A29. Deadly poisons and what they do to the human body
40.	A30	A30. How the atom bomb functions
41.	A31	A31. Explosive chemicals
42.	A32	A32. Biological and chemical weapons and what they do to the
43.	A33	A33. The effect of strong electric shocks and lightning on t
44.	A34	A34. How it feels to be weightless in space
45.	A35	A35. How to find my way and navigate by the stars

46.	A36	A36. How the eye can see light and colours
47.	A37	A37. What to eat to keep healthy and fit
48.	A38	A38. Eating disorders like anorexia or bulimia
49.	A39	A39. The ability of lotions and creams to keep the skin youn
50.	A40	A40. How to exercise to keep the body fit and strong
51.	A41	A41. Plastic surgery and cosmetic surgery
52.	A42	A42. How radiation from solariums and the sun might affect t
53.	A43	A43. How the ear can hear different sounds
54.	A44	A44. Rockets, satellites and space travel
55.	A45	A45. The use of satellites for communication and other purpo
56.	A46	A46. How X-rays, ultrasound, etc. are used in medicine
57.	A47	A47. How petrol and diesel engines work
58.	A48	A48. How a nuclear power plant functions
59.	X2	page brake, finished items on page 2
60.	B01	B1. Working with people rather than things
61.	B02	B2. Helping other people
62.	B03	B3. Working with animals
63.	B04	B4. Working in the area of environmental protection
64.	B05	B5. Working with something easy and simple
65.	B06	B6. Building or repairing objects using my hands
66.	B07	B7. Working with machines or tools
67.	B08	B8. Working artistically and creatively in art
68.	B09	B9. Using my talents and abilities
69.	B10	B10. Making, designing or inventing something
70.	B11	B11. Coming up with new ideas
71.	B12	B12. Having lots of time for my friends
72.	B13	B13. Making my own decisions
73.	B14	B14. Working independently of other people
74.	B15	B15. Working with something I find important and meaningful
75.	B16	B16. Working with something that fits my attitudes and value
76.	B17	B17. Having lots of time for my family
77.	B18	B18. Working with something that involves a lot of travellin
78.	B19	B19. Working at a place where something new and exciting hap
79.	B20	B20. Earning lots of money
80.	B21	B21. Controlling other people
81.	B22	B22. Becoming famous
82.	B23	B23. Having lots of time for my interests, hobbies and activ
83.	B24	B24. Becoming 'the boss' at my job
84.	B25	B25. Developing or improving my knowledge and abilities
85.	B26	B26. Working as part of a team with many people around me
86.	X3	page brake, finished items on page 3
87.	C01	C1. How crude oil is converted to other materials, like plas
88.	C02	C2. Optical instruments and how they work (telescope, camera
89.	C03	C3. The use of lasers for technical purposes (CD-players, ba
90.	C04	C4. How cassette tapes, CDs and DVDs store and play sound an
91.	C05	C5. How things like radios and televisions work
92.	C06	C6. How mobile phones can send and receive messages
93.	C07	C7. How computers work
94.	C08	C8. The possibility of life outside earth
95.	C09	C9. Astrology and horoscopes, and whether the planets can in
96.	C10	C10. Unsolved mysteries in outer space
97.	C11	C11. Life and death and the human soul
98.	C12	C12. Alternative therapies (acupuncture, homeopathy, yoga, h
99.	C13	C13. Why we dream while we are sleeping, and what the dreams
100.	C14	C14. Ghosts and witches, and whether they may exist
101.	C15	C15. Thought transference, mind-reading, sixth sense, intuit
102.	C16	C16. Why the stars twinkle and the sky is blue
103.	C17	C17. Why we can see the rainbow
104.	C18	C18. Properties of gems and crystals and how these are used
105.	X4	page brake, finished items on page 4
106.	D01	D1. Threats to the environment are not my business
107.	D02	D2. Environmental problems make the future of the world look
108.	D03	D3. Environmental problems are exaggerated
109.	D04	D4. Science and technology can solve all environmental probl

