# EXPLORING A ROSE-GARDEN

## Norwegian youth's orientations towards science – seen as signs of late modern identities

Based on ROSE (The Relevance of Science Education),
a comparative study of 15 year old students' perceptions
of science and science education

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# FOREWORD

The moving song *Sommerfuglvinger* (*Butterfly wings*), written by the Norwegian singer Anne Grete Preus (1998), is about the butterfly-effect (Lorenz, 1963): Science and technology have enabled us to predict the future. But even when the forecast says storm and heavy showers, the day may turn into a calm and sunny one – thanks to the flaps of a butterfly's wings. When *the river flows too fast and makes too many sudden turns*, Preus wishes she had been born with butterfly wings. I will argue that we all have butterfly wings.

From the moment I came to the ROSE project, I have found it exciting and engaging – but for quite a while, I searched for a way to angle *my* research in the spacious ROSE material. Being a meteorologist, I found little help in the (to me more familiar) theories on tropospheric ozone production... In pursuit of a research focus, I knocked on people's door: Thank you, Berit Bungum, Gudrun Eckblad, Astrid Eggen, Ivar Frønes, Knut Hagtvet, Doris Jorde, Berit Karseth, Thor Arnfinn Kleven, Svein Lie, Prem Naidoo, Sverre Pettersen, Trond Solhaug and Marianne Ødegaard, for greeting me and for influential input. I am grateful to you, Edgar Jenkins, for following me up and for the many kind invitations to Leeds. (Be aware – *next* time I will accept!) And thank you, Rolf Olsen and Are Turmo, for being my ever-open information banks on methodological issues. Magne Vestøl – thank you for all our talks. The thesis would not have been the same but for you. Ellen Henriksen, Sonja Mork and Astrid Sinnes – thank you for all encouragement and for being my lovely and inspiring colleague friends. And thanks to all sweet colleagues inside and outside my corridor for support, good chats and for being around, and to the staff at the Department of Teacher Education and School Development and the Norwegian Centre for Science Education for flexibility and for providing good working conditions. Thanks also to the Research Council of Norway for funding.

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Oslo, November 2005, Camilla Schreiner

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# ABSTRACT

The thesis is based on the view that science teaching must build on an understanding of the students' culture, priorities and concerns.

The empirical material is collected through the ROSE project. ROSE (The Relevance of Science Education) is a comparative project meant to shed light on affective factors of importance to the learning of science and technology. The target population is students towards the end of lower secondary school (age 15). The research instrument was developed in cooperation with an international group of science educators. The resulting questionnaire consisted mostly of closed questions addressing the students' interests, attitudes, plans, views on the environmental challenges, etc. This thesis uses data from more than 26 000 students in 25 countries in Europe, Africa, Asia and South America.

The research aims were to develop a student typology based on the Norwegian data, to characterise the student types' orientations towards science, and to study Norwegian youth's interests against a background of students from less modernised countries. The results can be summarised under three main conclusions:

- Norwegian students can be divided into five student types with distinct orientations towards science.
- Students' interests in science are sex-specific.
- There are some characteristic cross-national patterns in youth's interests that follow a modern–traditional divide.

The results are discussed in the light of sociological theories on youth in late modern societies, especially by drawing on perspectives on the late modern project of identity construction. The students' responses in the questionnaire are interpreted as identity expressions, and the typology is seen as signs of five different social identities.

The study has an explorative and data-driven approach. The next step of the analysis has been successively adjusted according to the previous step and results. The following is a brief account for the way through the data material and a summary of the results.

**Exploring the data material**

The students were not divided into categories of sex or any other background variable. This choice was based on the belief that there might be other and more appropriate ways of categorising students for describing their orientations towards science. One question in the questionnaire, *What I want to learn about*, is an inventory of more than a hundred possible topics to learn about. By k-means cluster analysis, the Norwegian respondents were divided into clusters based solely on their interests in these topics, irrespective of sex, school, home background, etc. After some trials, it was decided on *five* clusters. This number was not "given" from the data. One could have decided on fewer and one could have decided on more, but the five clusters seemed distinctive and interesting. Each cluster was seen as representing one *student type*. The student types have been described by their scores in different parts of the questionnaire.

Two clusters turned out to be sex-specific – one girls' and one boys' cluster. The most salient features of their orientations towards science were their selective interest and their conscious preferences and attitudes. These student types were labelled the *Selective Girl* and the *Selective Boy*. The three other clusters were mixed, and the main characteristic of these student types was the unselective general level of interest and concern: Almost regardless of topic, they showed low, medium and high interest, and almost regardless of issue, they showed reluctant, undecided and enthusiastic attitudes. The student types were labelled the *Unselective Reluctant*, the *Unselective Undecided* and the *Unselective Enthusiast.*

The interest profiles of the three Unselective student types were standardised by removing the differences in general interest levels. Next, the three clusters were merged and divided into new clusters by k-means cluster analysis (with the same interest variables as in the first analysis). Again, by constructing two clusters, the result was two more or less sex-specific clusters: the Unselective Girl and the Unselective Boy. Although the Unselective Girl and the Unselective Boy fluctuated with much smaller span between the extreme values than the two Selective student types did, the interest profiles of the two sex-specific Unselective clusters turned out to be remarkably similar to the corresponding profiles of the Selective Girl and the Selective Boy.

This means that although the five *student types* would not have appeared if the students from the outset were categorised according to their sex, sex appeared as an important factor for understanding the students' typical *interests*.

**The five Norwegian student types**

The individuals in one cluster are diverse. Characterisations of *student types*, represented by mean scores of all students in one cluster, will inevitably do injustice to the individuals. The focus of the study is on the *typical,* rather than on the particular. Thus, this injustice is a compromise that the study makes. The student type characteristics can broadly be summarised as follows:

*The Unselective Enthusiast:*

- S/he is a school-committed student type: Has an unchanging positive, progressive and willing attitude towards all matters raised in the questionnaire. Responds with eagerness and interest almost regardless of subject matter.
- Represents the socially accepted and politically correct attitudes, and wants to make a good impression on the science teacher and others.
- Sees the benefits of science in society, is personally engaged in the environmental issue and ranks environmental protection before her/his personal economy.
- School science is interesting, useful and not too difficult; but the science classes are not more interesting than most other school subjects.
- Plans to take an advanced education. Wants to work with and help other people, and is less concerned about power, glory and money than the other student types are.

*The Unselective Reluctant:*

- S/he is a school-rejective student type: Aloof and unwilling.
- "Superb" does not exist in her/his vocabulary, at least not when the questionnaire is answered in the school science context. Expresses little interest regardless of topic.
- Has negative attitudes towards school science in particular and possibly also towards school in general. Strongly disagrees that science is better than other school subjects.
- Does not see much benefit of science in society, shows little engagement for environmental protection.
- Wishes, like all students, to realise her/himself in a future job, but most of all s/he wants to earn lots of money. Maybe work with something involving the use of hands and tools. Will not be a scientist or work with technology. Does not plan for a profession that requires an advanced education.

*The Unselective Undecided:*

- S/he is undecided, indifferent and avoids taking clear stances. Invisible, appears with an unclear contour.
- Not enthusiastic, not reluctant – but in-between.
- Not interested and not disinterested – but in-between.
- Science classes are not useful, not easy, not useless, not difficult – but in-between.
- Perhaps, s/he is not school-committed, not school-rejective – but in-between.

*The Selective Girl:*

- She is modern, reasonable, outspoken and self-expressive. Critical and with conscious preferences and attitudes. Expresses herself through strong commitments and rejections.
- Has typical girls' interests (see below) and rejects the masculine topics.
- Knows who she is and wants to be, and who she is *not* and does *not* want to be. Has an identity connected to the late modern female expressions, and emphasise this also by refusing the masculine symbols.
- School science is somewhat difficult, and not very interesting; she prefers other subjects much more.
- In her future job, she wants to realise herself through working with people. The chance that she will become a scientist or an engineer is negligible.

*The Selective Boy:*

- He is a male version of the Selective Girl: Self-expressive, with critical and conscious attitudes and with intense, precise and discriminating preferences.
- High interest in masculine topics and rejects feminine topics (see below).

- School science is not very difficult, rather it is interesting – but not his favourite when compared to other subjects.
- Wishes to fulfil himself through his work. Would like to work with his hands and with tools, and with technology. Working with people is not important for him.

The Selective Girl cluster was divided into two sub-clusters representing different student types. These serve as examples of how one cluster contains a range of different kinds of student types and identities, and how femininity has a variety of expressions. Also the other clusters could have been divided into sub-clusters; and with a large enough sample, one could continue and continue to divide clusters into sub-clusters, and presumably continue and continue to find different and interesting student profiles.

**Norwegian girls' and boys' interests**

Even with the explorative approach to the data, sex emerged as an important factor for understanding youth's interests in science. Girls' and boys' interests can broadly be summarised as follows:

Many of the subjects that are of greatest interest to students of one sex are of least interest to those of the other sex. There are, however, also some meeting points:

- Both girls and boys are interested in learning about enigmas and phenomena science still cannot explain, such as dinosaurs, the origin of life and mysteries in outer space. They are also interested in earthquakes, volcanoes, tornados and hurricanes.
- Neither girls nor boys are much interested in: The weather, the sunset, how mountains and rivers develop and change; botany and farming; environmental protection; the work and life of scientists and how scientific knowledge develops; general everyday matters such as detergents and soaps, plants in the local area and how food is produced and conserved.

The interest profiles for girls and boys form sex-stereotypes: Boys are interested in the masculine and the "tough stuff" and girls are interested in the feminine.

*Boys:*

- Spectacular phenomena, such as supernovas, bombs, weapons, shocks and explosives.
- Technology, including satellites, rockets and space technology, TV, radio, computers, mobile phones and DVDs as well as petrol and diesel engines, and repairing everyday mechanical equipment.
- Influential discoveries and recent inventions, cutting-edge science.
- Boys' interest increases when a topic is framed as cutting-edge science. For example, they are not interested in environmental protection in general, but they are interested in new sources of energy.

- They are not interested in animals in general, but if the subject is angled more provocatively, e.g. towards cloning of animals or dangerous animals, their interest increases.
- Not interested in the human body in general, but interested in how to exercise to keep the body fit.
- Do not share the girls' interests in mysteries (see below).

*Girls:*

- Topics related to the human body, including human biology, health issues and how to keep and shape a fit body.
- Mysteries and things we still cannot explain, e.g. what our dreams may mean, thought transference, ghosts and witches, the human soul, alternative therapies, astrology and horoscopes.
- Girls do not share boys' interest in explosives and other horrifying matters.
- They are not interested in technology or in recent inventions and cutting-edge science.
- Not interested in atoms, molecules and chemicals.

**Cross-national patterns in youth's interests**

Western students' disenchantment with school science, and declining recruitment of students to science and technology studies, are widely described in the literature. The background for this study's use of theories on late modernity is the assumption that students' orientations towards science and school science are related to modernisation processes. Therefore, in the final analysis, the Norwegian students were studied against a background of students from a range of other countries, including some less developed, more traditional countries. The results show some characteristic cross-national patterns in youth's interests that follow a modern–traditional divide, with respect to both sex differences and what subject matters young people are interested in learning about.

The UNDP (United Nations Development Programme) Human Development Index is used as an indicator of a country's level of modernisation. The analysis does not allow firm and absolute conclusions, but it seems like students' interests in some topics may be related to modernity, others not. This outlines some rough and tentative results:

- The more modernised a country is, the more interested both girls and boys are in mysteries, enigmas and the universe, and the less interested they are in learning about environmental protection, the work and life of scientists, plants and farming.
- Girls in modernised countries are more interested in the human body, human health and in animals, and less interested in technology.
- Boys in modernised countries are more interested in explosives, and less interested in the human body.
- Boys' level of interest in technology is not related to the degree of development: The interest in advanced technology is high among boys in more *and* less modernised countries.

There is a tendency for all girls in all countries to be interested in the same subjects, and similarly for all boys, but we often find that the more modernised a country is, the larger the sex differences are. There were no topics with the opposite pattern; i.e. with a tendency for girls and boys to approach each other's interests with an increasing level of development. When interests are interpreted as signs of late modern identities, this result can be understood as follows: The more modernised a country is, the more girls accentuate that they are girls and boys accentuate that they are boys.

**Reflections**

The underlying purpose of the research is to promote a science education that aims to empower students to make a better world, and make students see themselves as actors, not onlookers. The last section discusses how sociological perspectives on modern youth can inform the area of science education and how science teachers can use the youth culture as a teaching resource for making the students more actively engaged. Schools can:

- meet young people in their culture – *and* represent a counterculture
- accommodate youth's identity projects – *and* challenge them to deviate from their student roles
- accentuate collective efforts for the future – *and* develop the students to become autonomous individual actors

Based on knowledge about how young people understand themselves, their surroundings and the world, school science can aim to develop in young individuals their sense of autonomy and independence to make priorities and to choose actions in accordance with these.

# 1 INTRODUCTION

My science education imperative is: Teaching must be based on an understanding of the views of the learners. Brickhouse and her colleagues state that:

> [T]o understand learning in science, we need to know much more than whether students have learned the proper explanation for how plants make their food or why there are seasons. We need to know how students are engaging in science and how this is related to who they think they are [...] and who they want to be (Brickhouse, Lowery & Schultz, 2000, p. 443)

I will study the relation between students' identities (i.e. "who they think they are and who they want to be" in the quote) and their orientation towards science and science education.

## 1.1 Background

Throughout history, peoples' different ways of thinking and behaving have attracted interest. For example, the bulk of literary short stories, dramas, novels and poetry reveals a curiosity about why people behave the way they do and how they became as they did. Although each person is unique, persons may have some characteristics in common. Consequently, classifying persons into *categories* has been found to be a fruitful approach for studying the *typical*. Examples of early person typologies are horoscopes, based on the observed motions of the sun, moon, planets and stars, and the four ancient Greek *humours* (the sanguine, choleric, melancholic and phlegmatic) based on, among other things, physiology (fluids that were thought to permeate the body). Since then, numerous typologies have been developed, for example based on perspectives or theories from psychology, sociology, biology or education research.

I will identify and describe a set of Norwegian student types based on their orientation towards science, and try to understand the results by drawing on sociological perspectives on late modernity[1], youth culture and late modern identity construction. My choice of *sociology* as a frame of reference implies that I assume that factors in the students' *social environment* exert a major influence on their orientations towards science in general and at school.

We live in an era characterised by rapid changes at the global, societal and individual level. Naturally, the spirit, the values and the ideas of a culture have major effects on how young people see themselves, their surroundings and the world. *Individualisation* is seen as a key characteristic of modern societies. Individualisation

[1] *Late modernity*: By *modern* or *late modern* societies, I mean societies that are influenced by the processes associated with modernisation – i.e. societies in the *state* or *condition* of modernity (see more about this in chapter 2). The term should not be confused with more value-laden connotations like "up-to-date", "leading edge", "avant-garde" or "innovative". Antonyms to *modern* might be *traditional*, *non-modern* or *pre-modern*. These terms should not be confused with everyday meanings like "out-dated" or "old-fashioned" – they are simply sociological terms describing societal development.

implies, among other things, that people to a lesser degree than before inherit their identity from their families and cultural backgrounds, and that people in general and young people in particular, feel that they have to develop their identity and their lives by themselves.

This era of rapid change is, moreover, characterised by a low recruitment of students into science and technology (S&T) education. *Europe needs more scientists!* is the title of the final report from an EU project addressing the condition of S&T in the European Union, with special attention to the number of people entering S&T educations and careers (EU, 2004). The title of the report reveals the point: Europe will need more scientists, researchers and S&T teachers, in order to meet strategic European goals. The low number of students enrolled in S&T education is seen as a large problem in most European countries, including Norway (UFD, 2005). The same concerns are noted in the US (NSB, 2004) and in the OECD (Organisation for Economic Co-operation and Development) countries (Sgard, 2005).

There are large and interesting differences between the countries with respect to the proportion of students enrolled in S&T studies, which subjects show the weakest recruitment, how large the recruitment problem is perceived to be, etc. Especially in the "hard" S&T-subjects, such as technology, engineering, physics and to some extent also chemistry, the recruitment figures are low. Furthermore, the sex differences vary from one country to another, but, in most countries, the boys outnumber the girls in physics and engineering studies, while the gender balance is shifted towards the girls in subjects like biology, medicine, veterinary medicine and environmental science.

However, the overall picture of people's interest in S&T is not merely negative. Popular science magazines, books and radio and television programs do attract an audience[2], and science museums and science centres report lots of visitors. Interesting results can also be read from the Eurobarometer surveys. These studies monitor views, values and attitudes held by European citizens on many aspects of life. They indicate a rather widespread respect for, belief in and positive interest in S&T issues, which also shows a positive trend over time. The interest scores are, however, not the same for women and men. While women express more interest in medicine and the environment, men are more interested in technology (EU, 2001, 2005). Although these surveys describe entire populations and not the youth cohort in particular, one may interpret them as indicating that the low recruitment of students into S&T studies is not due to a general lack of interest in S&T as such, but rather to a decline in the willingness to enter into S&T-related studies and careers.

The causes of the difficulties in recruitment into scientific and technological studies are many and complex. Since the decline in recruitment is a phenomenon occurring in many (although not all) highly developed countries, but seldom in developing countries, one might expect that some explanations can be found in patterns and processes in social life that are related to the level of societal development.

[2] I have not found any good references with figures supporting this claim, but according to booksellers whom I have asked, the book- and magazine-selling trades have not registered low or declining sales of popular science literature.

Recruitment decline is not a key issue for this thesis; that is to say, my research focus is not directed towards how this situation should be understood or met. However, the phenomenon has aroused my curiosity to see whether young people's perceptions of science and science education can be understood against a background of sociological perspectives on youth in late modern societies.

My empirical material is data collected through the ROSE project. ROSE (The Relevance of Science Education) is a comparative project meant to shed light on affective factors of importance to the learning of S&T. The target population is students approaching the end of lower secondary school (age 15). The research instrument is a questionnaire, mainly consisting of closed questions. A more detailed presentation of the project and its rationale may be found in chapter 4, in Schreiner and Sjøberg (2004c) and at the project website.[3]

## 1.2 Research aims and objectives

My research focus emerges from the belief that science teaching must be connected with knowledge about the culture, values, concerns and priorities of young people, and their understandings of themselves, their surroundings and the world. I am assuming that societal modernisation processes influence young people's interests in and perceptions of science and school science. I will study students' interests in and perceptions of science and school science, and try to understand my results by drawing on sociological perspectives on youth in late modern societies. According to such perspectives, *identity construction* and *identity expression* are seen as key projects in modern adolescence. I will try to read the student responses as signs of their identities. Or stated differently:

> ***I will study the relationship between different student identities and different student orientations towards science, and discuss the results in the light of sociological perspectives on youth in late modernity.***

More precise, I will:

- *I* ***Develop a student typology based on the Norwegian students' orientation towards science***
- *II* ***Describe the interests of the student types developed in I***
- *III* ***Describe the student types' relations to some other aspects of science and science education***
- *IV* ***Study Norwegian youth's interests against a background of students from less modernised countries***
- *V* ***Discuss how sociological perspectives on modern youth can inform the area of science education***

[3] www.ils.uio.no/english/rose/ (accessed 2006-02-01)

(The last objective will not involve empirical analysis.) The purpose of this study is not to report results of an opinion poll among students, in order to adapt the science curriculum to current trends in youth culture and the topical interests and values held by young people. Rather, results from my study (together with other studies) can be applied for *bridging* what science educators see as the overall purposes of school science with the horizons of the youth. We, as science educators, should aim to know and understand youth's values and concerns, but without adopting or embracing them. For example, we may be aware of and understand young girls' focus on a sculptured and sexualised body without supporting it in the classroom. On the contrary, education in general and school science in particular can draw on youth's culture and values, and use these as resources for activating and engaging youth in *other* ideologies.