110.	D05	D5. I am willing to have environmental problems solved even
111.	D06	D6. I can personally influence what happens with the environ
112.	D07	D7. We can still find solutions to our environmental problem
113.	D08	D8. People worry too much about environmental problems
114.	D09	D9. Environmental problems can be solved without big changes
115.	D10	D10. People should care more about protection of the environ
116.	D11	D11. It is the responsibility of the rich countries to solve
117.	D12	D12. I think each of us can make a significant contribution
118.	D13	D13. Environmental problems should be left to the experts
119.	D14	D14. I am optimistic about the future
120.	D15	D15. Animals should have the same right to life as people
121.	D16	D16. It is right to use animals in medical experiments if th
122.	D17	D17. Nearly all human activity is damaging for the environme
123.	D18	D18. The natural world is sacred and should be left in peace
124.	X5	page brake, finished items on page 5
125.	E01	E1. Symmetries and patterns in leaves and flowers
126.	E02	E2. How the sunset colours the sky
127.	E03	E3. The ozone layer and how it may be affected by humans
128.	E04	E4. The greenhouse effect and how it may be changed by human
129.	E05	E5. What can be done to ensure clean air and safe drinking w
130.	E06	E6. How technology helps us to handle waste, garbage and sew
131.	E07	E7. How to control epidemics and diseases
132.	E08	E8. Cancer, what we know and how we can treat it
133.	E09	E9. Sexually transmitted diseases and how to be protected ag
134.	E10	E10. How to perform first-aid and use basic medical equipmen
135.	E11	E11. What we know about HIV/AIDS and how to control it
136.	E12	E12. How alcohol and tobacco might affect the body
137.	E13	E13. How different narcotics might affect the body
138.	E14	E14. The possible radiation dangers of mobile phones and com
139.	E15	E15. How loud sound and noise may damage my hearing
140.	E16	E16. How to protect endangered species of animals
141.	E17	E17. How to improve the harvest in gardens and farms
142.	E18	E18. Medicinal use of plants
143.	E19	E19. Organic and ecological farming without use of pesticide
144.	E20	E20. How energy can be saved or used in a more effective way
145.	E21	E21. New sources of energy from the sun, wind, tides, waves,
146.	E22	E22. How different sorts of food are produced, conserved and
147.	E23	E23. How my body grows and matures
148.	X6	page brake, finished items on page 6
149.	E24	E24. Animals in my area
150.	E25	E25. Plants in my area
151.	E26	E26. Detergents, soaps and how they work
152.	E27	E27. Electricity, how it is produced and used in the home
153.	E28	E28. How to use and repair everyday electrical and mechanica
154.	E29	E29. The first landing on the moon and the history of space
155.	E30	E30. How electricity has affected the development of our soc
156.	E31	E31. Biological and human aspects of abortion
157.	E32	E32. How gene technology can prevent diseases
158.	E33	E33. Benefits and possible hazards of modern methods of farm
159.	E34	E34. Why religion and science sometimes are in conflict
160.	E35	E35. Risks and benefits of food additives
161.	E36	E36. Why scientists sometimes disagree
162.	E37	E37. Famous scientists and their lives
163.	E38	E38. Big blunders and mistakes in research and inventions
164.	E39	E39. How scientific ideas sometimes challenge religion, auth
165.	E40	E40. Inventions and discoveries that have changed the world
166.	E41	E41. Very recent inventions and discoveries in science and t
167.	E42	E42. Phenomena that scientists still cannot explain
168.	X7	page brake, finished items on page 7
169.	F01	F1. School science is a difficult subject
170.	F02	F2. School science is interesting
171.	F03	F3. School science is rather easy for me to learn
172.	F04	F4. School science has opened my eyes to new and exciting jo
173.	F05	F5. I like school science better than most other subjects

174.	F06	F6. I think everybody should learn science at school
175.	F07	F7. The things that I learn in science at school will be hel
176.	F08	F8. I think that the science I learn at school will improve
177.	F09	F9. School science has made me more critical and sceptical
178.	F10	F10. School science has increased my curiosity about things
179.	F11	F11. School science has increased my appreciation of nature
180.	F12	F12. School science has shown me the importance of science f
181.	F13	F13. School science has taught me how to take better care of
182.	F14	F14. I would like to become a scientist
183.	F15	F15. I would like to have as much science as possible at sch
184.	F16	F16. I would like to get a job in technology
185.	X8	page brake, finished items on page 8
186.	G01	G1. Science and technology are important for society
187.	G02	G2. Science and technology will find cures to diseases such
188.	G03	G3. Thanks to science and technology, there will be greater
189.	G04	G4. Science and technology make our lives healthier, easier
190.	G05	G5. New technologies will make work more interesting
191.	G06	G6. The benefits of science are greater than the harmful eff
192.	G07	G7. Science and technology will help to eradicate poverty an
193.	G08	G8. Science and technology can solve nearly all problems
194.	G09	G9. Science and technology are helping the poor
195.	G10	G10. Science and technology are the cause of the environment
196.	G11	G11. A country needs science and technology to become develo
197.	G12	G12. Science and technology benefit mainly the developed cou
198.	G13	G13. Scientists follow the scientific method that always lea
199.	G14	G14. We should always trust what scientists have to say
200.	G15	G15. Scientists are neutral and objective
201.	G16	G16. Scientific theories develop and change all the time
202.	X9	page brake, finished items on page 9
203.	H01	H1. tried to find the star constellations in the sky
204.	H02	H2. read my horoscope (telling future from the stars)
205.	H03	H3. read a map to find my way
206.	H04	H4. used a compass to find direction
207.	H05	H5. collected different stones or shells
208.	H06	H6. watched (not on TV) an animal being born
209.	H07	H7. cared for animals on a farm
210.	H08	H8. visited a zoo
211.	H09	H9. visited a science centre or science museum
212.	H10	H10. milked animals like cows, sheep or goats
213.	H11	H11. made dairy products like yoghurt, butter, cheese or ghe
214.	H12	H12. read about nature or science in books or magazines
215.	H13	H13. watched nature programmes on TV or in a cinema
216.	H14	H14. collected edible berries, fruits, mushrooms or plants
217.	H15	H15. participated in hunting
218.	H16	H16. participated in fishing
219.	H17	H17. planted seeds and watched them grow
220.	H18	H18. made compost of grass, leaves or garbage
221.	H19	H19. made an instrument (like a flute or drum) from natural
222.	H20	H20. knitted, weaved, etc
223.	H21	H21. put up a tent or shelter
224.	H22	H22. made a fire from charcoal or wood
225.	H23	H23. prepared food over a campfire, open fire or stove burne
226.	H24	H24. sorted garbage for recycling or for appropriate disposa
227.	H25	H25. cleaned and bandaged a wound
228.	H26	H26. seen an X-ray of a part of my body
229.	X10	page brake, finished items on page 10
230.	H27	H27. taken medicines to prevent or cure illness or infection
231.	H28	H28. taken herbal medicines or had alternative treatments (a
232.	H29	H29. been to a hospital as a patient
233.	H30	H30. used binoculars
234.	H31	H31. used a camera
235.	H32	H32. made a bow and arrow, slingshot, catapult or boomerang
236.	H33	H33. used an air gun or rifle
237.	H34	H34. used a water pump or siphon