## 1.3 Research approach

The lack of perceived 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 aims to provide insight into factors that relate to the relevance of the content, as well as the contexts of S&T curricula, and to assist in describing a few of the many affective dimensions of S&T in a way that can stimulate debate and reflection. 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[4]

The motivation behind ROSE is also to support capacity-building, including collaboration and exchange of experiences and expertise, and to encourage international cooperation and joint research. Countries from all continents and at different levels of development have collected (and still are collecting) data. *Cultural diversity* is the core dimension of the project and a key issue in the questionnaire design.

The questionnaire was developed in cooperation with ROSE partners from all continents (see chapter 4). It is *not* designed with the intention of confirming or falsifying precisely defined hypotheses about relationships between strictly defined variables. By design, there is not one specific theoretical framework (e.g. within sociology) on which the study is based. By design, there are no exact or sharp definitions of concepts such as *relevance, science, technology, interests* and *attitudes*. Neither did we wish to adopt questionnaire items from standard attitude scales in reference books (e.g. Fraser, 1978; Gogolin & Swartz, 1992; Robinson, Shaver & Wrightsman, 1991). During the process of questionnaire development, our attention was directed towards what we perceived as relevant views held by students in various countries – or, in the words of a ROSE-partner, who had actively participated in the development of the questionnaire, at a ROSE workshop in Oslo November 2004:

[4] These points are key formulations from the research grant contract.

> We did not want to define research questions, hypotheses or definitions. All our discussions were about *what is in the mind of the students* in the different countries.

Several science education students are doing their doctoral degree on the ROSE project. When the time came for me to close the data file and stop waiting for more partners to send their national data (February 2005), we had received data from more than 30 countries. I have met seven colleagues from other countries doing their doctoral work on the same data material as I do. As the instrument was developed with the intention of *opening up for diversity* rather than meeting one particular research interest, we have all, from the basis of our own curiosity and concerns, developed our own and distinctive research design involving different theoretical frameworks and different research aims.

### 1.3.1 Explorative, data-driven, pragmatic, robust

The purpose of drawing this picture of the project is to make clear that ROSE is by design an *explorative* and *pragmatic* project. *Explorative* in the sense that the nature of the data material invites examination, investigation and generation of hypotheses more than it invites confirmation, explanation and falsification/verification of hypotheses. And *pragmatic* in the sense that, both methodologically and conceptually, the data must be studied in a practical and sensible way, rather than by connecting the data to fixed theories, hypotheses, definitions and principles.

Consequently, my analyses are *explorative* and *pragmatic*. I will *explore* matters rather than explain them. My use of terms like *relevance, science, technology, perceptions*, *interests* and *attitudes* will resemble the pragmatism of the ROSE project – without confining them to precise theoretical definitions, I will use them as practical tools for communicating my points. My choice of theoretical background for understanding the results, sociological perspectives on youth in late modernity, is also a pragmatic choice. Probably, I will find that these are fruitful perspectives for understanding some of the results, but not all. Sociology is one among many possible frameworks for understanding the data. With perspectives from other fields, e.g. anthropology, cognitive and social psychology, biology or education research, some results could possibly have been interpreted somewhat differently.

My explorative approach to the data also implies that from the outset, I will not develop a scheme or a systematic plan for how the analysis shall proceed. As I proceed, and as I arrive at new results, I will successively adjust the choice of methods, statistical tools and the way ahead. This means that my analyses are *data-driven*[5].

Some research aims require precise hypotheses and operational definitions of the concepts that are to be measured. For example, research in psychology 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. In

[5] ... which reveals that the research aims (*I-V* in 1.2) have been refined *after* the data analysis was completed.

general, one may say that the more exact and detailed the hypothesis and research questions are, the more precisely the concepts must be defined, operationalised and measured. Projects like TIMSS (Trends in International Mathematics and Science Study[6]) and PISA (Programme for International Student Assessment[7]) are examples of studies with precise definitions and operationalisations of distinct concepts that the projects aim to measure. Such projects gather data that facilitate complex methodology, sophisticated statistical analysis and exact and accurate results (see e.g. Mullis & al., 2001; OECD, 2005).

By research design, the ROSE data do not enable such levels of methodological complexity. On the contrary, in order to present well-founded and generalisable conclusions, only *robust* results should be pursued and reported. This means that in order to be put forward the results must be stable, sound and convincing.

I have not found many other large-scale quantitative projects with the same cross-cultural, explorative and pragmatic design. In fact, the only studies I am aware of are SAS (Science and Scientists, the pilot study of ROSE, see Sjøberg, 2002b and chapter 4) and the study of Ornauer, Wiberg, Sicinski and Galtung entitled *Images of the World in the Year 2000* (1976). More traditionally, research designs within education are described like this:

> Quantitative research uses objective measurement and numerical analysis of data to try to explain the *causes* of changes in social phenomena. This type of research usually begins with hypotheses that will be supported or not supported by data. Qualitative research, on the other hand, seeks a complete *understanding* of a social phenomenon through the researcher's total immersion in the situation. Qualitative research does not usually begin with hypotheses, although the researcher may generate them as events occur. It may be said that quantitative research seeks explanation, while qualitative research is more concerned with understanding. (Ary, Jacobs & Razavieh, 1996, p. 20-21, authors' emphasis)

(The differences between these two traditions are however debated, and some argue that the distinction is considerably exaggerated, see e.g. Lund, 2005.) ROSE may be said to fall in the middle between these two research designs. To explain my research aims (*I-IV* in section 1.2) and my research approach, I use terms like *describing* and *studying* the students through *data-driven* analysis. Although I have a "hypothesis" about modernity's influence on youth's perception of science, the data themselves do not have the capacity to reject or verify it. However, hopefully, I will encounter some surprises; and I may generate some new hypotheses, and achieve some new understanding.

So, in the garden metaphor: The ROSE-garden is fenced in and defined by the ROSE questionnaire. The ROSEs are the students with their responses. In a *data-driven* and *pragmatic* way, I will *explore* this garden. Only *robust* characteristics of the ROSEs will be pursued.

### 1.3.2 Student typologies

It is in the nature of quantitative research to compare *groups* of students rather than individuals. Students are categorised according to, for example, sex, age, socioeconomic

[6] http://timss.bc.edu (accessed 2005-09-16)

[7] http://www.pisa.oecd.org (accessed 2005-08-10)

status of the home, religion, race, language, school type and urban/rural place of living. All research based on groups of respondents entails a loss of information at the level of the individual. This means that quantitative data facilitates characteristics of the *typical* – but inevitably at the expense of the particular.

In the present study, too, *groups* of respondents will be the unit of the research. But rather than categorising the students according to pre-defined background variables such as sex and place of living, i.e. rather than dividing the students into categories based on presuppositions about the influence of some biological or structural variables, the students will be classified according to their own expressions. Independent of the students' sex or structural backgrounds, respondents with similar response patterns will be clustered together, forming distinctive *student types*. Above, I stated that I will study the relationship between different student identities and different student orientations towards science. Naturally, the questionnaire does not have background questions directly addressing the students' identities. Rather, I will interpret their response patterns as signs of their identities.

This means that I will develop a student typology and classify the Norwegian students as different student types. Literally, *typology* means the study of types. The term also refers to a model, or a type gallery, in which students can be classified as different student types. It appears to me that more typology studies have been done with college students than with students in secondary school; nevertheless the author of a recent college students typology study stated that such work is "seriously underused and under-researched. Only a handful of authors have worked on the subject" (Luan, 2003). The main argument for knowing and understanding student types is that when students feel seen and understood, they respond with increased school motivation (Larkin-Hein & Budny, 2000). (See references to more literature on student types in 2.4.2 and 3.4).

School motivation has great influence on how students choose their future. Several studies of youth's educational choice find that *interests* constitute a key criterion (Angell, Henriksen & Isnes, 2003; Hovdenak, 2004; Lindahl, 2003; Ramberg & Kallerud, 2000; Sjödin, 2001). *Abilities* also play a crucial role, but even students who perform well in mathematics and science will often choose other studies and jobs. This is particularly the case for the girls (Støren & Arnesen, 2003). But school motivation and school satisfaction are not just means to an end, but important aims in itself. Also, in most subject curricula, everyday enjoyment and engagement are seen as goals of schooling in their own right. The many students (and teachers) who spend a considerable part of their everyday life at school would naturally argue that school *is* life, and not merely a preparation for it, so school satisfaction is closely connected to quality of life. Teachers' job satisfaction is strongly influenced by whether the students give positive responses to their work, and teachers evaluate the success of their teaching partly on the basis of whether they were able to engage the students (Ramsden, 1998). Many science teachers consider students' attitudes and interests, and how to make the students more positive toward their science classes, to be the most pressing area of research in science education (ibid.).

## 1.4 Purposes of science education

### 1.4.1 Curriculum arguments, emphases and trends

There are several arguments for science as an important and relevant subject in the school curriculum. The four most commonly referred are: (1) The *utility argument*: for coping with everyday matters. (2) The *economic argument*: for the economy of the individuals in S&T jobs and for the economy of the society through further S&T developments. (3) The *democratic argument*: for qualified and informed participation in society. (4) The *cultural argument*: for understanding how S&T developments have influenced society (accounted for and discussed in e.g. Osborne & Hennessy, 2003; Quale, 1997; Sjøberg, 1997).

One may ask, as Douglas Roberts did in 1988: *What counts as science education?* (Roberts, 1988). Roberts argued that what counts as science education depends on what one sees as the overall objective of education and school science. He identified seven purposes, or seven *curriculum emphases*, and argued that what one perceives as the overall purpose has implications for most other aspects of school science (subject matters, teaching methods, student evaluation, teacher training, etc.). The seven emphases representing different areas of societal or human endeavours are (1) *Everyday Coping:* This emphasis brings the message that the overall purpose of school science is to understand, use and manage everyday applications of science and technology. (2) *Structure of Science:* This emphasis suggests that the purpose is to understand how scientific theories and ideas develop and change. (3) *Science, Technology and Decisions:* This emphasis is related to the more familiar STS (Science, Technology and Society) objective of science education (Solomon & Aikenhead, 1994). In this emphasis, the objective is to be aware of the role of S&T in society, including the moral, ethical, economical, political and social effects of S&T developments. (4) *Scientific Skill Development:* This emphasis conveys that students should learn the *processes* of science, e.g. to observe, measure, experiment and hypothesise. (5) *Correct explanations:* This emphasis focuses on the conclusions, or the *products* of science, and that the students should learn it "because it is correct". (6) *Self as Explainer:* In this emphasis, students should understand in what way scientific explanations (and their own explanations) are influenced by the presuppositions of the explainer. (7) *Solid Foundation:* This emphasis conveys that the students must learn "this stuff" now, because s/he will need it to be able to learn "that stuff" next year.

In contemporary Western societies, compulsory school science is targeting *all* students, and not only future scientists. Consequently, there is a trend towards broadening the aims of the *science* curriculum towards including also the aims of the *general* curriculum (Sjøberg, 2002a). Sjøberg summarises eleven contemporary science curricula trends (some are overlapping and closely related) under the following headings: (1) *Towards "Science for all":* School science is increasingly aiming at the overall purposes of schooling, including liberal education and attention to ethical and social dimensions of S&T. (2) *Towards more subject integration:* School science is becoming more issue-based and more integrated with other school subjects. (3) *Widening perspectives:* By including historical, cultural and philosophical aspects of science, scientific theories are described more as outcomes of human exercises, and less as factual explanations. (4) *NOS: The Nature of Science:* Curricula include issues related to NOS, such as the purpose of scientific

developments, the nature of scientific knowledge and science as a social enterprise. (5) *Context becomes important:* Science is increasingly taught through project work and in relation to everyday life and socio-scientific issues. (6) *Concern for the environment:* School science is increasingly permeated by an environmental awareness. (7) *Emphasis on Technology:* Technology is included in the curriculum as a separate subject, or as an integrated part of the science curriculum. (8) *STS: Science, Technology and Society:* Science is increasingly seen in its relationship with technology and society. (9) *Attention to ethics:* Includes ethical aspects of both S&T research and S&T developments in society. (10) *Less is more:* A thorough, comprehensive and multifaceted coverage of fewer issues is prioritised, at the expense of an encyclopaedic presentation of "all" scientific topics. (11) *Information and communication technologies (ICT) as subject matter and as tools:* ICT is increasingly used as a means of S&T learning.

The dimensions of science curricula outlined here are naturally related, and science curricula in most countries suggest that the students should develop awareness, knowledge and skills that may be sorted under *several* of these arguments, emphases and trends. For example, the Norwegian science curriculum (UFD, 1996)[8] states that the school subject shall help the students to:

- enjoy their experience of nature
- develop imagination, creativity and an interest in exploring their surroundings
- enable them to see connections and make environment-friendly choices
- develop insight into technology, various physical phenomena, and the physical world picture, which they can apply in their daily lives
- contribute to sustainable development
- look after their own bodies and health
- show care and respect for others
- know about and practise scientific thinking and methods
- see that science develops
- become acquainted with the impact of science and technology on the development of society
- learn that the natural sciences form an important part of our cultural heritage
- acquire experience in the use of tools, experimental equipment, and electronic aids
- learn about seeking, processing and mediating information
- put their knowledge of the subject to practical uses
- evaluate information, technical aids, consumer goods and new products (quotes from UFD, 1996)

Science curricula in other countries may have other emphases.

### 1.4.2 Emphases in S&T research

Also in the science education research community, different actors express different curriculum emphases. For example, the American National Association for Research in Science Teaching (NARST) declares that "The ultimate goal of NARST is to help all

[8] Norwegian school science is labelled "Nature and the environment". From August 2006, the Norwegian Ministry of Education and Research (UFD) will implement a new school curriculum (which will be called just "Science"). The quotes in this text are extracted from the prevailing curriculum (UFD, 1996).

learners achieve science literacy"[9], while the mission statement of the International Organization for Science and Technology Education (IOSTE, 2004) reads "IOSTE identifies science and technology education with the real and changing needs of humankind as a whole and with specific needs of its component communities and nations". The mission statement continues that science education should:

1. highlight S&T education for citizenship and for informed, critical, and active participation in democracy
2. stress the relationship between science, technology and society
3. emphasize the cultural and human values of S&T
4. promote equity in S&T and S&T education
5. advance S&T education for a just and sustainable development and consider how S&T education can contribute to the fight against poverty, discrimination and injustice
6. encourage the peaceful and ethical use of S&T in the service of humankind
7. encourage cultural diversity and international understanding through S&T education
8. stimulate international collaboration in the domains of research and development and promote cooperation with other international organizations (quote from IOSTE, 2004)

After following a group of students through six years with science classes and after observing science topics being taught that were of little significance and value to the life of the students, Reiss says that:

> To be bluntly honest, there were times when I wondered why, on earth, students were studying the science they were (Reiss, 2004, p. 100)

Most actors in the science education community have some ideas about how the science curriculum could be improved, and most of our work is inspired by some visions for a future school science. Such perspectives may be more or less explicitly stated. Some arbitrarily picked and simplified (and thereby maybe unjust to the authors) examples of visions or purposes of science education may be: science education for supplying high quality scientists and engineers (Roberts, 2002), for recruiting more scientists (Woolnough, 1994), for science curriculum knowledge (Mullis & al., 2001), for bringing meaningfulness and usefulness to all students (Fensham, 2000b), for doing science (Duggan & Gott, 2002), for Bildung[10] (Sjøberg, 2004), for public understanding of science (Millar, 1996), for understanding the nature of science (Driver, Leach, Millar & Scott, 1996), for love for nature (Kupetz & Twiest, 2000), for reading, writing and communicating science (Osborne, 2002), for citizenship (Kolstø, 2001), for democracy (Sjøberg, 1994), for action (Jenkins, 1994), for socio-political action (Roth & Désautels, 2002), for social justice (Reiss,

[9] www.educ.sfu.ca/narstsite/ (accessed 2005-08-22)

[10] The Norwegian terms *allmenndannelse* and *dannelse* are closely related to the German concepts *Algemeine Bildung* and *Bildung*. The Bildung concept does not exist in English, but is commonly translated by *liberal education*. In this thesis, I will use the German term *Bildung*. The concept carries the meaning that a person with *Bildung* is "independent and autonomous, can have basis for making her/his own decisions, has control over her/his life, does not let her/himself be manipulated, has a rich set of all-round knowledge and skills, and so on" (Sjøberg, 1989, p. 36, translated by Ødegaard, 2000).

2003), for participation in the community (Roth & Lee, 2004), for gender equity (Sinnes, 2004), for development (Lewin, 1995), for enhancing students' cultural identity (Aikenhead, 1998), for sustainable development (Ekborg, 2002), for empowerment (Zahur, Barton & Upadhyay, 2002), for empowerment against global warming (Schreiner, Henriksen & Hansen, 2005), for envisioning and bringing about a desired future (Lloyd & Wallace, 2004), for collaboration (Mork, 2003), for school satisfaction (Alsop & Watts, 2003), for imagination and creativity (Holmes, 2002), for personal growth and well-being (Ødegaard, 2000), and so on and on. The last decades, much attention is paid to science education for *scientific literacy* and different suggestions for how this should be understood and defined (see e.g. Bybee, 1997; DeBoer, 2000; Hodson, 1998; Jenkins, 1990; Laugksch, 1999; OECD, 2003; Shamos, 1995).

Some would argue that the most essential purpose of science classes is less related to exactly *what* the students learn and more to *that* they learn. I believe that an important goal of school science is to develop in students a general interest, curiosity and concern about their surrounding world, and concur with Aikenhead's suggestion that to prepare students for a diverse world

> it would not seem to matter what science content is placed in the curriculum, as long as it enhances students' capability to *learn how to learn* S&T content within a relevant context (Aikenhead, 2004, p. 6, author's emphasis)

The slogans in the list above are of course multifaceted and may carry multiple meanings. Furthermore, the purposes in the list are overlapping and interrelated, and neither one-dimensional nor mutually exclusive. Most of them can be sorted into one or more of the arguments, curriculum emphases and trends described in 1.4.1.

Although I can support most of the purposes listed above of school science, I find some issues more important than others. I will promote a science education that aims to

- ***empower students to make a better world***
- ***make students see themselves as actors, not onlookers***

(The latter point is inseparably connected to, and almost a specification of, the first.) Although this concern is not related to my empirical data or to my research aims, it will inevitably influence my writing about youth, schooling in general and school science in particular.

Also in the Norwegian curriculum, science education is seen as a means for promoting awareness about the link between one's actions and the societal development:

> It is difficult to master, understand or influence modern society unless one has basic knowledge of science and technology and of their consequences for nature and the environment. [...] Teaching in science and technology, and teaching about interconnections in nature, are intended to help pupils to acquire the adequate knowledge, skills and attitudes they need to become active citizens and participate in sustainable development. For resources to be used sensibly, and for people to participate in decision-making concerning our common future, individuals must have the knowledge they need to understand the consequences of the choices they and other people make. (UFD, 1996)

In the following paragraphs, I will elucidate the meaning of the two points above.

### 1.4.3 Empower students to make a better world

I do not need to go into misery descriptions about the state of the world, as I see it as indisputable and unquestionable that the world could and should be more balanced and just. Neither will I point out *the* most imperative problems. The German philosopher and educator Wolfgang Klafki identifies five key problems of our time (Klafki, 2001), the Canadian science educator Derek Hodson identifies seven areas of concern (Hodson, 2003) and the UN has defined eight Millennium Development Goals[11]. Personally, I am most concerned about the global warming problem and its implications for life on earth (see e.g. Schreiner, 2004; Schreiner & al., 2005), but others, both people from the same culture as my own and people from different cultures, may naturally hold other key concerns.