238.	H35	H35. made a model such as toy plane or boat etc
239.	H36	H36. used a science kit (like for chemistry, optics or elect
240.	H37	H37. used a windmill, watermill, waterwheel, etc
241.	H38	H38. recorded on video, DVD or tape recorder
242.	H39	H39. changed or fixed electric bulbs or fuses
243.	H40	H40. connected an electric lead to a plug, etc.
244.	H41	H41. used a stopwatch
245.	H42	H42. measured the temperature with a thermometer
246.	H43	H43. used a measuring ruler, tape or stick
247.	H44	H44. used a mobile phone
248.	H45	H45. sent or received an SMS (text message on mobile phone)
249.	H46	H46. searched the internet for information
250.	H47	H47. played computer games
251.	H48	H48. used a dictionary, encyclopaedia, etc. on a computer
252.	H49	H49. downloaded music from the internet
253.	H50	H50. sent or received e-mail
254.	H51	H51. used a word processor on the computer
255.	H52	H52. opened a device (radio, watch, computer, telephone, etc
256.	X11	page brake, finished items on page 11
257.	H53	H53. baked bread, pastry, cake, etc
258.	H54	H54. cooked a meal
259.	H55	H55. walked while balancing an object on my head
260.	H56	H56. used a wheelbarrow
261.	H57	H57. used a crowbar (jemmy)
261.	H58	H58. used a rope and pulley for lifting heavy things
263.	H59	H59. mended a bicycle tube
264.	H60	H60. used tools like a saw, screwdriver or hammer
265.	H61	H61. charged a car battery
266.	J	J. How many books are there in your home?

APPENDIX D CODE BOOK QUESTION I

The code book for the open-ended question:

I: Myself as a scientist

Use a separate SPSS file for this item..
The question identification nb (Q_ID) will be used for merging this file with the other SPSS file after coding.
The file you need for data entry in SPSS is called **"ROSE item I.sav"**

Q_ID Questionnaire identification number

I_WORDS I. number of words written
(Simple count of total number of words in the response.
Code 0 words if no response or if the response to the item is not serious, and skip the rest)

For all following variables: code 1 if applicable, otherwise leave blank.
Note that several responses are possible, since each student may give mixed responses. The responses are on two dimensions:

1. **What** (I1… description of *topics* mentioned – one or more)
2. **Why** (I2… description of *reasons* given for the choice)

Name	Label	
I1B_BODY	I.what	Biology: human, body
I1B_MED	I.what	Biology: deceases, medicine, cure
I1B_MICR	I.what	Biology: microbiology, gene technology
I1B_NATU	I.what	Biology: animals, plants, nature
I1B_OTHR	I.what	Biology: other
I1T_ICT	I.what	Technology: computers, electronic, new tech, etc.
I1T_CAR	I.what	Technology: motors, buildings, roads, car, transport, etc
I1T_WEAP	I.what	Technology: weapon
I1T_OTHR	I.what	Technology: other or in general
I1G_ENVR	I.what	Environment
I1G_GEO	I.what	Earth, weather, climate
I1G_CHEM	I.what	Chemistry; atoms, reactions, etc.
I1G_PHYS	I.what	Physics; electricity, heat, etc.
I1G_SPCE	I.what	Space; stars and planets, black holes, space travel, etc.
I1O_PSYC	I.what	Psychology, human behaviour
I1O_INVN	I.what	Invent things
I1O_EXPR	I.what	Do experiments, work on laboratory
I1O_WNDR	I.what	Paranormal, philosophical, mysterious, wonder, etc.
I1O_SOC	I.what	Social and economic sciences
I1O_NO	I.what	Do not want to do research
I1O_OTHR	I.what	Other
I2_SELF	I.why	Curiosity, interests, seems fun, want to, exciting
I2_PROF	I.why	Related to the profession I want
I2_IMPRT	I.why	Important in general or for society/humanity
I2_HELP	I.why	Help (people, animals, etc.)
I2_RICH	I.why	Get rich, popular, famous
I2_OTHR	I.why	Other
comments	If you need to comment on the response, use this string variable	

APPENDIX E DATA COLLECTION REPORT

A data collection report with Norway as an example:

Report on organizing the ROSE survey in Norway

Camilla Schreiner, University of Oslo, February 2004

ROSE team

The Norwegian ROSE team constitutes Professor Svein Sjøberg, master student Kristjan Ketill Stefansson and Ph.D. student Camilla Schreiner. We are all located at University of Oslo, Department of Teacher Education and School Development.

School system and science teaching

The Norwegian school system has ten years of compulsory education. Children start at school at the age of 6, and are 15 when they leave. Compulsory school is divided into two steps: primary school with grade 1 to 7 and upper secondary school with grade 8 to 10. Through all grades in the 10-year compulsory school there is one common subject for the natural sciences called "Science and the environment".

Norway is sparsely populated and many of the primary and lower secondary schools are very small. For example, we have that one quarter of all lower secondary schools in Norway has twelve or less students at grade 10.

In Norway there is no streaming or grouping of students according to ability or gender, etc., but we have a few private schools basing their teaching on particular religions, philosophies or alternative educational approach. 96-98 percent (varies with grade) of all children in Norway attend the state schools.

There are a few special schools for deaf children and children with very weak abilities, but most students with special learning needs are integrated in ordinary public school. The only significant minority group in Norway is the several thousand indigenous Saami inhabiting the northern part of the country. They go to Saami schools with Saami curricula.

Translation

Although the ROSE questionnaire was developed in Norway, the master version was in English. Svein and I were both involved in the translation into Norwegian.

In October 2002 the English version of the questionnaire was regarded as finalized, and I developed the first Norwegian draft. This was proofread and commented by Svein, and after a couple of meetings we agreed on the final Norwegian version.

In the Norwegian as well as in the English edition, we have been aiming at keeping the expressions and the wording simple and clear. During the Norwegian translation of the questionnaire, we met a few items in the English version in which the wording could be

further simplified. In this way the process of developing the Norwegian version of the questionnaire functioned as a last check through the English version as well.

National questions

We did not add any items for background variables, but in the end of the questionnaire, we added two national questions:

> **K.** What profession would you like to have when you are grown up? .....
> (open ended)
>
> **L.** Below is a list of possible goals people may find important. In what degree do you find these goals important for our society?
> (response in a Likert scale with ten categories from "not important" to "very important")
>
> 1. Achieve high economic growth
> 2. Protect untouched Norwegian nature
> 3. More emphasis on medical research (e.g. on cancer and HIV/AIDS)
> 4. Protect the environment against pollution
> 5. Give the elderly safe and decent conditions
> 6. Preserve law and order
> 7. Enhanced emphasis on research on new technology
> 8. Bring in prohibition of smoking
> 9. Provide protection of our big predators
> 10. Prepare Norway for welcoming more refugees and immigrants
> 11. Eradicate all forms of poverty and distress in Norway
> 12. Lower taxes and duties
> 13. Use gender quotas to have more women in senior appointments
> 14. Enhanced emphasis on education and better schools
> 15. Give economic support to poor countries
> 16. Provide a society free from drugs

Piloting

When we had available a Norwegian translation of the final version, it was tested by interviewing two students after they had filled in the questionnaire. In the beginning of November 2002 we brought the questionnaire development to a close both for the English and for the Norwegian version.

Official permission

In October 2002 we wrote an e-mail to The Norwegian Social Science Data Services with descriptions of the ROSE project and the questionnaire. We requested an account of what formalities and official procedures that had to be followed in connection with surveys of this kind. The response was that since the only background variables were sex, age and name of the school, no official permission or registration was required.

Population

The ROSE target population in Norway was the cohort of 15 year old Norwegian students living in our country in 2002. As ROSE samples school classes and not individual students, the target population was more precisely defined as the students at the grade level where

most 15-year old students were likely to go. This means the grade level with most students born in 1987, which corresponds to grade 10 in lower secondary school. 96 percent of the students born in 1987 were attending grade 10 in 2002.

Sample and participation

The Norwegian Ministry of Education and Research has the review of all schools and school statistics in our country. We got the database from which we drew the sample from the Norwegian TIMSS/PISA group. As they were about to draw the sample for PISA 2003, they had recently received the database from The Norwegian Ministry of Education and Research.