As mentioned, the purposes listed in the previous paragraph are overlapping and multi-dimensional. For example, *action* is a prerequisite for making the world better. People also need *hope and visions for the future.* Furthermore, we need *recruitment of students to S&T studies* in order to find better solutions to our way of living. Empowering students to make a better world is probably facilitated by *love for nature*. Furthermore, I believe that a student who is *creative, collaborative and involved* is closer to empowerment for making the world better than one that is not. In order to understand the problems and possible solutions, people also need to be *scientific literate* and to have sufficient *knowledge*. *Science education for making the world better* is also inseparably connected to science education for *sustainable development, citizenship* and *democracy*.

There is an ongoing debate within the science education community about purposes of schooling in general and of science education in particular. One view is that education should basically equip the students with knowledge and skills, but that it is *up to the students themselves* to decide how to apply these competences; otherwise education risks becoming indoctrination. Although I see the important point this argument is making, I assume that an extreme interpretation of this is that it is up to the students themselves to decide whether they will use their knowledge to develop weapons of mass destruction, or technology for eliminating landmines, or less energy-consuming technologies. This thesis is based on the belief that some values, such as democracy, peace, equity, human rights, social justice and environmental protection, are universal. Klafki argues that the purpose of education is inseparable from the challenges facing the society in which the teaching and learning is situated (2001). Bildung is not merely about developing intellectual skills, but

> on the contrary, absolutely always to facilitate, express and reflect over *emotional* experiences and involvement, and furthermore to appeal to the *moral* and *political responsibility*, *the ability to make decisions* and *to act* (Klafki, 2001, p. 83, author's emphasis, my translation).

As mentioned above, Klafki defines five key problems of our time, and states that

> Bildung does in this context [of key problems of our time] mean having a historically disseminated consciousness about central problems of the current time and – to the extent it is predictable – the future, to achieve the insight that

[11] www.un.org/millenniumgoals (accessed 2005-08-31)

> everybody is jointly responsible for such problems, and to achieve a preparedness to contribute to the solutions of the problems (Klafki, 2001, p. 73, my translation).

I support this view, and will not firmly disallow science education to act as agent of influence on students' value preferences. On the contrary, I believe this is an important purpose of school science, and that the notion of "value-free" science is too facile as a way of understanding science and its role in society.

### 1.4.4 Make students see themselves as actors, not onlookers

Not all people see themselves as actors with a capacity to change the world. People may feel powerless, and feel that the societal development happens outside the range of their actions. People may have the feeling that the mechanisms in the development constitute an organism, so to say, that lives its own life unaffected of how one acts. Rather than seeing themselves as agents or actors, people may see themselves as onlookers, pieces, pawns or marionettes, and that the development is directed by something outside themselves and their own choices (see e.g. Nygård, 1993; or the influential essay of the Norwegian philosopher Skjervheim, 1957). An important overall purpose of schools and science education should be to address and counter this view among students.

*Action competence* is a core issue in Bildung for democracy (Schnack, 1994). According to the Danish philosopher of education Karsten Schnack, action competence involves developing in students the competencies needed for the students themselves to realise the connections between their actions and the problems facing our society, and the competences needed for taking responsible actions. The Bildung perspective does not involve campaigns or other pedagogical actions that intend to change the attitudes and the actions of the students. The purpose is

> not to direct the students to particular actions, but to support their development so that they by themselves can come to a decision and act alone or with others as political creatures (Schnack, 1994, p. 98, my translation).

Science education should develop in the students a sense of autonomy and a feeling that they are personally independent, with the capacity to make their own moral decisions and act on them.

Many studies conclude, maybe not surprisingly, that young people think they personally can have an effect on the future of 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). 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 realising and fulfilling themselves: they try to achieve a less complicated life through regression into a short-sighted day-to-day perspective on their own lives (Brunstad, 1998; Hicks & Holden, 1995).

One can understand that the individual may feel helpless when facing problems at international and global levels. In a recent article on climate education, Henriksen, Hansen and I identified a number of scientific, societal, political and educational related complexities of the global warming problem. As many of these would apply to other problems of our time as well, I will present some extracts from the article:

> The worldwide scale of the global warming problem [...] makes individual contributions seem insignificant. A person may make "climate-friendly" choices in his/her everyday life, but despite his/her efforts to reduce emissions of greenhouse gases, welfare growth in many countries will cause more production and consumption of goods and services. Consequently the total global emission of greenhouse gases will continue to increase, and one's feeling of powerlessness may increase in pace with the public focus and concern. Young people may experience that the problem is out of reach of their actions (Schreiner & al., 2005, p. 10).

Furthermore, the "experts" may give public announcements of the insignificance and irrelevance of efforts at the level of the individual:

> [T]here are heated debates among educators, environmentalists and scientists concerning the extent of each individual's possible influence on climate. The old argument that "if everyone does their small part, it will make a difference" is, according to some, simply not valid. Population size, affluence, fossil fuel consumption, and energy efficiency are the main driving forces of the man-made global warming (IPCC, 2001). Every individual can to some extent control and adjust his/her own affluence and energy consumption, as well as avoid contributing to population growth. S/he can even promote development of new and more energy-effective technology by choosing and buying the right products. But on a global scale, such individual contributions are without any practical impact on the global warming problem. The effect of a person's turning off the light when leaving the room or walking to work instead of driving the car, is so microscopic that it is simply misleading to say that such actions will make a difference. The only thing that will work, according to this view, is international agreements and economic measures forcing nations, industry and citizens to change their patterns of energy use (Schreiner & al., 2005, p. 10).

I acknowledge that this view makes an important point, but my discussions will nevertheless be based on the view that individual contributions do make a difference. This stance is based on three counter-arguments presented in the same article:

> First, it is the sum of our individual consumption patterns that drive the energy consumption in homes, industry and transport. Consumer power works in this as well as other contexts: If great numbers of consumers stop buying certain (energy-intensive) goods or services, the supply of these (and therefore their energy use) will go down. Second, we argue that even if changing a few daily habits has limited impact, it may develop and sustain an environmental awareness in each individual, making it more likely that s/he will take environmental concerns into account for instance when making political decisions. Thus, it is a premise in this article that individual efforts *can* make a difference to climate, both through consumption patterns and through political choices. [...] A third 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 realises are coming, may lead to feelings of alienation, powerlessness and meaninglessness (Schreiner & al., 2005, p. 10-11).

Science education can show young people the connections between their actions and the world among other means by showing how "everything is connected to everything" (Klafki, 2001) (e.g. how people's consumption is connected to energy consumption, which is connected to fossil fuel combustion, which is connected to global warming, which is

connected to drought and famine in India, which is connected to larger differences between rich and poor, which is connected to ... ). Thereby, provided that the students see themselves as autonomous, independent and free to act, science education can develop in young people a sense that it is in their power to change the world and make it better.

## 1.5 Definitions of interests and attitudes

Several researchers in the field of affective qualities related to science education state that the field suffers from vague definitions of the various concepts. Differing definitions, operationalisations and measurement methods make the studies hard to match up, compare and summarise (Gardner, 1996; Nergård, 2003; Osborne, Simon & Collins, 2003; Ramsden, 1998).

Gable and Wolf (1993) give a review of literature and various suggestions for definitions of affective concepts such as *interests* and *attitudes*. However, in spite of the extensive research effort in identifying and defining such concepts (e.g. in Gable & Wolf, 1993; Gardner, 1985; van Aalst, Emus & Kapteyn, 1985), the boundary between them is still blurry, as neither of the constructs are unrelated or unidimensional (Gable & Wolf, 1993; Gardner, 1996; Ramsden, 1998). Also the interrelation between attitudes, motivation/intention and action/behaviour is attempted described and defined, but the area is complex and the concepts are found to be more or less connected to one another (Ramsden, 1998).

Furthermore, the *scaling* of affective qualities is widely discussed (Gable & Wolf, 1993). *Attitudes* are commonly seen as a quality with two opposite directions, ranging from *unfavourable* or *favourable*. This means that people can have negative or positive attitudes towards an issue. When it comes to *interests*, there are more differences in opinions and practices. A person may be *disinterested* or *interested* (negative or positive), or s/he may be interested with *low* or *high* intensity (from zero to positive). This means that interests may be seen as a quality measured in a scale representing direction *and* intensity, or in a scale that only captures intensity. Whether one sees interests as a quality measured in *intensity* (in a scale ranging from zero to positive), or as a quality also including *direction* (in a scale from negative to zero to positive) is determined by the operational definition of the concept.

Even though Gable and Wolf argue that "If the operational definitions are poorly constructed, it is doubtful the instrument could have much content validity" (Gable & Wolf, 1993, p. 37), I do not see it as important for my research to define the exact meaning of the numerous terms in the whole complex and interconnected field of *curiosity, interests, intrinsic/extrinsic motivation, attitudes, perceptions, values,* etc. Generally, the questions in the questionnaire, i.e. the question that we actually did ask the students, will be used for specifying the meaning I put in the concepts.

The interest scale in the ROSE questionnaire goes from *Not interested* to *Very interested*. This means that I suggest that interest is a quality measured in intensity, and that there hardly is something like a negative interest. A person may lack interest, but cannot, in my view, be negatively interested. *Disinterest* means *free from interest* rather than negative interest. (*Agreement*, on the other hand, goes from negative to positive. In

cases where the ROSE questionnaire asks students to take a stance towards various statements, the response scale ranges from *Disagree* to *Agree*; i.e. from negative to positive.)

In spite of this definition of an *interest scale* in the ROSE questionnaire, I have not arrived at one specific definition of *interests*. The reason is that I find it pointless for me to hold one accurate definition as long as the respondents may have other perceptions of their own interest. As I will come back to later, I assume that in the head of the students, both scales (negative-zero-positive and zero-positive) act interchangeably. For some items in the questionnaire, they express negative interests and for other items, they express zero interest – in the one and the same response category in the one and the same question (see 8.5.2).

I interpret this as indications of the unclear demarcation of interest and attitudes: Although the questionnaire requests the students' *interest* (in a scale from zero to positive), students probably in some instances express their *attitudes* (in a scale from negative to positive). I do not see how detailed and specific definitions of the concepts *interests* and *attitudes* from *my*, the researcher's, side can help me understand the meaning the *students* put in their responses.

## 1.6 About the present text

### 1.6.1 Thesis overview

This thesis comprises 11 chapters. In chapter 2, I aim at tapping into the "spirit of our time" by drawing on sociological perspectives related to young Western people's values and concerns, and of the late modern project of identity construction. In the next chapter, chapter 3, I give a brief review of literature and research related to students' orientations towards science and science education, while in chapter 4, I describe the rationale and the background of the ROSE project, the instrument development, the data collection, the participating countries, etc. Chapter 5 is a "textbook" chapter about the statistical concepts and methods that are applied in chapter 6, 7, 8, 9 and 10, which are the empirical chapters. Chapter 6 and 7 can be seen as preparations – i.e. as preparing a basis for the subsequent empirical chapters. In chapter 6, I determine the student types by dividing the Norwegian sample into five clusters; and in chapter 7, I try to validate one part of the questionnaire, and to understand what the questionnaire items actually have been tapping into. In the remaining empirical chapters, the student types are characterised by their responses to different parts of the questionnaire: in chapter 8 and 9 I describe the student types in terms of their interest and attitude scores, while in chapter 10, I try to see the Norwegian students against a background of students from other countries. Number 11 is the closing chapter, with a summary of the results, suggestions for further research, and a discussion of implications of my study.

### 1.6.2 Terminology and notation

In the Norwegian language, the concept *gender* for classification of cultural or psychological masculinity and femininity does not exist. The closest term may be

*kjønnsroller* (sex roles), which is more related to sex-specific behaviours. Since the Norwegian students in my study have reported their biological sex, and not their cultural gender, I prefer to use *sex* rather than *gender*. However, some places I have, to avoid ambiguous meanings, found the term *gender* more appropriate, especially in idiomatic expressions such as *gender pattern* and *gender effect*.

Above, I explained that due to the questionnaire design, I will not commit concepts like *relevance, science, technology, interests, attitudes* and *perceptions* to precise definitions. This list may be further expanded, with concepts such as *youth, youth culture, identity* and *lifestyle*. In chapter 2, I have explained some meanings and understandings of the terms, but I do not see it as important for my research to settle on one particular definition of each concept. Furthermore, I do not limit myself to any narrow definition of the two concepts *science* and *technology*, so in most instances, I use *science*, *S&T* and *science and technology* synonymously.

When referring to questionnaire items, I use a capital letter followed by two digits. The letter refers to the question, while the digits refer to the item number in the question. In order to give the reader a hint on the topic of the item, the letter and digits are in most instances followed by brackets with a couple of keywords from the item text. I wish to stress that the keywords alone might give a biased idea about the item content. In order to be acquainted with the full item text, one should look up the wording of the questionnaire items (Appendix A).

In cross-references, I refer to texts under a heading numbered with two digits as *sections* and to texts under three-digit headings as *paragraphs*.

In order to save space in tables, I have left out the zero in front of the decimal point when reporting numbers lower than 1. The zero is left out also in the normal text.

Parts of this text are published elsewhere in co-authorships (Schreiner & al., 2005; Schreiner & Sjøberg, 2004b, 2004c, 2005b, 2006a). These publication are written during my period as a doctoral student, and I have seen them as steps on my way towards completing the thesis. Therefore, in most instances I will use pieces of my contributions to these publications without giving references to my own writing.

# 2 THEORETICAL PERSPECTIVE: YOUTH IN LATE MODERNITY

I do not believe in the existence of one single theoretical framework that has the capacity to explain either youth's interest and attitudes to science and science education, or the recruitment patterns of students into secondary and tertiary science studies in Western societies, or the results of my data analysis. However, as many of the challenges facing S&T education described in the previous chapter are facing Western cultures like the US, Canada, Western Europe and Australia, but not to the same extent recognised in economically less developed countries of Asia, Africa, Oceania and Latin America, I am led to ask: Can these challenges be connected to modernisation of societies? Might some of the challenges facing science education in Western societies have been raised by late modernity? Can sociological perspectives on modernisation of societies and youth culture deepen our understanding of the results from my forthcoming data analysis?

This chapter refers mainly to sociological literature about Western late modern societies. I believe that the *identity construction* is of particular relevance for interpreting my empirical results. Consequently, the core of the chapter is the late modern youth project of identity construction and self-realisation. But before I come to this, I will draw on some perspectives related to certain driving forces that are often associated with modernisation processes and leading up to the current focus on identity development. I will also outline the meaning of some key concepts in youth sociology. The last section is tapping into the central and ongoing discussion in youth sociology, regarding to what extent today's youth are absorbed in merely themselves and their own lives, and how they meet the challenges facing the society and the world.

I am writing for the field of science education, and I will consequently try to illustrate my points with examples from the education context.

## 2.1 Late modernity

Today's Western highly developed societies have developed through various characteristic eras – from hunting and gathering society to agrarian society, then from agrarian society to industrial society, and from industrial society to the current modern era (Giddens, 2001). The periods are characterised by particular cultural and social 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 about oneself, one's surroundings and the world (Frønes & Brusdal, 2001). There are powerful linkages between the political and socioeconomic characteristics of a society and the belief-systems of the citizens (Inglehart, 1997).

Several theorists and researchers have contributed to my understanding. My main sources are contemporary social philosophers and researchers widely referred to in literature on late modern youth, such as Anthony Giddens, Ulrich Beck, Thomas Ziehe, Ronald Inglehart, Andy Furlong and Fred Cartmel, and some Nordic writers like Thormod Øia, Ivar Frønes, Willy Aagre, Johan Fronäs and Knud Illeris. I do not aim to give a

comprehensive review of their writings. Rather, I wish to outline some perspectives concerning motivational tendencies and personal value orientations of late modern youth that I consider relevant for my research interest. No social philosophical interpretation of the present is total; different thinkers emphasise different mechanisms in society. I have chosen some perspectives, but other views, theories or explanations may illuminate other aspects or the same aspects from another angle. I have my theoretical background in the field of science[12], and can therefore not go into elaborated theoretical discussions of different traditions and directions within the field of sociology. Possible tensions and conflicts between the various thinkers, and different nuances in their definitions of various concepts, will not be worked out in details here.

*Modernity* and *modernisation* are terms connected to cultural, economic and political developments in Western societies through at least the last two hundred years (Fornäs, 1995). Modernity is a state, type or mode of society, but it is also seen as a stage of social development (ibid.). Modernity is associated with the era of industrialisation[13]. My focus will be restricted to the latest decades in the post-war period. Although I acknowledge that many of the following aspects are interesting and relevant primarily when seen in contrast to non-modern societies, I will not go into descriptions of the past or of pre-modern societies.

The present-day post-industrial period is referred to as *high modernity*, *late modernity*, *reflexive modernity* (Giddens, 1991), *second modernity* (Beck, 1999), *liquid modernity* (Bauman, 2001), etc. I will use the term *late modernity* (sometimes shortened to *modernity*). Some theorists, e.g. Jean Baudrillard and Jean-François Lyotard, argue that we have passed from the modern epoch into a new condition of *post-modernity* (Giddens, 2001). As the prefix indicates, post-modernity is an epoch that will occur (or has occurred) *after* the end of modernity. A post-modern society is described as highly pluralistic and diverse, with no universal principles and no common ideas or *grand narratives* (concept proposed by Lyotard) that can direct the social development (ibid.). The post-modern idea of our society is debated (Fornäs, 1995; Giddens, 2001), and many would argue that rather than an epochal shift, we are undergoing a continuation of modernity into a late and accelerated stage – an ultra- or super-modernity. The epoch is recognised by a radicalisation, amplification and intensification of modernity (Beck, Giddens & Lash, 1994; Fornäs, 1995; Miles, 2000). I will not go into the post-modernity discussion, but simply state that I find the post-modern perspectives difficult to grasp and apply. Therefore, I will not attempt to interpret my results in the light of theories about the post-modern society.

The way people understand themselves and their surroundings is related to cultural, political and economical characteristics of the society. Consequently, one cannot understand the zeitgeist of a society without drawing on societal developments within

[12] My master degree is in geophysics, meteorology. In my master thesis, I applied a numeric model for analysing tropospheric ozone production (Schreiner, 1996).

[13] It is not easy to specify the period of modernity. Different social philosophers give modernity different starting points: the revolution of the natural sciences (16th/17th century), the enlightenment (18th century), the industrial revolution (late 18th and early 19th century), the modern corporation with separate research and development departments (early 20th century), and so on... (Mjøset, 2003).

economy, politics, infrastructure, etc. Therefore, before I come to descriptions of late modern peoples' way of seeing themselves and the world, I will sketch out some driving forces behind the modernisation processes.

## 2.2 Some characteristics and driving forces

Although modernity theories are not very precise in defining the exact roots and driving forces of the processes leading to modernisation of societies (Frønes, 1998), modernity is inseparably connected with political, socioeconomic and technological developments. Industrialisation is often seen as the triggering factor, since with industrialisation follow occupational specialisation, bureaucratisation, centralisation, rising educational levels and beliefs and values that support high rates of economic growth (Inglehart, 1997). Capitalist development, urbanisation, secularisation and democratisation are processes associated with modernisation as well (Fornäs, 1995). Other factors that are frequently mentioned in relation to modernisation are: technologisation (rising importance of science and technology), more people employed in industry and service vs. in agriculture, commercialisation, market orientation, rise of mass media and individualisation.

Through intensified and accelerated communications systems with the capacity to transport people, goods and information, the development leads to *globalisation*. Modernisation processes originate in Western societies, but globalising tendencies and worldwide effects are embedded in the nature of the process, and traditional non-modern societies are regarded as *pre*-modern and as a "disappearing world" (Giddens, 2001). Except from a few hunting and gathering societies in places like arid parts of Africa and in the jungles of Brazil and New Guinea, modernity has spread globally into most of the worlds' societies.[14]

Globalisation connects people and societies through time and space and leads to universal standardisation. At the same time, modernisation and globalisation have differentiating tendencies leading to disconnections "between state, market and lifeworld, between individual and society, between spheres like art, science, religion and politics, and between different types of human action and social interaction like work and leisure, reason and emotion" (Fornäs, 1995, p. 31).

Modernisation and globalisation are leading to individualisation and liberation of people, in the sense that people can choose their life and who they want to be. Within one country, people's ways of living have become more similar across sex, social classes, and

[14] In a recent article, Gaskell (2003) discusses "appropriate school science in a diverse world". For underpinning his argument, he tells a story about an Indonesian village that he visited. His story can be seen as an example of how the modernisation processes are spreading far and wide: There were no roads, no telephone lines and no electricity supply to the village, and the "highway" to and from the village was a river. In many senses, the life in this village represented activities in a traditional hunting and gathering society. Nevertheless, every evening the local electricity generators were turned on and the village people were watching television news, movies and programs originating in far-off cities and countries. According to Giddens (1991), television and films are instruments as well as expressions of the globalising tendencies of modernity. Gaskell's story illustrates how aspects of modernity is dispersed over the world. In spite of the traditional ways of living and surviving in the jungle, the village citizens are exposed to, and do probably adopt, some modern ways of thinking about themselves and their surroundings.

geographical distances. But at the same time, there is a larger degree of lifestyle diversity within each structural variable. Many processes following modernisation and globalisation may be perceived as positive, like enhanced personal freedom and creativity, liberation of women, more cultural diversity, the spread of democracy, and development of material wealth. But the drawbacks are also widely described in the literature. Beck sees multi-religious, multi-ethnic and multi-cultural societies and tolerance for cultural differences as positive effects, while on the negative side he sees the loss of legitimacy by the state, the growth of unemployment and high level of everyday violence and crime (Beck, 1999).

A late modern society may be described as a

- *Knowledge and qualification society:* As the society grows more complex, it needs more skilled and educated people. In addition, the institutions for education, knowledge and research play a central role (Frønes, 1998).
- *Education society or meritocracy:* People are getting more formally educated. "Education inflation" (Miles, 2000) means that people to a larger extent need some kind of specialisation in order to gain access to the labour market. Education certificates are seen as signs of how willing a person is to make an effort (Frønes, 1998).
- *Communication society:* Telecommunication, media, internet and travelling open up for meetings between cultures (Frønes, 1998) and exchange and diffusion of cultural traditions, perceptions and belief systems.
- *Information society.* More information is being created and new media and communication systems make updated information instantly available (Frønes, 1998).
- *Media society:* Mass communication (print and broadcast media) influence people's experiences. Media is not only communicating and mirroring social realities, but also shaping people's perception of oneself and one's surroundings (Frønes, 1998; Miles, 2000; Rørhus, 1993).
- *Consumption society:* Services and goods are not only for utility and use, but also for symbolising status and identity. People buy and consume not only for satisfying a need – *shopping* is an activity in its own right. People are increasingly seen as costumers, also in public services and citizens' roles as patients, clients, students and electorate (Brusdal & Frønes, 2003).

The vast literature on each of the various keywords and processes mentioned in this section indicates that they are worthy of attention in their own rights. Nevertheless, I will now leave these sides of modernity, and rather proceed with aspects of modernity that are more related to the late modern mentality or zeitgeist.

## 2.3 The late modern zeitgeist

The aim of this section is to tap into the "spirit of the age" and the predominant ideas held by young people. I will try to describe aspects of the late modern *zeitgeist, mindset, worldview, mentality* and *concerns*; i.e. late modern youth's thinking and understanding

about the world, their surroundings and themselves. Because my focus is on young people, this text is written with reference to youth and the adolescent phase of life, but many of the perspectives will apply to other age groups of the population as well[15].

Identity construction will be a central issue in this section. According to Heggen (2004), there are tensions between different sociological traditions concerning how this should be understood. On the one hand, there are perspectives with origin in the modern industrial society, connecting youth's identity to their background in family, social class, local society, etc. On the other hand, sociologists describe how these classical structures have a weakened function in guiding and defining young people in the late modern post-industrial society. Hence, young people must to a larger extent define and construct their identity and their biography by themselves. Theories of Anthony Giddens and Ulrich Beck have been especially influential and widely used as frameworks for interpreting results in youth research (Heggen, 2004).

In my empirical material, there is not much data relating to the structural background of the students (parents' education and profession, place of residence, economical resources of the family, social class, etc.). Nor is the sample stratified for comparing students by such variables. This means that theories on late modernity in which such structures play a minor role for youth's identity construction will form a more fruitful frame of reference for my data and results. Besides, I find these perspectives credible and useful for my study. However, my reading of the literature has not led me to a single comprehensive understanding of late modern youth. I find that there are several and diverse perspectives; some conflicting and others overlapping. The following will naturally carry traces of this. I cannot give one consistent summary of the late modern youth mentality. Rather, I will present fragments and pieces of disconnected descriptions of youth's way of understanding themselves and the late modern world.

I have chosen to organise the descriptions under the keywords *detraditionalisation, cultural liberation, risks, reflexivity, individualisation* and *identity construction,* with somewhat more focus on the last one. Many of the following perspectives are developed by sociological thinkers from philosophical and theoretical reasoning, rather than from empirical studies. Frequently occurring words in descriptions of late modernity are terms like *rapid changes, dissolution, fragmentation, heterogeneity, ambivalence, pluralism and chaos* (Beck & Beck-Gernsheim, 2002; Berger & Luckmann, 1995; Brunstad, 1998; Fornäs, 1995; Giddens, 1991; Skårderud, 1998). According to Mjøset (2003), the task of interpreting the present is always a delicate balance. The present, or any present, will always appear as chaotic. Compared to earlier periods, which we feel we can understand, the current period will inevitably be experienced as over-complex and difficult to

[15] Øia sees today's 40-50 year-olds as the first true-born children of late modernity "They appear as adaptable social chameleons that rapidly change opinions and perform new social roles." (Øia, 1995, p. 23, my translation).

Young people do easily embrace and adopt social changes, and attitudes and values that are developed at the adolescence stage of life are likely to influence people for the rest of their life. Some changes are also occurring in older generations, but not to the same extent. On the contrary, older generations are often seen as causing a *cultural lag*. The rate of the social changes is slowed down by older generations bringing values and worldviews from the past into the present (Frønes & Brusdal, 2001; Inglehart, 1990).

comprehend. This means that aspects of the perspectives below should be seen partly as *rhetoric* on late modernity, rather than as correct and precise descriptions of reality.

### 2.3.1 Detraditionalisation

Giddens' perspectives of detraditionalisation involves weakened roles of traditions and authorities (Beck & al., 1994). As people gain access to more information, amongst other means through media and education, people have experienced how so-called "facts" can be temporary, incomplete and object for debate. This leads people to question the credibility of the established traditions and "truths" that are passed down from authorities and older generations (called *grand narratives*). The consequence is that authorities lose some trustworthiness, and that God, scientists, politicians, teachers and parents have a weakened function in guiding young people in their beliefs, choices and actions. Giddens (1991) sees this as undermining the certainty of knowledge; even knowledge from the core domains of the natural sciences are questioned.

Along with weakened authorities and traditions follows some degree of relativism and pluralism of meaning. Different and conflicting systems of values, cultures and norms may coexist without being put against each other. The extreme (post-modern) interpretation of this is that every fact must be enclosed by inverted commas, as truth is perceived to be a relative construct; every person may have her/his own truth, and no truth is truer than any other (Berger & Luckmann, 1995).

Inglehart finds[16] that some values go together in coherent patterns. People in more secularised and detraditionalised countries express the view that politics is important, that abortion and divorce is ok, work is a source of personal satisfaction, etc. (Inglehart, 1997). (While in more traditional countries, work is seen more for the sake of survival; religion (not politics) is perceived to be important; people have distinctive norms concerning abortion, homosexuality and divorce, favour large families with many children, and emphasise respect for parents and authorities.)

### 2.3.2 Cultural liberation

According to Ziehe (in Ziehe & Stubenrauch, 1993), the breakdown of traditions has lead to *cultural liberation* of the individual. The decomposition of traditions has resulted in a weakened position of religion, altered sexual morals and norms, weakened generation and sex roles, and less respect for authorities. Cultural liberation means that the family background and the geographical background of the individual have to a lesser extent the capacity to define a person's identity in terms of class, social status, ethnicity, sexuality, profession, geographical belonging, etc. Cultural liberation means that the individual is released from traditions and norms, and saved from handed-down interpretations of who s/he is. Identity is no longer perceived as something that is given, but as something one chooses and develops. Young people in late modern societies thereby feel culturally,

[16] Inglehart use data from the comparative World Values Survey, addressing a wide range of issues, e.g. religion, politics, sexual norms and attitudes towards science. Homepage at www.worldvaluessurvey.org (accessed 2005-08-06)

socially and geographically liberated. According to this view, young people are, almost regardless of home background, free to choose their address, religion, social group, politics, education, profession, sexuality, lifestyle and values.

With this freedom follows advantages. Today's youth can benefit from having the chance to form their lives in correspondence with their interests and values. But this freedom carries some challenges, since traditions and norms have to some extent functioned as safe and supporting frameworks. Cultural liberation gives the freedom to choose, but also the obligation to choose, and young people must make their choices with less guidance from (the weakened) traditions and authorities. Furthermore, when they have made their choices, they are themselves responsible for the outcome; and they have only themselves to blame, and must themselves handle the consequences if something goes wrong (Furlong & Cartmel, 1997). For example, one's educational choice represents risks, as it may lead to drop-out or failure by not fulfilling expectations, or by being too demanding and hard to get through. This unhappy situation can not be explained by lack of other options, nor by God, destiny, nature, inheritance or limitations of social class.

These perspectives describe a late modern *notion* or *idea* of a free choice. The theory is questioned both by sociologists and by empirical studies that point towards a still very pronounced social reproduction. Young people may have the *impression* that they have an infinite number of options and degrees of freedom, but youth studies find that the home background of young people will still influence their dispositions related to lifestyle, values, educational choices, etc. (Bourdieu, 1984, 1990; Fauske & Øia, 2003; Furlong & Cartmel, 1997; Hansen & Mastekaasa, 2003; Heggen, 2004; Krange, 2004; Øia, 2001; Seljestad, 2003; Turmo, 2003)[17]. This means that in reality, they do not choose their life as freely as it may seem here. Individuals are not free to be anyone they wish, but on the other hand, society does not totally define a person. The ways forward are, more or less, opened and closed due to conditions in the background of the individual[18].

Nevertheless, these perspectives are widely used for describing how young people *perceive* their possibilities and possible future directions ahead. Or, in the words of Furlong and Cartmel (1997):

> 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. (ibid., p. 5, my emphasis)

[17] The concept of *cultural liberation* (Ziehe in Ziehe & Stubenrauch, 1993) can be perceived as related to *cultural liberty,* as defined by the United Nations Development Programme (UNDP, 2004). I find it interesting that cultural liberty, among other dimensions defined as "the capability of people to live and be what they choose, with adequate opportunity to consider other options" (ibid., p. 4), is seen as a vital part of human development and as a superior developmental goal for *all* societies and nations.

[18] Although there are many examples of youth choosing the same profession as their parents, both parents and children find it important to add that it was a choice the youngster did "totally" by her/himself (Skårderud, 1998).

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. (ibid., p. 7, my emphasis)

### 2.3.3 Risks

The theory about the *global risk society* is proposed by Beck (e.g. Beck, 1999). Risks are unforeseeable future accidents or disasters caused by present-day choices. These are among the unpleasant outcomes of modernisation. With departure in the environmental problems, Beck describes how the social and technological development, along with globalisation, has lead to unpredicted and unintended side-effects of the development.

Humans have always been facing environmental risks of one kind or another, but the risks facing today's generations are qualitatively different from those facing the previous. Until a few decades ago, people and societies were threatened by environmental risks such as drought, famine, earthquakes, volcanoes and storms[19]. But no matter how large and devastating such pre-industrial risks were, they could be seen as "strokes of fate" (ibid.) or "fortuna" (Giddens, 1990), unrelated to human activity. Beck argues that the post-industrial society is facing new risks of a new nature.

Man-made risks are diffuse in origin, and their consequences are unintended and unforeseeable (Beck, 1999). The Chernobyl disaster in 1986, BSE (Bovine Spongiform Encephalopathy or "mad cow disease"), ozone layer depletion, global warming, overpopulation and regional water shortage are examples of such unintended by-products of technological developments. Beck describes risks 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, sex and social status (ibid.). As the problems originate from the lifestyle of an entire population, we can hardly find persons to blame, and it is unclear who is responsible for taking action against the problems. Consequently, although the risks depend on human decisions and actions, possible disasters are detached from individual responsibility.

This theory about the risk society is developed further, to include the personal lifeworld of the individual (Beck & Beck-Gernsheim, 2002). For example, people in late modern societies are aware that by choosing an education, a career, a lover, a hobby or a lifestyle, one exposes oneself to risks. Things can go wrong and the choice may turn out not to be the right one. The choices one makes may be perceived to be decisive, or even fatal. Accidents, illnesses, divorce, educational failure, unemployment and poverty may all be seen as results of wrong choices. Consequently, people's actions and choices may be guided by risk evaluations, and by steering clear of danger.

[19] Some demarcate *risks* from *danger*. Dangers may be seen as caused by the environment (e.g. volcanoes), while risks are related to people's decisions (e.g. possible consequences of global warming). However, the concepts are interrelated and the boundary between them is unclear. For example, a car-drive can be seen as representing *risks* for the driver and *dangers* for others. (See more about these and related concepts in e.g. Munthe, 2003.) I will use the words synonymously.

### 2.3.4 Reflexivity

According to Beck, a higher level of knowledge among people is the mechanism that most significantly distinguishes late modernity (or the risk society) from the industrial society. Giddens argues that, because people in Western societies through new information and communication technologies have access to larger amounts of information, they have experienced the untrustworthiness of scientific discoveries and theories. People know that information may be temporary, short-lived, and after a period either up- or outdated. This makes people less convinced about prevailing "truths" and "facts", and hence traditions and authorities have lost some credibility (se 2.3.1 above). According to Giddens (1991), this creates a world in which individuals have become more and more *reflexive*.

Reflexivity implies that people constantly get new information and achieve new knowledge and experiences, and as they do so, they respond and adjust to the changes. Late modern beliefs and actions have become more reflexive in terms of continuously being subjected to discussion, explanation and confusion. Choices are weighted up against other options and possible risks and consequences. This means that one continuously considers, reconsiders, decides, re-decides, chooses and re-chooses one's beliefs and one's actions (Giddens, 1991).

When conditions appear to be stable – for example, when a person completes her/his education, or when a couple stays together – this is not merely a consequence of the right choice of education or partner some time previously. The education, or the partner, has been re-considered and re-chosen over and over again since the choice was made in the first place.

### 2.3.5 Individualisation

Together with other processes, the processes described above leads to *individualisation* of the individual. Individualisation means that the society accentuates the individual's freedom and independence. The individual is the "unit" in the society; liberated from collective structures. This gives the individual the feeling that her/his life has a range of possible ways ahead. S/he must make the choice by her/himself, and then take the responsibility for the consequences. The Norwegian school and education system can serve as one example:

All have in principle the same right and opportunity to get schooling and education. According to the Norwegian curriculum (UFD, 1996), the students have "responsibility for their own learning", while the teacher is to be perceived as a "facilitator" and a "supervisor". The timetable brings a notion of voluntariness and freedom – every week the students receive a week-plan, so that they can manage the workload during the week by themselves. They are given optional tasks, and in project work they can often choose the subject and their collaborators themselves. After compulsory school (up to and including lower secondary school), everybody has the right to continue on to upper secondary school. The old "subject packages" or "study tracks" are dissolved, and the students choose and compose their own timetable and "education package". If they want, they can put effort into the schoolwork, and thereby get good grades and have access to the higher education they want to undertake. If they choose to work hard with their

studies, they increase their chances of getting a good job afterwards. If they fail somewhere on their way through the school and educational system, they can blame themselves for making the wrong priorities and choices.

Again, this may account for young peoples *ideas* about their choices, but in reality, we know that their talents, abilities and home background are decisive for which way they will choose ahead, and how well they will perform (see 2.3.2). Nevertheless, an empirical study of Simonsen and Ulriksen (1998) indicates that students have a genuine experience of themselves as responsible for their own learning and achievement. The researchers saw these results as internalised consequences of individualisation in school and society.

Late modern individualisation processes are related to the disintegration of previously existing social frames, such as class, social status, sex roles and family, and to the new demands and constraints that are thereby imposed on individuals (Beck & Beck-Gernsheim, 2002). As traditions, authorities and grand narratives play smaller roles in people's life, the individual has to consider and choose for her/himself. Western people are living "a life of one's own in a runaway world" (ibid., p. 22). Each individual has to develop her/his own biography – an "elective biography", a "reflexive biography" and a "do-it-yourself biography" (ibid., p. 3).

### 2.3.6 Identity construction

Across most epochs and cultures, the youth phase is commonly seen as a period in life which is particularly occupied with identity construction:

> Adolescence is a time when an individual struggles to determine the exact nature of his or her self, and to consolidate a series of choices into a coherent whole which makes up the essence of the person (Coleman & Hendry, 1999, p. 52)

Identity is a self-definition, or an understanding of who one is. Even though a person's identity is unfixed and in continuous reflexive development, an identity carries a notion of a relatively consistent and stable perception of who one is (Giddens, 1991). The concept implies that there is some degree of consistency in a person's behaviour, appearance, priorities, attitudes, activities, etc. (Syltevik, 1997).

*Role* and *identity* are not the same. Youth are actors in a collection of different arenas. They may appear in different roles as a student, daughter/son, friend, patient, sportsperson, consumer, etc. (Beck & Beck-Gernsheim, 2002; Frønes, 1998). Nevertheless, one may perceive one's multiple roles as consistent with one identity.

Although social interactions affect the identity construction, the process is above all seen as something the individual has to work out by her/himself. Since young people are in the phase of emancipating themselves from their parents, their contemporaries or peers function as the dominant *significant others* (Frønes, 1998). The American anthropologist Margaret Mead argues that Western societies are developing towards a social structure in which the older generations have decreasing capacity to teach and direct the younger generations. She describes three forms of relations between generations in different kinds of societies (Mead, 1970 in Côté, 1996 and Skårderud, 1998). (1) In stable societies, societies that do not change much across time, the younger generations learn from the older, as the older generations possess knowledge that still will be valid and

useful when the younger generations are grownup. (2) In societies with generation-specific functions (e.g. youth going to school and adults going to work) people learn from their contemporaries, but the older generations may still have authority and capacity to guide the younger generations. (3) In rapidly changing societies, the experiences of the older generations will soon be outdated and worthless, so older generations must learn from the younger generations with more adaptability. In such societies, the younger generations are the cultural innovators, creating new ideas and trends within design, fashion, music, etc. Mead labelled these three social orders the post-figurative, the co-figurative and the pre-figurative society respectively[20], and she argued that Western societies are developing from co-figurative towards pre-figurative societies (ibid.)[21].

The late modern project of identity construction is a consequence of individualisation. As a person's identity is no longer seen as inherited or given, identity construction is a task and a project imposed by late modernity on everyone (Frønes, 1998; Giddens, 1991). Who one wants to be and how one will develop one's self is perceived to be up to each person to decide. In pre-modern societies, one's identity is *ascribed* and determined on the basis of sex, parents' social status, etc., while in late modern societies one's identity is increasingly *managed* through one's personal reflexive choices of identity signs (Côté, 1996).

Goffman sees social life as performances with agreed rules for behaviour. Through empirical analyses of human interaction, he describes how every facet of people's public choices and behaviour, such as language, actions, values and beliefs, are tacit symbols or codes of social identities (Goffman, 1959). With the term *reflexive self,* Giddens refers to the individual's self-confrontation and reflexive choices related to the design and the construction of her/his identity. In light of new knowledge and new experiences, people are continuously reconsidering and redeveloping their self (Giddens, 1991). Choices related to everyday matters like clothing, appearance, leisure activities, music taste, sports, sexuality and beliefs all carry a message about an identity (ibid.).