The database contained totally 1.125 schools and 55.163 students at grade 10. Saami and special schools were not in the database. The smallest schools had only one student at grade 10, while the largest school had 182.

We developed a small routine in Excel which drew 70 schools randomly. All the students in the database were assigned a unique number, and the Excel program picked randomly one student from the database. Once the student was drawn, the school to which this student belonged was transferred to the sample. Such sampling routine implicates that the probability of one school to be drawn was identical to the number of students attending grade 10 at the school, and that the chance to be sampled was higher for students going to large schools.

In the end of October 2002, we sent letters to the 70 sampled schools and invited them to participate in the ROSE survey. We received 58 affirmative and 12 negative answers. This gave us participation on school level of 83 percent, which we regard as an overall positive attitude towards participating in the survey. As we do not know the exact number of students in each school class, we cannot report the participation percentage on the level of the students.

As large cohorts are often divided into smaller groups of students in parallel classes, and as we wished to sample no more than one class from each school, we requested the schools to indicate how many parallel classes their school had at grade 10. Again we made use of an Excel routine for drawing one class randomly from the total number of parallel classes. One school reported that for practical purposes they conducted the survey in an other parallel class than the one suggested in our instructions. But besides this single feedback, we do not know whether the schools carried out the survey in the class we proposed.

Except from the Saami minority, the Norwegian population is ethnically homogeneous.

In 2002 the immigrants constituted 7.3 percent of the Norwegian population. European immigrants make up 45 percent of the total immigrant population, Asian immigrants for 38 percent and Africans 10 percent. Some 90 per cent live in urban settlements, so in most areas of the country immigrants represent only an insignificant part of the sample.

There may be some weakness in our sample due to issues described above, like missing respondents and immigrants, but our overall impression is that the quality of the sample is

high. We believe that we can regard the sample being representative for the Norwegian target population.

Carrying out in schools

At each school, the headship came up with one person that could organize the project locally. Through these coordinators we could distribute one class set of printed questionnaires to each class. Successively as we received affirmative answers to our invitation, the class sets of questionnaires were sent to the coordinators at the schools.

In the sending with the bunch of questionnaires we attached a letter with various instructions and descriptions of practicalities for conducting the survey, like: which of the parallel classes that should participate, the survey should preferably be conducted before Christmas, ca. 40 minutes would be sufficient for most students, students needing more time could complete the questionnaire in their homework, the school could preferably carry out the survey in a science lesson, the questionnaires should be kept unnamed and anonymous, etc.

We also attached a letter addressed to the parents with a piece of general information about the ROSE project, and for letting them know that the survey was based on volunteer participation. If desirable, the coordinators could duplicate and distribute this letter to the parents. The sending also contained a stamped and addressed envelope for returning the questionnaires to the University of Oslo.

During November and December 2002 all schools but five had conducted the survey and returned the filled-in questionnaires, and within the end of January 2003 we had received the five remaining envelopes.

Feedback and experiences

To each participating school we sent a written acknowledgement for recognition of their work and their help. In this letter/e-mail we also took the opportunity to ask about their experiences with carrying out the survey in the classes, what kind of practical obstacles they met, the spontaneous reactions from the students, etc.

We received totally eight responses to this request, and all were predominantly positive...

"the questions seemed clear and good"
"a straightforward survey, but with numerous items"
"no questions had to be clarified on the way"
"appropriate time"
"the students found the questions interesting"
"they worked concentrated through the questionnaire"
"they were proud to join it - especially as this was something youth from the whole world took part in"
"they needed 20 to 40 minutes for answering"
"I received no questions on the way"
"it was obviously easy to understand"
"some of the students with weak reading ability found that it was much to read, but they brought the questionnaire home and delivered it the day after"