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

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

Also in the school and classroom context, young people define and communicate their identities through reflexive choices. Like any other activity, *learning* can be seen as a

[20] Note the counter-intuitive labels.

[21] I see this theory as consistent with the view emerging from Hodson's (2003) discussion of "What kind of science education is appropriate as preparation for this relatively unknown world?"

> in previous generations, we have been able to predict the kind of knowledge, skills and attitudes that students currently in school would need for a lifetime of employment. Now, for the first time in history, we are educating students for life in a world about which we know very little, except that it will be characterized by substantial and rapid change, and is likely to be more complex and uncertain than today's world. (ibid., p. 648)

process involved in a persons' identity development (Wenger, 1998). If students find that the discourse or the appearance of a school subject is inconsistent with their idea about who they are and who they want to be, they may refuse to learn and participate in the subject classes (Boaler, William & Zevenbergen, 2000). According to Lyng (2004b), all school activities, e.g. performance, subject preferences and behaviour in the classroom and the breaks, carry a message of one's identity. In order to communicate one's identity, signs of what one *is not* are just as important as signs of what one *is.* Consequently, one means for constructing and expressing one's identity is signals of how one *differs* from other people, and who one is *not* (Bauman & May, 2004; Frønes, 1998).

According to Heggen (1993), education is inseparably connected with identity construction, because through young people's educational choices, they express their perspective of themselves – both for the present-day and for the future. Illeris et al. argue that the traditional question "What do you want to be when you're grown-up?" addresses a more far-reaching issue than before. Today, the answer of this question should to less extent be seen as perceptions about a safe job and income, and more as an answer to the question "*Who* do you want to be when you're grown-up?" (Illeris & al., 2002, p. 57, my translation). When young people choose an education or profession, they express at the same time key components of their identity.

Identity has one individual biographical and one social component (Illeris & al., 2002). The *individual identity* refers to the unique identity of a person and her/his sense of a consistent self, while the *social identity* is one's perception of belonging to a group with members that have something in common with her/himself. The next section is about the more collectively defined youth cultures.

## 2.4 Youth and youth culture

There are many suggestions of *youth* definitions. Youth may be seen as a mentality, an age, a phase of life, a generation, a social and cultural construction, etc. Moreover, there are several suggestions of age ranges that comprise the youth phase of life. Definitions of these kinds vary across time and cultures (Aagre, 2003; Coleman & Hendry, 1999; Fauske & Øia, 2003; Frønes, 1998; Heggen, 1993, 2004; Illeris & al., 2002; Miles, 2000). In spite of different approaches to and definitions of the youth concept, literature shows agreement in some fundamentals; namely in seeing late modern youth as a matter related to *the transition from childhood to adulthood, the development of one's own identity, and spending much time with peers in educational institutions.* [22]

Young people easily embrace and adopt social changes, and studies comparing the values and principles held by different generations often find pronounced differences between age groups. There are different perspectives on whether the attitudes and values people develop at the youth stage of life will be sustained through later phases, or whether people, as they grow older, leave their youth values behind and grow into more or less the same values as the generation above. Or phrased differently: Should cohort differences be

[22] Regardless of what definition one may prefer of *youth*, the 15 year old students in my sample will be covered by the definition.

seen as a *generation effect* or as a *life-phase effect*? (Hellevik, 2001). The answer to this question will influence how society should meet youth values and youth culture. Naturally, the answer is not either–or, but both–and. Some values are characteristic for the phase of life, and will vanish as young people grow older. Other values are connected to the generation. Such values have the potential of changing the society in the coming time. Sociologists often assume that values that are developed at the youth stage are likely to survive through later phases and influence them the rest of their life (Frønes, 1998; Hellevik, 2001). Therefore, attitudes and values held by young generations are often seen as a "cultural mirror image of the future" (Fauske & Øia, 2003).

The education society strengthens the mutual relationships of youth, since *more* education and education for *everyone* make young people spend more time in educational institutions, i.e. more time with each other. The synergy of detraditionalisation, individualisation and youth spending more time with youth provides fertile soil for the development of youth cultures (Frønes, 1998; Heggen, 2004). Youth culture as a phenomenon implies that young people to some extent share a set of norms, values, ideas, beliefs, practises, material and symbolic artefacts, etc. Aagre (2003) suggests the following relatively comprehensive and descriptive definition of youth culture:

> Youth culture is related to meaning-making of cultural expressions of the age in which young people live. Youth actively develop the culture among themselves, and adults' direct influence on the process is limited or absent. Youth culture can comprise linguistic expressions, attitudes and taste [...], and consciousness for example about clothes, music, and style. The expressions of the youth culture are often influenced by the agenda of popular media. Youth culture is locally differentiated and often forms distinct subcultures within the youth community (ibid., p. 117, my translation)

### 2.4.1 Youth subculture and lifestyle

Several Norwegian studies have aimed at identifying and describing sub-groups of youth and youth subcultures (Frønes, 1998; Øia, 1994, 1998; Vestel, Bakken, Moshuus & Øia, 1997). Some examples of youth subcultures are "mainstream youth", "traditionalists", "trendy youth" (Øia, 1994), "school nerds", "taggers", "heavy rockers", "Greenpeace youth", "athletics", "motor youth" (Øia, 1998), "hip hop/rappers", "house/techno youth", "skateboard youth" and "snowboard youth" (Vestel & al., 1997).

Such studies find large differences in girls' and boys' cultures. Frønes (1998) sees this as a result of detraditionalisation and individualisation. Although one's identity is to less extent inherited or handed down from traditions and family background, sex still is an inborn quality. This means that one's sex may be experienced as the only noticeable inborn characteristic that has some capacity to define one's identity. Especially in the earliest teenage, in the most ambiguous and demanding phase of identity construction, young people lean to, cling to and emphasise their sex as an evident identity symbol. This leads to sex-stereotypes. Boys' environment apply very straightforward codes for the "physical", the masculine and the tough, while girls emphasise the feminine.

Norwegian youth studies indicate that girls dominate in youth cultures that are characterised as more modern, while boys rule in more traditional environments. From my understanding of Frønes (1998), this may be seen as a consequence of the new roles of the

late modern education society. In many senses, girls are superior to boys in the school context (Heggen, 2004)[23]. Thus, in the education society, girls are not subordinated to the cultural pattern of the boys (as they were in the industrial society). Consequently, youth subcultures of young girls have emerged in the current late modern post-industrial epoch. Compared to these up-to-date girls' cultures, the cultures of the boys are falling behind by still carrying components of the traditional masculine roles of the industrial society.

*Lifestyle* is another central concept in youth sociology. Leisure activity is one example of a component in a youth lifestyle, and the activity (e.g. ballet, football, Greenpeace, horse-riding and playing in a band) often develops from a lifestyle into a youth subculture (Frønes, 1998). This means that for example music taste, consumption and media use are not only matters of what kind of music, goods and media one prefers. They are also expression of what lifestyle and subculture one belongs to (Frønes, 1998; Heggen, 2004; Miles, 2000).

Although definitions of *youth lifestyle* is somewhat more focused on practices than *youth subculture*, I find the two concepts overlapping and not easy to distinguish between. My confusion is legitimised by Miles (2000), who argues that sociologists tend to misuse the term *youth subculture,* and suggests substituting the word with *youth lifestyle*. In any case, youth lifestyle is, as youth subculture, seen as an important identity indicator, and as something that is reflexively chosen rather than handed down:

> A lifestyle can be defined as a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of self-identity. (Giddens, 1991, p. 81)

### 2.4.2 Lyng's student types

From youth cultures and lifestyles, I will now jump to a description of *student types* as they are characterised in a study undertaken by the Norwegian sociologist Selma Therese Lyng. The reason for the following relatively thorough review of her empirical results and discussion, is that I regard her work as relevant for my study. Besides, I see her points as credible and significant for any person interested in how teaching, regardless of subject, can meet young people in (or in spite of) their process of identity construction and identity communication. I base my review on two publications: a Norwegian published book (Lyng, 2004b) and an English unpublished paper (Lyng, 2005).

Lyng's main point is that the individuals in a classroom perform roles of distinctive *student types* [24]. She collected qualitative data through student and teacher interviews and observations in lower secondary school lessons. Eight student types were constructed; all but one were sex-specific. The Macho Boy, the Dude and the Geek are the student types of

[23] In most subjects, the girls outperform the boys (Heggen, 2004). Even in mathematics and science, the boys' performance is not substantially superior to the girls' (Grønmo, Bergem, Kjærnsli, Lie & Turmo, 2004; Kjærnsli, Lie, Olsen, Roe & Turmo, 2004). One possible explanation is that the school favours traits that are typical for girls, as being obedient and conscientious (Heggen, 2004).

[24] She uses the term *student types* in the book (Lyng, 2004b) and *student styles* in the paper (Lyng, 2005). As I see her work as *typologisation* of students, I will use the term *student types*.

the boys, while girls may perform as the Wild Cat, the Mouse, the Golden Girl or the Babe. The Nerd can be both a girl and a boy[25]. The types are general in terms of appearing in all Norwegian classes and schools, in urban as well as in rural areas[26].

Along with each student type follows rules, recipes and requirements on how to act and interact. The student types are recognised by *symbols* like way of dressing[27], music taste, who they pal with, how they behave in the classes and in the breaks and which subjects, projects and teachers they like. Some student types demonstrate active or passive school *commitment*, while others signify subtle or open school *rejection*. Although there are many exceptions, it is in general not perceived as cool to be absorbed in school. It is more socially accepted among peers to not care much about teachers, classes and schoolwork.

Norms and expectations result in "packages" of symbols, in the sense that one way of dressing implies a specific music taste, a specific behaviour, etc. Students expect consistency between the symbols. In order to be accepted among other students and not be tagged as a "wannabe", each student has to appear as one coherent student type through her/his entire schooling enterprise. This means that one cannot pick and choose among the symbols. For example, one cannot dress like a babe, favour heavy metal music and do schoolwork like a nerd.

Lyng gives rich and thorough representations of the eight student types and the corresponding student type symbols. The following are only some keywords from how the student types are described by the teachers, the peers and themselves. Although Lyng finds that the student types relate differently to different schools subjects, little information is given on how the student types perceive the various school subjects. This means that I cannot connect the student types to students' interests and attitudes to school science in particular.

- *The Wild Cat:* She is extreme and different, she hates school and perceives everything as boring. She is a low achiever – not because she cannot, but merely because she does not want to. Adults see her as problematic, and her peers see her as scary, bragging and pathetic.
- *The Mouse:* She is quiet and almost invisible in the classroom. She is bored and tired of school. Furthermore, she finds that there is little to do both in the breaks and outside school. She achieves medium grades, and believes that she gets less than fair treatment from the teachers.
- *The Golden Girl:* This girl performs her duties, and is appreciated by the teachers. She achieves good grades, which she perceives as important. She finds it good to go

[25] The English names are proposed by Lyng (2005).

[26] In Norwegian lower secondary public school, students in the same class have age and place of living in common, but there is no streaming or grouping of pupils according to ability or sex. In upper secondary schools and in private schools, students may be grouped with respect to other factors, so her results should perhaps not be generalised to other school types.

[27] Norwegian students do not wear school uniforms.

to school, and thinks that most of the schoolwork is interesting. Although she is not classified as cool, she has good relations to many of her peers.

- *The Babe:* She is the coolest girl at school, and interested in youth-issues such as clothes, makeup and boys, rather than school-issues. The Babe is reasonable, and not crazy as the Wild Cat. But she emphasises other aspects of life than theory, and thinks school is too much about theory and textbooks. Nevertheless, she does most of the schoolwork she is assigned.
- *The Macho Boy:* He is cool, tough and provoking. Although he does not totally disregard or lack concern about school, he emphasises social intelligence and life experience before school subjects and textbooks. He thinks that the highlights of the schooldays are the breaks and when something "different" from traditional schoolwork happens in the lessons.
- *The Dude:* He is positive, polite, reasonable and relatively serious about the schoolwork. Teachers see him as the supporting pillar in the classroom. He is a good performer both intellectually and socially. He works toward good grades, because they will be his keys to the gateways to later arenas in life. In spite of his approval of most school activities, he has high social status among the other students.
- *The Geek:* Lyng's Norwegian term for this student type is "the Boy-room Boy". The scene of his life is outside school. In his boy-room at home he is absorbed in leisure interests like space, computers or science fiction. In the classroom, he is merely existent, and does not get much attention. Although he is passive, he behaves reasonable. He believes that school is tolerable, and he achieves medium grades.
- *The Nerd* is perceived as an expert, rather than as a boy or a girl. S/he is bright and absorbed in schoolwork. S/he thinks school is fun, does schoolwork even in the breaks, and gets good grades in all subjects except gym. The Nerd is not perceived as cool, but may be appreciated as an information database.

In addition, Lyng has one category for the Typeless student type. This student does not appear with a clear style and does not follow the recipes for any of the student types. Her/his peers perceive this student as strange and abnormal, and they try to avoid her/him. They find her/him annoying and unintelligible, and in turn feel anger and pity for her/him. The Typeless is often without friends.

Lyng sees the student types as signifiers and indicators of identities, and the symbols tie the students to specific youth subcultures. The student type tells who a person is. Young people resist putting their identity aside. This means that regardless of the task imposed by the teacher, the students have to perform in coherence with their identity and student type.

Today's schools are, according to Lyng, designed for meeting the school-committed student types (like the Nerd, the Golden Girl and the Dude). Students with these identities are the school winners. The losers are those constructing an identity that involves school rejection. Differentiated teaching is, to a too large extent, seen in relation to learning abilities, while obstacles following students' identity project fail to be noticed or handled. For the schooling to succeed in meeting and handling the diversity of students, Lyng argues that teachers as well as politicians and policymakers have to realise, accept and

respect the students' identity project. The follow-up question is then: How can the teaching meet the various student types?

Students have to be faithful to their identity and are obligated to follow the recipe of their student type. Consequently, the Macho Boy, the Wild Cat and the Babe can only be actively engaged in the learning situation if they are allowed to work with symbols that are in agreement with their identity. If not, they will perform as saboteurs and cheeky and dim blighters. Lyng suggests that the teaching must find approaches to the subjects that make it socially possible for more student types to engage in the schoolwork. This calls for differentiated teaching in the sense that the learning situation must allow the students to approach the subject from an angle that corresponds with their student type. Lyng suggests project work, with optional collaborators and optional subjects, as a teaching method that has the capacity for this. Lyng's suggestion addresses politicians and policymakers in the sense that teachers will need more time, resources and curriculum space for differentiated teaching and evaluation.

For some topics, there are no ways around rote learning. Lyng sees it as a paradox that student types expressing school rejection at the same time are the students requesting and appreciating strict teachers. This can be interpreted as self-insight: The student may know that the only way a teacher can make her/him learn by rote, is by structuring the learning situation in a way that does not allow her/him to back out.

## 2.5 Self-realisation and citizenship

In youth research, there is an ongoing discussion related to whether late modern youth show traits of *narcissism*. The present section taps into this discussion. I will start by presenting some background perspectives that I perceive as relevant for the discussion. Keywords in this section are *self-realisation, body construction, future pessimism, materialism/post-materialism and narcissism*.

### 2.5.1 Self-realisation

Beck and Beck-Gernsheim states that

> We live in an age in which the social order of national state, class, ethnicity and the traditional family is in decline. The ethic of individual self-fulfilment and achievement is the most powerful current in modern society (Beck & Beck-Gernsheim, 2002, p. 22).

Individualisation means that each person has a unique character with special potentials that may – or may not – be fulfilled (Frønes & Brusdal, 2001). The only worthwhile thing is to be unique, and *the worst thing in life is to be ordinary* [28]. Being common and ordinary is like being nobody, nothing and nonexistent (Skårderud, 1998). Gullestad labels our time "the age of expressivity", and finds from her analysis of Norwegian biographies that there is a shift from the idea of "being useful" and "being obedient" in older generations, towards "finding oneself" and "being oneself" in younger generations (Gullestad, 1997). Young

[28] ... as the young girl Angela repeatingly says in the movie *American Beauty* (Mendes, 1999)

people in late modern welfare states wish to develop their abilities, to fulfil themselves, and to live their lives to the fullest potential.

As the existential meaning of life is no longer defined by God or traditions, every person has to figure out the meaning for themselves. According to Frønes and Brusdal (2001), the late modern welfare society makes precisely this, *the meaning of life*, a key issue, and *happiness* appears as the new ideology (illustrated by happiness research, e.g. Hellevik, 1996; Layard, 2005). For understanding the culture of self-realisation, one may apply classical psychological theories proposing that as some needs are satisfied, new and more sophisticated needs appear:

The idea behind Abraham Maslow's psychological pyramid of needs (from 1968) is that humans are by nature a searching creature. Our needs will never be saturated, because as soon as one need is satisfied, we will search for satisfaction of other needs. Maslow's pyramid illustrates that human needs are hierarchically arranged. When needs at one level are satisfied, one will turn towards the more sophisticated needs at the level above. The basic needs are of a physiological character (to breathe, eat, sleep, etc.), while at the top of the pyramid lies the need for self-realisation (Imsen, 2005).

With an increasing level of modernisation and social welfare follows more emphasis on subjective well-being (Inglehart, 1997). People in the Scandinavian countries are among those who put the greatest emphasis on values connected with the condition of subjective well-being, such as friends, leisure, good health, life satisfaction, ecology and people's free choice (ibid.).

These perspectives are of relevance for school and education, since also educational institutions are seen as arenas for self-realisation and of fulfilling and developing personal talents and abilities. Young people wish to be occupied with something they can *throw themselves into;* something exciting and enriching. Late modern words of honour like *urge*, *desire* and *pleasure* have replaced *patience*, *hard-work* and *obedience*. Students expect passion and enjoyment also in the learning situation, while monotony and tediousness are perceived as "cheating" their identity. *Independence*, *flexibility*, *communication* and *creativity* are key words for their future job expectations (Illeris & al., 2002; Ulriksen, 2003). *Leisure* and *friends* are key parts of young people's lives (Sjödin, 2001), and they are only to a limited extent willing to sacrifice their extra-curricular activities in favour of schoolwork. An empirical study of Danish students' explanation for their educational choice shows that the majority of the students choose their subject for "existential individualistic" reasons – they wish to "develop themselves", "get wiser", "become deeply absorbed", etc. (Simonsen & Ulriksen, 1998).[29] Especially among girls, there is a pronounced emphasis on self-realisation, while boys are more inclined to accentuate issues related to material standards and achievements (Sjödin, 2001).

### 2.5.2 Creating the young body

The massive focus on body in newspapers, magazines, movies, television and commercials reflects and/or stimulates the increasing focus on how to make the body look young,

[29] (See more about youth, identity and educational choices expanded with results from comparative analysis of the ROSE material in Schreiner & Sjøberg, 2005b, 2006a)

healthy, fit 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 late modern body is, according to Giddens (1991), not perceived as handed down from fate, fortune or nature. Body appearance, shape and health are becoming a reflexive project – something people choose and construct themselves. Shilling (2003) describes the *individualisation* of the body and the notion of *body as a project*.

In the wake of detraditionalisation and weakened authorities comes the lower status of adulthood, maturity and age. Consumption culture idolises the young, sculptured and sexualised body, and suggests that it is available to everyone (Shilling, 2003). One's identity is, to an increasing degree, tied to the surface and appearance. The body functions thereby as a central instrument for constructing a self, and for expressing an identity. A young and slim body carries a symbol of self-control and success (Skårderud, 1998).

The late modern risk society threatens our body with risks connected to health as well as to appearance and shape. Heart disease, cancer, overweight and wrinkles are increasingly perceived as consequences of people's actions and lifestyle choices. This means that individuals are to a larger extent seen as personally responsible for their health and appearance. This notion of the self-determined body is accentuated by the vast possibilities offered by health clubs, plastic surgery, gene technology, etc.

A Norwegian study reports that body issues are the only area in which today's youth show more troublesome traits than youth of some decades ago. Compared to previous youth, young people today are significantly more worried about their appearance and their health, while there are no noteworthy differenced in their worries about issues related to their education, home, economy, etc. (Bø, 1999). Anorexia nervosa belongs to modern times, and particularly to late modernity (Giddens, 1991), and is closely connected to the association between beauty and slimness, i.e. the association between dieting and the late modern values of bodily appearance (Giddens, 1991; Shilling, 2003). The increasing number of young girls with eating disorders may be seen as signs of youth's "striving for security in a world of plural, but ambiguous options" (Giddens, 1991, p.107) and as expression for taking control over one's life (Skårderud, 1998).

### 2.5.3 Images of the future

One of the grand narratives of the past stems from the Age of Enlightenment, and relates to *future progress and growth* (Giddens, 1990) with *more and better of the same* (Frønes & Brusdal, 2001). People were convinced that the step-by-step progress of science would eventually explain every phenomenon in nature, society and in the human mind. People expected that science, evidence and reason would wipe out injustice and human irrationality for the benefit of knowledge, technology, truth, freedom and welfare for everyone.

Today, people have experienced that this enlightenment has not stopped human irrationality. Wars, environmental devastations and social inequity attest that although humans hold high level of knowledge and awareness, they still do not necessarily make choices that ensure a safe and good future.

Views of the future are inevitably influenced by a person's background, experiences and knowledge. But future images also mirror social, economic, political, environmental and other challenges facing a society. This means that images of the future change from one epoch to another, and that people in different societies hold different and often characteristic types of images. This relationship between social development and future images held by the citizens can be connected to individual actions, as a person's actions in the present may be affected by her/his images of the future. Actions are often directed towards the future one wishes for, or the future one believes will come (Bell, 1998). This link between actions and future images makes studies of young people's images of the future relevant for science and environmental education (Hicks, 1996a; Lloyd & Wallace, 2004; Palmer, 1998).

Future views vary with the viewpoint one adopts. 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. Images 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).

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 influential pessimism occurs together with pessimistic images of the probable future (Polak, 1961). 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).

In 1974, Toffler disclosed a discrepancy between personal and global images of the future, as held by US youth (Toffler, 1974). Since then, numerous studies of youth in Western societies have confirmed his finding of personal optimism and global pessimism – the further the future images are from the personal level, the darker and more hopeless they become: 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 with friends, and travelling. When it comes to the future of the nation, with 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 planet, they seem to have somewhat apocalyptic expectations. War, ecological catastrophes, overpopulation and famine are their main global fears, and they expect a continuation or worsening of the problems in the future (Brunstad, 1998, 2002; Eckersley, 1987, 1999, 2002; Head, 1997; Hicks, 1996b; Hicks & Holden, 1995; Rubin, 2000). This pessimism about the future of the globe increases with increasing age of the students (Eckersley, 1997; Hicks, 1996b).

Polak (1961) found that future images show traits of self-fulfilling prophecies, in the sense that images of the future seem to precede or accompany the raise and fall of cultures. This relationship between societal development and future images may be

connected to individual actions, as one acts in accordance with what one believes will come. Young peoples' *hopes* for the global future are: peace, no poverty or hunger, less pollution, more environmental awareness, etc. (Head, 2002). Young people who have higher hope for the future also show a higher level of subjective well-being (Ojala, 2005).

### 2.5.4 Post-materialistic youth?

Ronald Inglehart finds that contemporary youth have values that are less materialistic than previous generations (Inglehart, 1990, 1997). His theory of the transformation from a materialist to post-materialist society is much debated and only to a limited extent empirically supported. But his theory is important in the sense that it is widely used as a reference for understanding late modern values.

Inglehart's sociological theory of the post-materialist society is seen as related to Maslow's psychological theory of the pyramid of needs (see 2.5.1). Through the comparative World Values Survey (see footnote 16), Inglehart finds that older generations are more directed towards materialistic values than younger generations. He interprets this as indicating that, because the older generations have grown up under conditions with limited material goods, their values are (still) addressing economic and material security. Young people in modern welfare societies experience material security. Therefore, their attention is directed towards non-materialistic values, such as personal liberty, self-development, participation in the democracy, care for others and environmental protection. According to Inglehart, these non-materialistic values characterise the late modern zeitgeist, and since all people are influenced by the spirit of the time, the whole youth generation, including those with limited material resources, will hold the same values (Inglehart, 1990, 1997)

The Norwegian Monitor survey [30], a longitudinal study of Norwegians' value orientations, also shows value differences between generations (Hellevik, 1993, 1996, 2001). Hellevik finds that the age variable is the most powerful background variable for explaining values held by Norwegian citizens, as compared to other survey variables like sex, region, urban-rural place of living, level of education and income. Young people are more liberated, have less respect for laws, have a more liberal view of consumption, and are more directed towards enjoyment and pleasure. Furthermore, they are less religious, more spontaneous and materialistic, they enjoy the urban life and news, and are more positive to new technology. They also express more worry and concern for environmental problems, and they prioritise the environment before e.g. creating new jobs. But on the other hand, they are less willing to make a personal effort for the environment, and less willing to give up some of their goods for the benefit of e.g. foreign aid and environmental protection. Hellevik categorises Norwegian youth as *modern materialists*. Also other studies find that, compared to students of 1970, today's young people are more materialistic and more pleasure-oriented, particularly the boys (Sjödin, 2001).

Hellevik points to traits in the social development that stimulate more materialistic values, for example increased spending power in the population, media and advertisements

[30] Information available from www.mmi.no (accessed 2005-08-06)

declaring that more goods will make people happier, the continual appearance of new products and more shopping opportunities (Hellevik, 1996). Today's youth is a pioneer generation in terms of being the first generation that grows up with such high level of commercial pressure (Heggen, 2004).

By following the perspective of the generation effect (see section 2.4), Hellevik concludes that today's youth will probably develop a society that is more materialistic than the current one (Hellevik, 1996, 2001). Furthermore, the *meaning* of materialism will shift from *saving, security* and *investment in lasting goods,* towards more short-sighted pleasure-pursuing consumer materialism. Religious values, frugality, and willingness to sacrifice will to some extent be replaced by values like creative development, individual qualities, tolerance and equity. Hellevik interprets that a more materialistic society may threaten democracy and the welfare state, as conscious civic action demands citizens who are willing to spend time and engagement on collective ambitions (Hellevik, 1996).

### 2.5.5 Narcissistic youth?

In 1980, a US study aiming at providing "a picture of what today's students are really like, how they have changed since the 1960's", concluded that

> students today are overwhelmingly materialistic, cynical about society and its institutions [...]. More significantly, their aspirations are inward, personal, and individualistic rather than social and humanitarian (Levine, 1980)

Today's young people are labelled the "me-generation" (Beck & Beck-Gernsheim, 2002), recognised by "me-firstism" and "overmaterialism" (Eisler, 2002). The societal development makes the individual "the center of our moral universe, to assess everything – from personal relationships to taxes – in terms of 'what's in it for me'" (Eckersley, 2002, p. 39).

In Freud's psychoanalysis, narcissism is a disorder describing individuals who are unaware of the surroundings outside the me-centred and self-absorbed world of a child. While the egoist prioritises her/himself before others, the narcissist is not even aware of the existence of others' needs. Lasch has developed the narcissism concept from the level of the individual into a social and cultural phenomenon, and describes what he calls the "me-decades" (Lasch, 1979). The culture of narcissism is recognised by pleasure, self-satisfaction, self-realisation and self-desire. Also Ziehe uses the term *narcissism* for discussing and describing value tendencies among youth in late modern societies (Ziehe & Stubenrauch, 1993).

Late modern narcissism culture or tendencies are seen as related to individualisation and modernisation. This attracts attention and concern to issues like developing a unique identity, shaping a fit body, fulfilling and developing one's potentials, avoiding dangers and risks and ensuring future happiness. The me-centeredness is also seen as a regression from a complicated world facing a gloomy future for which they can do nothing, into oneself, ones own body, one's own life and happiness (Brunstad, 1998). The following quote is Giddens' description of Lasch's culture of narcissism:

> Global risks have become such an acknowledged aspect of modern institutions that, on the level of day-to-day behaviour, no one any longer gives much thought to how potential global disasters can be avoided. Most people shut them out of their lives

> and concentrate their activities on privatised "survival strategies", blotting out the larger risk scenarios. Giving up hope that the wider social environment can be controlled, people retreat to purely personal preoccupations: to psychic and bodily self-improvement. (Giddens, 1991, p. 171)

The societal development is seen as creating uncertainty and confusion with an increasing sense of anxiety, depression and despair (Miles, 2000), young people do not find any meaning in life (Brunstad, 2002), they are living in the age of boredom (Qvortrup, 1991), they expect the apocalypse of the world, the project of making one's own biography is so demanding that other issues are put aside, etc. Thus, narcissism or self-centeredness can be perceived as a necessary attention and love for oneself, and as a credible and acceptable consequence of late modern individualisation and future pessimism, rather than as a disorder.

Much literature, both of a theoretical and empirical character, gives a *problematic* portrait of youth (Eckersley, 2002). Young people are

> cynical, alienated, pessimistic, disillusioned, and disengaged. Many are confused and angry, uncertain of what the future holds and what society expects of them. While they still work within "the system", they no longer believe in it or are willing to serve it (ibid, p. 33)

This portrait is supported by increasing rates of youth depression, violence, suicide, drug abuse, etc. (Gidley, 2002).

According to Eckersley, late modern youth can be described through three different portraits that describe different *depths* or *aspects* of how late modern youth see themselves and the future (Eckersley, 2002). The second *post-modern* portrait describes youth as

> equipped for its [the postmodern world's] abundant opportunities, exciting choices, and limitless freedoms – and its hazards and risks. They are confident, optimistic, well-informed and educated, technologically sophisticated, self-reliant (even self-contained), street-wise, enterprising and creative, fast on their feet, keeping their options open (ibid., p. 33)

while in the third *modern* portrait most young people

> successfully negotiate the transitions of adolescence to become well-adjusted adults. Most cherish their families, enjoy life, and are confident they personally will get what they want out of life – a good job, travel, a partner, and eventually a family of their own (ibid., p. 33)

The aim of this paragraph was not to define or elaborate on the narcissism concept, but rather to point towards the ever re-occurring issue in youth research of whether young people in late modern societies put a distance between themselves and their surroundings and societal matters. According to Aagre, youth statistics may be interpreted as showing fluctuations with time (Aagre, 2003) rather than as narcissism or regression from one's surrounding world. For example, there is a notable decline in recruitment into political youth organisations in Norway (Ødegård, 2003; Øia, 1995) as well as in other European countries (Beck & Beck-Gernsheim, 2002; Grundy & Jamieson, 2004). Also, youth participation in general elections is low and declining (Kimberlee, 2002; Ødegård, 2003).

However, one may question these figures as indicators for social engagement and concern. Kimberlee (2002) suggests alternative understandings of youth's non-participation. Rather than a "don't care culture" of ignorance, alienation and apathy, one explanation may be that youth are concerned about alternative values related to empathy and personal autonomy (like animal rights, environment, HIV/AIDS, racism and homophobia), and that politicians and political parties fail to acknowledge their values. Kimberlee also reports increasing youth membership in Greenpeace, Amnesty International and other social movements or single-issue groups. Norwegian figures show that the majority of students in secondary school have participated in activities like signature protest actions, product boycotts and protest marches (Ødegård, 2003). Furthermore, they believe that media attention is just as important as elections for political influence (Ødegård, 2003). Besides, not only political organisations are undergoing recruitment decline. The same tendencies are noted in other types of youth organisations (Øia, 1995). This may be seen as a natural consequence of individualisation, stimulating individual rather than collective enterprises (ibid.).

Øia (1995) proposes that having a belief in future progress plays an important part in motivating for political engagement and actions. As long as young people do not believe in future progress, they find no use in taking any kind of action (including political action) addressing the problems.

The social status of young persons who are active in environmental protection should not hinder participation in organisations, as Øia (1995) found that "green" active youth, and youth working for other global concerns (e.g. Amnesty International), achieved high popularity and respect from their peers. Young people who are concerned about the environment are not perceived by their peers as having a particularly radical or controversial political attitude. On the contrary, it is regarded as simply a commonsense reaction to the present situation (Henley Centre, 1991).

I have outlined some perspectives on late modern youth and their understanding of themselves and their surroundings. Some are conflicting, some overlap, some function as ideas about the current era rather than as descriptions of reality – some I find depressing and others bring hope.

I suggest that young people need to have a stronger feeling of the connection between themselves and their surroundings and about how their actions are connected to the world. It may be that they need to know more about how "everything is connected to everything" (Klafki, 2001), and to see themselves more as agents and less as onlookers.

This discussion will be followed up in chapter 11.

# 3 PREVIOUS RESEARCH ON ORIENTATIONS TOWARDS S&T

In this chapter, I will refer to previous research, related to students' orientations towards S&T, that I see as relevant to my data material and research aims. As my research focus is relatively wide, I do not aim at doing a comprehensive review of the literature. Rather, I will outline some general findings – partly by drawing on relevant review articles (e.g. Sjödin (2001), Osborne, Simon and Collins (2003), Ramsden (1998), Hicks and Holden (1995) and Nergård (2003)). Students' relationship to S&T may be closely interrelated with the perceptions held by the public. Still, I will confine this overview to literature referring to students between the ages of ca. 14 and 18.

Although I experience that the bulk of science education research is connected with conceptual understanding, knowledge and learning, much research is undertaken on the affective factors of schooling as well. Widely applied arguments for research in this area are that affective outcomes are perceived to be more lasting than cognitive outcomes, and that in order to motivate students for meaningful learning, the students have to feel that the subject is of some kind of personal relevance, and not just an imposed duty.

The decline in the number of students choosing to pursue S&T studies is commonly explained by a general disenchantment with traditional school science (Aikenhead, 2004; Osborne & al., 2003; Reiss, 2000; Sjøberg, 2002a; UFD, 2004). GASAT (Gender And Science And Technology) [31] is an international association concerned with the inclusion of girls and women in the world of science and technology. This association represents only one among many pursuits focusing on the fact that particularly girls refuse to give in to the subject (Carlone, 2004; Kelly, 1981; Lie & Sjøberg, 1984; Nergård, 2003).

Aikenhead's review of research on students' personal curiosity in science led him to deduce:

> Two unavoidable conclusions surfaced in this research: traditional science education played a meagre to insignificant role in most of the students' personal lives; and school science will only engage students in meaningful learning to the extent to which the curriculum has personal value and enriches or strengthens students' cultural self-identities (Aikenhead, 2004, p. 5-6)

Students' interests and attitudes towards science are influenced by a wide range of factors, operating at many different levels. In addition to individual factors such as personality, experiences, abilities, self-concepts and future plans, influences from school (the curriculum, the teacher, the teaching method), the home, and the peers are frequently analysed and discussed in science education literature. Affective qualities related to school science are also studied against variables such as sex, class and race (see e.g. George, 2000; Gilbert & Calvert, 2003; Krogh & Thomsen, 2005; Martin, Mullis, Gonzalez & Chrostowski, 2004; Nergård, 2003; Osborne & al., 2003; Reiss, 2000, 2004; Simpson & Oliver, 1990). Osborne et al. (2003) summarise research on students' attitudes towards science, in categories such as the science teacher, students anxiety, self-esteem, motivation

[31] www.gasat-international.org/ (accessed 2005-09-21)

toward science, students' enjoyment of the science classes, peers', friends' and family's attitudes towards science, achievements, and fear of failure in the course. In Nergård's (2003) review of literature on sex differences in attitudes towards school science, she discusses explanatory matters such as biological and genetic factors, self-confidence, the masculine "body language" and the impersonal "worldview" of science and school science, upbringing, parents' expectations, teachers' behaviour and expectations, teacher qualifications and teaching methods.

Since I do not have data that can be connected to most of these factors, I will not go into the various studies and report what they have found as the most important factors. My impression from the literature is that there is not one single outstanding factor that has the capacity to explain most of the variance in students' attitudes to science. Conversely, most of the above mentioned factors seem to have a major influence on the students' perceptions of their science classes, and on science as a school subject. (However, little empirical evidence for explaining sex differences in young people's attitudes towards science with biological and genetic factors has been found, Nergård, 2003.)

Naturally, there are numerous possible reasons for students' disenchantment with science, and the explanations are complex and interrelated. Before I go into some detail about relevant research findings, I will sum up Sjøberg's thirteen suggestions of possible explanations for students' lack of interest and engagement in S&T-related studies, at the secondary as well as the tertiary level of education (Sjøberg, 2002a).

## 3.1 Possible reasons for disenchantment with science

One explanation for students' dissatisfaction with school science may be that students perceive school science as dull, authoritarian, abstract, theoretical, fact-oriented and fact overloaded, with little room for fantasy, creativity, enjoyment and curiosity. The school curriculum seldom addresses contemporary issues of S&T in society. The subject is abstract and theoretical, and it contradicts common sense. It is perceived to be difficult and hard to understand, and consequently to demand much concentration and sustained hard work.

Another explanation may be a lack of qualified teachers, since S&T often are poorly served in primary teacher education, and teacher students are often those who did not like science at school themselves.

Also, anti- and quasi-scientific trends and the upsurge of "alternative" (metaphysical, spiritual and supernatural) belief systems, often rejecting scientific rationality, may weaken the potential of science to engage the students. Many post-modernist thinkers reject notions like *objectivity* and *rationality*, and terms like *reality* and *truth* are used with inverted commas.

Furthermore, students may hold stereotyped images of scientists and engineers as boring, narrow-minded nerds. The new idols and role models are rather found among football players, film stars, pop artists, journalists and others working on either sides of the camera.

Other reasons may be related to scientific discourses in society. For example, the dissension among scientists in contemporary socio-scientific issues (e.g. global warming and genetically modified food) may confuse and disappoint people acquainted with the

certainties of school science. People may also perceive the traditional values of science, which are meant to safeguard communalism, universalism, disinterestedness, originality and scepticism (CUDOS, Merton, 1973 in Sjøberg, 2002a), as values lacking ethical awareness and concern for social implications. Furthermore, people may be scared by scientists "tampering with Nature" and "playing God", searching for "the theory of everything" and "the God particle", and explaining animal and human behaviour only as means of survival of their genes. (Some may prefer to describe the natural world with irrational and unexplainable terms such as *sacred, mystical, beautiful* and *meaningful*.) Besides, scientists and engineers are no longer heroes, as the present welfare is taken for granted and more attention is paid to the drawbacks of S&T developments, such as environmental devastations and modern warfare.

## 3.2 Students' interest and attitudes related to S&T

Among students who find school science interesting, their motivation is often extrinsic or instrumental, e.g. for passing an examination or for their further education and career (Carlone, 2004; Osborne & Collins, 2001). Boys are more likely to study science with a career in mind, while girls learn science more for the intrinsic interests (Gardner, 1985; Nergård, 2003). Nevertheless, it seems that students find that scientific knowledge is an important part of their education (Jenkins, 2005; Osborne & Collins, 2001; Thompson & Windschitl, 2002).

The research interest for students' attitudes towards science is not a new occurrence. In 1984, the German Institute for Science Education, IPN, arranged an international conference on *Interest in Science and Technology Education*. The conference 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 up by a second conference, where the focus was on gender issues (Hoffmann, Krapp, Renninger & Baumert, 1998). In parallel with these international events, IPN has also had a series of research projects on various aspects of interest, under the umbrella of the *IPN–Interesse-studien* [32].