"I noticed that some of the answers were rather flippant, but not all of the students are that mature"
"most of the students felt rather important, which was good"
"my impression is that they found the form exciting. One can see such things from the intensity they put in their work with the filling-in"
"I think they regarded this as one of the more interesting surveys"
"my impression ... is that this is an interesting angle for developing the subject. In my opinion much more sensible than many other comparative studies"
"KEEP ON! WE ARE WITH YOU - 10B ARE WISE YOUNG PEOPLE WITH A BRIGHT VIEW OF THE FUTURE"

Coding (also of the open-ended I question)

All the Norwegian responses were coded by Svein's children Liv (18) and Are (16). They coded directly into SPSS according to the guidelines in the "ROSE Handbook", and in general they found the job uncomplicated and straightforward.

In some questionnaires the respondents had obviously not taken the task seriously, e.g. by making symmetric patterns in the response categories. Such questionnaires were excluded. In instances where Liv and Are where unsure about how to handle the responses, they made notes in the SPSS file.

Towards the end of February 2003 the coding was completed, and I reviewed and considered the notes from Liv and Are. There were for example instances where the respondent took the task seriously through the first few pages, but seemed to have flipped out during the last part of the questionnaire. There were other instances where entire pages were empty, like if the respondent had overlooked them. In cases where only minor parts of the questionnaire were not satisfactorily filled in, the variables were coded with 9 (missing). Otherwise the whole questionnaire was excluded from the SPSS file.

I also proofread the coded file by searching for misprints like empty cells, cells coded with two digits, and cells coded with letters different from the allowed letters for the question. Such coding errors were corrected by looking up the question in the corresponding questionnaire.

We consider it as likely that there still are some flippant responses and coding errors in the data file, but our overall impression is that the quality of the data file is rather high.

In the end of February 2003 the Norwegian SPSS file was finalized - with 1204 respondents evenly distributed on

601	girls
602	boys
1	respondent with missing response for sex

37	14-year-olds (3.1 %)
1144	15-year olds (95 %)
23	16-year-olds (1.9 %)

APPENDIX F ROSE PARTICIPANTS

As by September 2004

This list contains only the names and e-mail addresses of the contact person(s) in each country. Further details and updates are found on the ROSE web page. The countries are in alphabetical order. Countries where data collection is completed are marked with **boldface.** The other countries will finalize data collection in short time, although a few are uncertain.

1. Australia: Debbie Corrigan <Debbie.Corrigan@Education.monash.edu.au>
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4. Brazil: Luiz Caldeira <lcaldeira@hotmail.com>
5. Brunei Darussalam: Dk Hjh Siti Fatimah <p25713@brunet.bn>
6. Czech Republic: Martin Bilek <martin.bilek@uhk.cz>
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11. **Egypt**: Rashed Mohammed <rashed_17@hotmail.com>
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20. **Ireland:** Philip Matthews <pmtthews@eircom.net>
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23. **Lesotho:** Neo P. Liphoto <np.liphoto@nul.ls>
24. Malaysia: Suan Yoong <cygnet@tm.net.my>
25. Malawi: Andrew Nchesi <anches@hotmail.com>
26. **Norway:** Camilla Schreiner <camilla.schreiner@ils.uio.no> and Svein Sjoberg <svein.sjoberg@ils.uio.no>
27. **Northern Ireland:** Colette Murphy: <c.a.murphy@Queens-Belfast.AC.UK>
28. **Philippines:** vivien talisayon <vtalisayon@yahoo.com> and Celia Balbin <celia.balbin@up.edu.ph>
29. **Poland:** R. M. Janiuk <rmjaniuk@hermes.umcs.lublin.pl>
30. **Portugal:** Jose Azevedo <azevedo@letras.up.pt**>**
31. **Russia:** Sergey Bogdanov <sbogdanov@onego.ru> and Irina Tevel <tevel@sampo.ru>

32. Slovakia: Sona Bendikova <bendikova@server.infovek.sk>
33. **South Africa (Western Cape):** Keith Langenhoven <klangenhoven@uwc.ac.za>
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