Nor is students' dissatisfaction with science a new occurrence. Ramsden (1998) summarises some major review papers covering research findings from the late 1960s up to early 1980s, and concludes that there is little doubt that young peoples' attitudes towards science in general have been unfavourable through several decades. Especially in lower secondary school, the students' interest is found to drop markedly (Lie, Kjærnsli & Brekke, 1997; Reiss, 2004; Simpson & Oliver, 1990). Although there is a general tendency for students' interests in *any* school subject to decline during lower secondary school (Grepperud, 2000), special research attention is paid to students' declining interest in science, particularly in physics, technology and chemistry (Gardner, 1985; Osborne & al., 2003; Ramsden, 1998).

[32] These studies are confined to German students, and most of the reports are published in German and therefore inaccessible to me.

### 3.2.1 Interests in subject matters

When students are asked about their interest in science as one integrated subject, boys are found to be more positive than girls (Grønmo & al., 2004; Lie & al., 1997; Ramsden, 1998; Simpson & Oliver, 1990), but when dividing the subject into disciplines as physics, chemistry and biology, and furthermore into single topics within each discipline, the pattern becomes more nuanced. Studies find that when compared to biology, physics is perceived to be boring, uninteresting and irrelevant (Osborne & Collins, 2001; Ramsden, 1998; Williams, Stanisstreet, Spall, Boyes & Dickson, 2003). Especially girls express dissatisfaction with physics (Gardner, 1985; Kjærnsli & Lie, 2000; Ormerod, 1981; Ormerod & Duckworth, 1975; Osborne & Collins, 2001; Williams & al., 2003). Topics like torches and batteries, nuclear power, atoms and molecules do not attract girls' interest (Whyte, 1986). Osborne and Collins found that the girls did not share the boys' interest in cars and flight, although also girls expressed some interest in light and electricity (Osborne & Collins, 2001).

In chemistry, the sex differences are less pronounced, although there is a tendency for boys to rank the subject higher than girls (Ormerod, 1981; Salta & Tzougraki, 2004). In Reiss' study, the many negative comments concerning chemistry lead him 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 (Reiss, 2000). Students' dissatisfaction with chemistry was also remarked in the focus-group study of Osborne and Collins: Both girls and boys expressed that, in general, topics like the periodic table and other intangible and microscopic entities were pointless and remote from the students' concerns (Osborne & Collins, 2001). Topics attracting interests in chemistry might be "mixing chemicals", "smells and colours" and "elements of danger" (Osborne & Collins, 2001),

Technology is commonly found to be a boys' topic, and boys are more likely to be interested in learning practical skills, and how appliances function and work (Gardner, 1985; Greenfield, 1995). Girls are more interested in issues that connect the teaching to social sciences, and to social and environmental implications of science (Gardner, 1985; Krogh & Thomsen, 2005).

When it comes to biology, girls often respond more positively than boys (Gardner, 1985; Kjærnsli & Lie, 2000; Ormerod, 1981; Williams & al., 2003). Particularly human biology attract interest, especially among girls (Cerini, Murray & Reiss, 2003; Gardner, 1985; Jónsdóttir, 2005; Osborne & al., 2003; 1986; Williams & al., 2003), for example how to maintain a healthy body through diet and exercise, effects of drugs and cures for diseases (Osborne & Collins, 2001). In Reiss' long-term study of how students' attitudes to science develop over time, the students ended up with stating that, in general, they did not find school science to be relevant for their lives. Among the "most useful" topics they reckoned they had learned, they mentioned sex education, drug use and differences in boys' and girls' behaviour (Reiss, 2000). Also a study of youth's choices of exhibit in science museums found that girls were more likely than boys to use the exhibits related to the human body, while boys were more likely to use the computers and the exhibits demonstrating scientific principles (Greenfield, 1995). But also boys are found to express interest about human biology. Whyte found that girls' and boys' interests in the human

body overlapped. For example, issues like how our muscles work, our eyes and how we see, and how children develop aroused interest among the boys as well as among the girls, although somewhat higher interest among the girls (Whyte, 1986). Topics like different kinds of trees, the weather, and how seeds grow into flowers, were found to be particularly demotivating to the boys (Whyte, 1986).

The interest in animals is more pronounced among girls (Sjödin, 2001). Girls also express interest in paranormal issues, and a belief that such phenomenon in a while will be explained by science (Sjödin, 2001). Both girls and boys show interest in issues related to existential questions of life (Sjödin, 2001). Even physics has one subject matter that appeals to both girls and boys, namely issues related to space and the universe (Osborne & Collins, 2001; Williams & al., 2003). Also other aspects of the unexplored and unknown provoked the interest of the students in Osborne and Collins' study (2001). The authors see this as students' interest in existential questions of identity.

Osborne and Collins' students blamed science for giving little space for creativity, imagination, discussion and self-expression. The authors concluded that grand philosophical questions about who we are, what we are, and where we are, attracted the students' interests, because such issues help the students to find out about self, identity and their role in the world.

Cerini et al. concluded that the students would have preferred a science curriculum including more contemporary socio-scientific controversial issues, as well as more philosophical and ethical matters (Cerini & al., 2003). Also other studies have revealed a general interest in socio-scientific issues suitable for discussion and deliberations, while fact-oriented topics had less appeal (Jarman & McClune, 2002; Osborne & Collins, 2001). Osborne and Collins interpreted this as indicating that the students were acquainted with the many political and ethical controversies connected to science and society (e.g. matters related to the environment, gene technology and population growth), and they questioned the emphasis school science put on facts and consensual knowledge. Students found it "strange that school science maintains a hermetic seal between itself and contemporary society" (Osborne & Collins, 2001, p. 454). Jarman and McClune have investigated how science teachers use newspapers in secondary science classrooms. One finding was the very positive responses the students gave towards using newspapers and discussing contemporary upcoming scientific developments and issues (Jarman & McClune, 2002).

Sjøberg's interpretations of results in the SAS suggest that students' interest in a subject matter vary with different *contexts*. For example, he found that *music* attracted much more interest than *acoustics and sounds*. Correspondingly, *the rainbow and sunsets* achieved higher interest scores than *light and optics* (Sjøberg, 2000a, 2002b). Corresponding context dependent interest differences were found in the study of Cerini et al. (2003), in which chemicals in industry was perceived as boring, while chemicals in the human body and drugs were more interesting.

Also, the study of Häussler and Hoffmann (2000) of 11-16 year old students' interests showed that the *context* was superior to the *content,* in terms of being decisive for the students' interest in physics. They designed a questionnaire in which one and the same subject matter (e.g. acoustics, optics, or energy) was repeated through five contexts: *practical* (promoting practical competence for everyday use), *socio-economic* (physics in

society), *emotional* (triggering affective dimensions like astonishment and beauty), *intellectual* (physics as a challenging scientific enterprise, but with little value for application and use in life) and *qualifying* (preparation for careers in physics). The researchers found that the older students were positive to 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. In the *practical* context, anything that had to do with the human body achieved high interest scores.

### 3.2.2 International comparisons

When it comes to comparative research on students' interests in science, I have not found many publications to draw on. The SAS study (Sjøberg, 2000a, 2002b) revealed a considerable interest divergence among students from different countries. Sjøberg found that in general, students from developing countries seemed to be more interested than students from the more developed countries in learning about most of the topics. The Japanese students gave overall low interest scores to the various topics. There were also remarkable cross-national patterns in sex differences: In the developing countries, differences in girls' and boys' interests were less pronounced that in the more developed countries.

In PISA 2006, there will be questions about students' attitudes, and maybe also interests, related to scientific literacy. But until now, TIMSS is the only large-scale comparative study with data related to students' attitudes to science. Analysis from TIMSS 2003 (Grønmo & al., 2004; Martin & al., 2004), show that students in Botswana, Egypt, Ghana, Jordan, Tunisia and the Palestinian National Authority had the most positive attitudes to science, while students in Chinese Taipei, Japan and Korea expressed the lowest positive attitudes. Martin et al. (2004) suggest that since the countries with the lowest positive attitudes also are among the countries with the highest average achievement, a demanding science curriculum may lead to high achievements but little enthusiasm. Norway, Italy and Australia were also among the countries in which the lowest percentage of the students express a positive valuing of science (Grønmo & al., 2004; Martin & al., 2004).

## 3.3 The role of S&T in society

According to the perspectives in 2.5.3, young people are growing up with a social background of general future pessimism. In a science education context, one may ask whether young people in modernised countries believe that S&T have the capacity to solve different problems facing our time.

It seems that there is a close relationship between the images people hold of the future and their attitudes towards the role of S&T in society. Those who are optimistic about the future also tend to be positive to the role of science and technology in society and to scientific and technological developments (Eckersley, 1999; Hicks & Holden, 1995).

The level of technological development in a country is a key factor for explaining the expectations people have of further developments in S&T. Sicinski (1976) found that people in developed countries are less confident about future achievements of science than people in less developed countries. The SAS study found that students in developing countries have far more positive images of scientists and their potential for helping people than students in developed countries (Sjøberg, 2000a, 2002b). The recent Eurobarometer survey (EU, 2005) also shows that the belief in the benefits of S&T is much stronger in the less developed countries than in the wealthier and more developed[33].

Several studies find that many young people in Western societies regard the benefits of science and technology as being more important than the drawbacks (Eckersley, 1987; Hicks & Holden, 1995), but there is something in the nature of the drawbacks that seems to worry young 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, p. 51).

When it comes to the capacity of S&T 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), and that boys have a somewhat stronger belief in the role of S&T developments than girls have (Eckersley, 1999).

## 3.4 Student typologies

Studying person types or styles is a well-known research approach, in qualitative as well as in quantitative research, and in sociology as well as in education research. In such studies, typical learning styles, personality styles, teacher styles, etc. are identified and described (e.g. in Astin, 1993; Clark & Trow, 1966; Costa, 1995; Dunn & Griggs, 2000; Eggen, 2004; Hellevik, 1996; Holland, 1966; Keirsey & Bates, 1984; Kolb, 1981; Kuh, Hu & Vesper, 2000; Lyng, 2004b; Medici & Montgomerie, 2001; Meyers & McCaulley, 1985; Phelan, Davidson & Yu, 1991; Saunders & Bauer, 1998; Vestel & al., 1997).

The most well-known personality typology is perhaps that of Myers and Briggs, drawing on the theories of the Swiss psychiatrist Carl Gustav Jung (Meyers & McCaulley, 1985). In 1921, Jung published his theory about psychological person types, based on three dimensions of personality traits. In 1942, Isabel Briggs Myers and her mother Katharine Cook Briggs published the first version of a personality inventory (Myers-Briggs Type Indicator, MBTI) that intended to assess the personality type of a person. The Meyers-Briggs types are based on Jung's work and further developed to include a forth dimension. Each dimension are polarised into dichotomies, such as *Extravert* versus *Introvert*, *Sensing* versus *Intuition*, *Thinking* versus *Feeling*, and *Judgment* versus *Perception*. All possible

[33] The recent Eurobarometer (EU, 2005) has collected data in 32 countries, among them the 10 new member states (previously Eastern Europe) as well as the "candidate countries", including Turkey, Croatia, Bulgaria and Romania.

combinations of these result in 16 psychological personality types, labelled with four-letter acronyms, e.g. ESTJ or INFP (Meyers & McCaulley, 1985).

The test is widely used in the areas of personal development, teaching and learning, group dynamics, education counselling, employee and leadership training, etc. (Ringstad & Ødegård, 1999).

There are also simplified versions of BMTI that apply only two-letter combinations (Ringstad & Ødegård, 1999), for example in the *Sensing–Intuition* and the *Thinking–Feeling* dimensions for learning styles, the *Extravert–Introvert* and *Sensing–Intuition* dimensions for leader styles, or David Keirsey's two-letter temperament styles (Keirsey & Bates, 1984).

The MBTI typology is based on psychological theories, not sociological. This means that influences from peers and culture are seen as unwanted noise, rather than as the key framework for interpretations (Ringstad & Ødegård, 1999). Therefore, I do not find it fruitful to connect the student types emerging from my material with any of the typologies based on the Myers-Briggs type inventory.

When it comes to *student types*, other studies have developed student classification schemes and instruments for style assessments. Many of these are applied and further developed in later research (e.g. in Dunn, 1995; Flowers, 2004; Frost & Teodorescu, 2000; Larkin-Hein & Budny, 2000; Luan, 2003; Miller, 2004; Sedlacek & Masters, 1980). Most student typologies refer to *learning styles* (Dunn & Griggs, 2000; Kolb, 1981). A learning style is a function of heredity and experience and develops over the life span, and "make the same teaching (and learning) methods effective for some and ineffective for others" (Larkin-Hein & Budny, 2000). For example, the Dunn and Dunn learning styles are defined by students' responses in a questionnaire, which aims to measure personal preferences within totally 21 factors grouped in five stimuli: *environmental, emotional, sociological, psychological* and *physiological* [34].

Due to the affective quality of the questions in the ROSE instrument (see chapter 4), my data can hardly be interpreted against a typology of learning styles. The following two examples of student typologies are based more on value, personality and interest orientations:

Clark and Trow identified four student subcultures, describing how students in US higher education interact and relate to their studies and their educational institutions (Strange & Banning, 2001):

- *The Academic:* These students are achievement oriented – they work hard and achieve high grades. They identify themselves with the college and are involved in the studies.
- *The Collegiate:* These students see their social life as a more central part of their studies than their intellectual achievements. They are engaged in extra-curricular activities, and in the social life on campus.

[34] www.learningstyles.net (accessed 2005-09-08)

- *The Vocational:* In this subculture, the students see their education as a means for having a job, but are not particularly engaged either in the intellectual learning or in the social campus life.
- *The Nonconformist:* Although these students may be good achievers, they do not conform to the accepted pattern of behaviour. They are individualists representing a counter-culture to the culture of the educational institution.

Astin (1993) used quantitative survey data from students' self-reporting of their own personality traits and personal goals in life, and identified seven student types in a *College Student Involvement* typology. The typology aims to describe college student behaviours:

- *The Scholar:* high achiever, intellectually self-confident, planning a high academic degree.
- *The Social Activist:* participating in community action programs, helping others, emphasising social and political values.
- *The Artist:* artistic ability, aiming at creating artistic work.
- *The Hedonist:* thinks that marijuana should be legalised, drinks alcohol, smokes cigarettes, stays up all night.
- *The Leader:* popular among other students, socially self-confident, leadership ability.
- *The Status Striver:* emphasises materialistic values, like being professionally and financially successful.
- *The Uncommitted:* anticipating changing educational choices, dropping out of the study.

Most of the student typology studies I have come across are related to college student retention, attrition and degree of completion, while I have not found much relevant studies in lower secondary school. In the next paragraph, I will go somewhat deeper into one particular study undertaken by Victoria Costa (1995). The reason for the following detailed reporting of her study is that it is related to school science in particular, and that it is widely applied and referred. Her study is inspired by a model developed by Phelan et al. (1991), presenting US high school students' lifeworlds of family, peer and school, and the types of transition they make as they move from one context to another. Among some fifty high school students from four high schools, they found four patterns of moving across settings. Students have different degree of success when grossing the borders between the different lifeworlds:

- *Congruent Worlds/Smooth Transitions:* The lifeworld of these student types are congruent, so the student type crosses the lifeworld boundaries uncomplicatedly.
- *Different Worlds/Boundary Crossings Managed:* For this student type, the lifeworlds are somewhat different with respect to culture, socio-economic status, religion, etc., but the students still manage successfully to traverse boundaries.
- *Different Worlds/Boundary Crossings Hazardous:* Here, the lifeworlds are so different that crossing the borders is "hazardous".
- *Borders Impenetrable/Boundary Crossings Insurmountable:* The lifeworlds of these students are disparate, and the boundaries are impenetrable (Phelan & al., 1991).

### 3.4.1 Costa's student types

As in Phelan's study, Costa aims at identifying boundaries that prevent students from succeeding in school science, and special attention is paid to whether home and school are "congruent". Costa's work is based on the assumption that "students' responses to science are related to the degree of congruency between their worlds of family, friends, school and science" (ibid. p. 313). The school success (or the lack of such) is explained by the students' handling of the boundaries, and how schools help or hinder the students.

Costa et al. gathered data through interviews with 43 high school science students, and the focus was particularly on the boundaries enclosing the world of school science. The authors identified five student categories:

- *Potential Scientists:* For these students, the worlds of family and friends are congruent with the worlds of both school and science. They are motivated and successful, and they see science as the door to the future. They are positive and active in the classroom, and are aspirants to scientific careers.
- *Other Smart Kids:* The worlds of family and friends are congruent with school, but not congruent with science. These students are smart, and excel in science as well as in all other subjects, but they question the value of science in their personal life, and do not see themselves as potential scientists. Science appears as unimportant to pursue.
- *"I Don't Know" Students:* The worlds of family and friends are inconsistent with both school and science. These students are not negative to school or to school science, but like all other school subjects, science is a "conglomeration of information" without much personal meaning for them. Their achievements are reasonable.
- *Outsiders:* The worlds of family and friends are discordant with both school and science, and this prevents success in science. These students spend their time "usually daydreaming". They fail in classes, and are alienated from school. At school, they are not together with friends, because school is merely "something to get through".
- *Inside Outsiders:* Worlds of family and friends are irreconcilable with the world of school, but potentially compatible with the world of science. These students have negative attitudes to most of their classes, including science. Due to their world of family, they are outside both science, school and society, but they have some interests and abilities in science, and could have been inside science.

Costa concludes that "students who plan a future in a science-related career have one major characteristic in common: their worlds of family and friends are congruent with the worlds of schooling and science" (Costa, 1995, p. 330). These are the Potential Scientists. None of the students that fall into any of the four other categories experience such congruency. Therefore, they become "academically and personally alienated from science". In order to engage more students in science and promote interests in basic concepts, Costa suggests that science courses should be organised around "issues over which students are genuinely perplexed", such as genetic engineering, environmental pollution and recent findings in cancer and HIV/Aids research. She points to the "necessity of curriculum and

school practices that facilitate the integration of the students' worlds of family, friends, schooling, and science" (ibid., p. 331).

### 3.4.2 Border crossing

Aikenhead follows up Costa's work, by suggesting a border crossing theory (Aikenhead, 1996). The theory is based on the assumption that student's lifeworlds of family and peers may be incompatible with the lifeworld of the science classes. When students travel from the subcultures of their peers and family to the subculture of school science and Western modern science (WMS), with its norms, values, beliefs, expectations and conventional actions, they might experience this cultural border crossing as more or less hazardous. In order to overcome subculture mismatches, teachers ought to act as culture negotiators:

> consciously moving back and forth between life-worlds and the science-world, switching language conventions explicitly, switching conceptualizations explicitly, switching values explicitly, switching epistemologies explicitly, but never requiring students to adopt a scientific way of knowing as their personal way (Aikenhead, 1996, p. 41)

Aikenhead discusses curriculum implications of Costa's student typology (Aikenhead, 1996), and suggests that all the student types in the one way or the other could benefit from an STS (Science Technology Society, Solomon & Aikenhead, 1994) curriculum:

The Potential Scientists are enthusiastically engaged in school science and have no problems with enculturation into the subculture of science or WMS. These students "derive pleasure from playing with abstract decontextualized concepts and solving idealized mathematical problems" (ibid., p. 37) – at least such matters will stimulate their short-term interests (in a longer perspective, many of the Potential Scientists will switch to political sciences, business studies, law, etc.). These students will probably not immediately value a curriculum shift towards an interdisciplinary STS curriculum, examining relationships between science, technology, society and culture, and involving e.g. discussions about social, political, moral and ethical aspects of S&T developments (Solomon & Aikenhead, 1994). Nevertheless, Aikenhead argues that in the long run, our society will be better served with Potential Scientists that have learned from "travelling through intellectual territory not often explored by these students" (ibid., p. 40).

In contradiction to the Potential Scientists, the Other Smart Kids would probably appreciate an STS curriculum. These students perform well at school, even in science, but they do not find the canonical WMS knowledge meaningful. For these students, "knowledge worth learning in school science is likely to be knowledge organised around everyday issues, derived from critical analysis, an involving reflection, self-expression, and humanistic rigor" (ibid., p. 33). Also the "I Don't Know" Students could benefit from an STS curriculum. As the Other Smart Kids, these students do not find their science classes personally meaningful, but they differ from Other Smart Kids in the way that they do hardly find *any* subjects relevant or meaningful. An STS curriculum would probably loosen up the border between the subculture of science and other life-worlds.

For the Other Smart Kids and the "I Don't Know" Students, Aikenhead suggests that the teacher should function as a "tour-guide" (for the "I Don't Know" Students) or as a

"travel-agent" (for the Other Smart Kids) into the science subculture. The underlying idea is that it is possible for the students to learn about the culture of science without adopting it. In both roles, the teacher must explicitly show the students the border of the science subculture as they cross it. The "I Don't Know" Students can be tourists and the Other Smart Kids can be travellers in the unfamiliar science subculture. The tour-guide takes the students to "some of the principal sites" and "coach them on what science to look at and how to use it", while the travel-agent "provides incentives such as topics, issues, or events that create the need to know the subculture of science" (ibid., p. 35).

The Outsiders and the Inside Outsiders challenge Aikenhead beyond the scope of his article, so he presents no curriculum implications for these two student types.

Aikenhead's border crossing theory is widely referred and used in science education research, both for understanding students' crossing from non-Western cultures over the border into WMS classrooms (Malcolm, 2006; Stanley & Brickhouse, 2001) and for understanding different Western students' relationship to school science (Krogh & Thomsen, 2005).

## 3.5 Science education and youth identities

In chapter 2, I referred to sociological theories describing youth's identity construction as a major project, permeating almost all facets of their lives, including their school activities in the breaks as well as in classes. Also in science education literature, young people's learning is seen in relation to youth's identities. For example, Brickhouse et al. (2000) develop Aikenhead's stories about cultural border crossings into stories about how students' identities do or do not coincide with school science identities. By building on Goffman (referred in 2.3.6), observations from Brickhouse and her colleagues' case studies of girls in science classes are interpreted against theories of student identities:

> The tasks for students are to decide which groups they identify with, what kinds of persons they wish to be as a part of each group, and what is required to become those kinds of persons (Brickhouse & al., 2000, p. 444)

The authors see students' behaviour in the science classes as expressions of whether, or to what extent, their social identities are compatible with scientific identities. They present detailed profiles of four high-achieving girls, and describe, among other things, how students choose identities of more or less *good students*. While Chandra "performed adequately and is very well liked by both teachers and peers" (ibid. p. 455), Tanisha's identity did not match the identity of a good student. Although she performed well, she was not very obedient and she did not want to take up a good student identity, because it would serve to silence and bore her.

Another study, undertaken by Thompson and Windschitl (2002), found that students with less focus on the extrinsic outcomes of science education were more likely to perceive the learning as related to their identity. Some students resisted seeking good grades because they were engaged in science in order to understand themselves, and not to understand science or to perform well. The students described how "their sense of who they are, who they are becoming, and the importance of relationships is central to how they relate to science and what they learn".

Finally, before I close this chapter, I wish to mention one more study, although it belongs to mathematics education. It is undertaken by Boaler and her colleagues (Boaler & al., 2000). They state that young people's identity development is an important and under-researched factor for understanding students' success at secondary school mathematics. When students develop an identity that does not resonate with the discourse of mathematics, they will not, regardless of abilities, choose to continue with studies in mathematics. Although most students wish to success at school, they do not want to succeed in a way that alienates them from their identity.

# 4 BACKGROUND AND QUESTIONNAIRE DEVELOPMENT

This chapter gives a description of the underlying rationale behind the project, and how the ideas have been used to develop the ROSE questionnaire (reproduced in Appendix A)[35]. I also give some details on the guidelines for data collection (population, sampling, logistics, data coding, etc.) that have been developed for the international partners who want their data to be part of the comparison.

## 4.1 The chronology and emergence of ROSE

As indicated, the ROSE project grew out of the SAS-study (e.g. Sjøberg, 2000a; Sjøberg, 2002b), which may be seen as a pilot study of ROSE. Based on the results and the experiences gained with SAS, the project organiser, Professor Svein Sjøberg at the University of Oslo, 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 funding was, however, much less than applied for, and plans had to be adjusted. Grants for a full time PhD researcher were the main part of the funding. This position was advertised, and among the 10 applicants, one was selected. This was me, educated as a data engineer, later as an M.Sc. in geophysics (meteorology), and with experience in science teaching. I started working in September 2001, which also marks the beginning of the ROSE project.

During the last part of 2001, invitations for participation were circulated through personal contacts as well as 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 Professor Sjøberg, and conditions for participation were clarified. The basis for participation was accounted for in the (revised) project description and a Handbook for participation (see appendix in Schreiner & Sjøberg, 2004c). This means that participants to a certain degree had a common understanding of aims, rationale and purpose of ROSE.

[35] Most of the text in this chapter has been published in *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* (Schreiner & Sjøberg, 2004c). The *we*-form in this chapter stems from the project partnership and co-authorship with Professor Svein Sjøberg. The reason for the relatively detailed descriptions in this chapter is that I see the project and instrument development as an important part of my doctoral education and work.

Early in the project, it became evident that additional funding was required, to support participation from developing countries, arranging workshops and seminars, releasing time available for the project coordinator, etc. This situation developed positively, and the funding enabled the project to support about 15 countries in their data collection and to hire Kristján Ketill Stefánsson in a part-time position from March 2004 to December 2004. Kristján comes from Iceland. He wrote his Bachelor dissertation based on ROSE and will base his Master thesis on the international data from ROSE. He was responsible for the maintenance of the ROSE website and handled the incoming data files (checking coding quality, merging the files, etc.).

## 4.2 Background, rationale and challenges

The ideological, political and social backgrounds and challenges for the emergence of ROSE are described in Schreiner and Sjøberg (2004). The report gives an account of some initial thinking and concerns prior to the launching of the project. ROSE intends to open up for variation and difference, and the project is 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 society. In addition, adolescence is not just a preparation for later life, but an important part of life itself. Students should therefore experience this period as interesting, positive and stimulating.

All such matters can naturally not be directly measured in a questionnaire and can consequently not explain what the ROSE questionnaire aims to address. However, the ROSE project aims to assist in describing a few of the many affective dimensions in S&T in a way that can stimulate debate and reflection.

### 4.2.1 *Relevance* as a key word

The word *relevance* is chosen in the project title of ROSE and our use of the term simply begs for a definition or at least some sort of clarification. Some obvious follow-up questions may be: *Relevant for whom?* and *Relevant for what?* Relevant for students who are aiming for S&T studies and careers? Relevant for promoting national economic growth? Relevant for qualified citizenship and participation in democracy? Relevant for high TIMSS/PISA test scores? Relevant for more enjoyable science lessons and everyday life at school? Relevant for sustainable development? and so on and so on (see 1.4).

Rather than *for whom and for what*, one may ask *Who decides what is relevant?* (Fensham, 2000a, in Aikenhead, 2004). Aikenhead (2004) synthesises research in science education into seven categories of *relevance*, and classifies the ROSE project as a *personal-curiosity science* in which relevance is related to students' own expressions of what they perceive as relevant in their culture and for their identity.

Our main perspective is *relevant from the viewpoint of the learners; i.e. what young people themselves express as their interests and concerns.* Students often blame school science for playing a small role in their everyday lives. As we all know, not all youth are miniature scientists with an urge and desire for revealing the hidden laws of nature. Their desires are naturally also directed towards their own interests, worries, lives and surroundings. ROSE aims to achieve 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.

In most highly developed countries young people are, to a lesser extent than before, willing to engage in learning that they do not feel is motivating, meaningful and relevant. 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, and promote sustainable development. Only by meeting the learners at *their* premises, can science teaching contribute to develop young people into concerned, empowered and autonomous individuals. Therefore, it is 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? 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. This means that our use of *relevance* is more an umbrella term for a wide spectrum of factors that, broadly speaking, belong to the affective domain. We could have chosen other words, like meaningful, motivating, interesting, engaging and important. *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.)

### 4.2.2 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 9300 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 & Imsen, 1987).

The SAS-study started with a curiosity about children's interests in science and their attitudes toward 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, 2000a, 2002b), 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 a pilot study for the ROSE-project, as we build on the experiences and 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 about 15 students are more mature and hence more likely to have done more conscious reflections on their interests, priorities, 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.

## 4.3 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 of *what* the questionnaire aims at measuring and *how* this 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 & al., 1996; Cohen, Manion & Morrison, 2000; Robson, 2002) describe a whole range of different research designs and their strengths and weaknesses.

As discussed in the introduction (in 1.3.1), some research requires precise hypotheses and operational definitions of the concepts that shall be measured, while other studies are more qualitatively oriented, flexible in design, and open for surprises and new ideas. They do not, however, lend themselves easily to comparisons and to generalisations. ROSE may be said to fall in the middle between these two research designs.

### 4.3.1 The explorative nature of ROSE

ROSE is quantitatively and statistically oriented, but aims to combine this with the openness mentioned above. Rather than confirming or falsifying certain precisely predefined hypothesis, ROSE 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 differences and similarities in students' interests, priorities, future wishes, experiences, etc. which are of relevance for the teaching and learning of science at school. ROSE is not aiming to assess *all* such relevant concepts. Nor is it trying to measure every possible facet of the concepts. 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 discussion about science curricula in various cultural and societal contexts.

Although the study aims at *exploring* and bringing *new* perspectives and theories to a cross-cultural context of science education, 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 the project partners do not in detail have the same approach to or theoretical

perspective on the study; there is not one specific conceptual or theoretical framework on which this study is based, and there is no fixed set of precisely defined research questions. Partners in the ROSE study may bring a variety of approaches, like cross-cultural perspectives, sociology, youth research, development perspectives, comparative education, curriculum policy, learning psychology or feminist theory. By providing data that can be analysed 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.

Primary 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. Our review of the literature indicates that there does not appear to exist any research instrument designed to measure the sort of attitudinal aspects of students' relationship to science that the ROSE project wants to assess. Hence, we had to develop this instrument ourselves. This has been an important element of the project. In the following, I will go into some detail about this process.

### 4.3.2 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; Ramsden, 1998). Some problems can only be dealt with in detail after the data collection, like data analysis and interpretations, and aspects of validity and reliability. 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 concerned (students, teachers and researchers)
- reviewing relevant literature
- specifying the underlying ideas
- defining the issues and subjects to be addressed
- designing and developing the instrument
- 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 need 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 chapter, I will elaborate on some of the other aspects that have preceded the data collection and analysis.

### 4.3.3 Instrument format

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.

We are aware of some of the critique of the quantitative survey research design. For example, it reads that surveys may contribute to *identify* some aspects, but surveys cannot help us *understand,* as they do not allow students to deepen their responses. Furthermore, questionnaires are developed from the angle of the adults, and are therefore not likely to capture the perspectives of the students. Data collected by open questions in which the voice of the students are allowed to come through, e.g. interviews, essay writings and open-ended questions, 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 gone 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 weak coding reliability and low response rates. Only one question in the ROSE questionnaire is open-ended (question I, see 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 using other data collection methods. In order to both validate the questionnaire and deepen our understanding of some issues, we wish to pursue some of the questionnaire topics for example by conducting interviews and/or focus group discussions. Many ROSE partners in other countries are collecting data on issues raised in ROSE by other, more qualitatively oriented methods.

An advantage with closed questions is that they entail relatively low costs, since 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 quickly and easily answered (Oppenheim, 1992). On the other hand, there are some drawbacks with closed questions: there is a loss of spontaneity and expressiveness, we get no knowledge about the respondents' thoughts of their own accord, and 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. Also, one may possibly lose responses, if the respondents become irritated because they do not feel that the questions express their own ideas (ibid.).

Closed questions are, as indicated above, easy to administer, code and analyse. Collection of large amounts of data is simple and relatively cheap. But the quality of the data obtained is, of course, limited by the quality of the instrument. One only gets answers to the questions one asks. Therefore, a closed and ready-made questionnaire requires a lot of time and effort spent on instrument development. I will, in the following, share some of our concerns from this process.

### 4.3.4 Item design

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)[36].

Some of these issues are particularly important in the case of ROSE, since this instrument will be used in very different cultures, translated into other languages, and used by students who may respond in another language than their mother tongue. We also tried to avoid tedious repetitions of nearly similar questions, although more items might have increased the reliability of the composite variables (see section 5.6). 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. Similar questions may even make the respondents feel that somebody is trying to lure them into a trap of contradicting themselves.

### 4.3.5 Response scale

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 such as Thurstone scales and Semantic Differential scales. Compared to Thurstone scales, Likert scales are easy to construct and easy to give responses 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 response categories in a Likert scale is discussed in many standard textbooks on research methodology, and the recommendations vary: In a five-categorised (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 to tick the middle neutral box. This high number of ticks in the neutral box is

[36] Still, we have slipped in some places. For example, one Norwegian student noted, in connection with item *G04. Science and technology make our lives healthier, easier and more comfortable,* that "Yes, easier and more comfortable, but not healthier!". This means that item G4 is an example of a double-barrelled item. (This item is a literal copy of a Eurobarometer item, see 4.5.6)

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 literature review, we have chosen to leave out the neutral middle point, as well as the "Do not know" category. Without these categories, the respondents are in a way "forced" to take a stance. The ethical aspect of this can of course be debated, and one can argue that people should have the right to remain neutral to an issue. In order to meet this issue, we remind the students in the introduction to each question that they may abstain from ticking any boxes if they do not want, or do not know what to answer. (See discussion of missing responses in 11.2.1.)

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

We decided to put headings *only* above the extreme categories in the Likert scales. In this way, we avoided the task of making good and balanced titles. It also simplified the translations of the titles into other languages, and avoided ambiguity in meanings. In discussions and interviews with some respondents (see 4.4.2), they did not indicate the lack of such headings as being problematic. We are 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.

### 4.3.6 Three major challenges

Every questionnaire developer faces several challenges. Numerous decisions have to be made, priorities have to be balanced, and compromises between competing concerns are frequent. Below (in paragraph 4.4) I shall give some details of how the questionnaire was developed into its final form. But before this, I will mention three major challenges which influenced the evolution of the questionnaire and had great impact on the final product. ROSE is burdened with three central features, which in themselves may be perceived as self-contradictions:

- *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.
- *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.

- *Cooperation without a common aim:*
  The questionnaire is developed in a cross-cultural collaborative process – involving actors who may bring in their own theoretical background, research agendas, ideologies, political aims, etc.

I regard the following description of the challenges as important in setting the scene for the process of developing the questionnaire.

**Exploring while wearing blinkers**

This challenge is related to the conflict between our ambition to *explore the unknown* – but by collecting data with a ready-made closed questionnaire. Wearing blinkers will reduce one's sight and horizon; and the questionnaire format is, by definition, restricting what one can possibly see. The obvious weakness of closed questionnaires is that one only gets answers to questions one actually has 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 be to allow the students to express their own ideas with their own words.

The ROSE questionnaire includes only one open-ended question (data from this question will not be analysed here). 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 item responses.

We have tried to meet these inevitable limitations through the process of developing the questionnaire. We have made an effort to maximise the span captured by the questionnaire items. For example, in question A, C and E (*What I want to learn about*, from now referred to as question ACE) we request the students to indicate how interested they are 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 them in order to be more open to the view of the students.

The active participation of scholars from a wide range of cultures in the process of instrument development has hopefully also enabled us to maximise the variety that we wish to capture and describe. The various stages and approaches throughout the questionnaire development (interviewing students, piloting, etc., see paragraph 4.4) has also helped us to be open to the variety that we are aiming at.

**Comparing the incomparable**

The second challenge concerns the complexity of comparing across very different cultural and developmental settings. Questions that are meaningful in one culture may seem strange, or even incomprehensible, in other cultures.

Diversity in ethnicity, religion, culture and tradition as well as political, economical, natural 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, health and nutrition, skin lotions, 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 set of underlying factors, or the way different items cluster (see 5.6), is likely to be different in different cultures. One should bear in mind that high reliability for a composite variable is not a property of the instrument itself but of the *data* that are gathered. Data collected with the same instrument may result in different latent variables in different cultures.

If one and the same question measures different theoretical constructs in different cultures, one must be cautious with commenting on observed differences between different cultures. 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 reach a degree of consensus on questionnaire items that 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 to different meaning, connotations and relevance between the countries[37].

The Norwegian ROSE team is, of course, most likely to see science, youth and schooling through Norwegian lenses. We have therefore been depended on collaboration with researchers from other countries – both with respect to the selection and the wording of items. 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 for national analysis and interpretations. In order to facilitate this and for exchange of findings and views we have arranged several workshops and seminars for ROSE partners, and are planning still more.

**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, carrying with them their own perspectives, theoretical approaches and research interests, often emerging from national or local educational and societal settings and challenges. This poses some problems, but it also

[37] Even within one country we cannot expect all students to put the same meaning in one and the same item. The following are comments from some Norwegian students to some questionnaire items:

*A06. The origin and evolution of life on earth* – "ha ha – never found any evidence!"
*C08. The possibility of life outside earth* – "if you mean God and Jesus"
*C17. Why we can see the rainbow* – "it is the covenant between God and Noah"

points to a 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 for us, in the development of the questionnaire.

A complete consensus among a group of S&T educators from all continents on every issue relating to the questionnaire structure, length and content is virtually impossible to achieve. 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. Still, we want to emphasise that it is a product of international cooperation, and we know that the research partners do feel a kind of ownership of the final product.

### 4.3.7 Translation: Language and meanings

The master version of the ROSE instrument is developed in English. This is also the working language of the project. Subsequently, the questionnaire has been translated into many other languages.

English and Norwegian 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 is of course much more difficult when translating into more distant languages. I will not go into details on general problems of translations from one language to another, but only indicate a few examples of how translation can be complicated.

When students are asked questions about attitudes to *science*, the meaning may indeed be different in different languages. In English, the term *science* is more or less synonymous to *natural science*. In daily use, there is no need to add *natural*. If one implies another field, one has to be explicit, like saying *social science*, *political science*, etc. In Norwegian, (natural) science is commonly translated to *naturvitenskap*, while *vitenskap* alone is the more general term for systematically organised knowledge. However, like in English, *vitenskap* may be used for the natural sciences in particular. But, while *naturvitenskap* is the term for science as an academic discipline, the corresponding school subject is *naturfag*. However, in everyday use of the words, *naturfag* (the school subject) is commonly used also for *naturvitenskap* (the discipline).

In the Norwegian version of the ROSE questionnaire, we have translated *science* into *naturvitenskap* and *vitenskap*, and *school science* into *naturfag* (or *Natur og miljøfag*, which is the accurate name of the school subject at the time when the data were collected). The meaning that students associate with the word *science* is probably closely related to their experiences in science classes. Reasoning about what understanding the Norwegian students have of the term *technology* is more complicated. Technology is not a distinct part of the Norwegian science curriculum. This term may consequently be associated with issues outside the school context, as for example industry and ICT.

The translation of *scientist* into Norwegian is also somewhat complicated. The most precise and correct Norwegian word for *scientist* would be *vitenskapsmann* (male) or *vitenskapsperson* (sex neutral). These are, however, long and unwieldy words. In everyday terminology, *forsker*, which means *researcher*, is more commonly used. In the Norwegian version of the ROSE questionnaire, *forsker* or *forsker i naturvitenskap* is used for *scientist*.

Such different meanings of *science* and *scientists* can cause severe misunderstandings. When *science* and *scientists* are translated to other, more "remote" languages, the problems will naturally become even more pressing.

These examples illustrate the point that translations may be difficult, and possibly misleading. I could have chosen other words as examples. The matter may be even more complicated when one moves from single words or concepts to full statements, maybe particularly in questions about attitudes, perceptions, emotions, etc. 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. TIMSS and PISA have established strict procedures for ensuring translation equivalence.[38] 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)

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. The ROSE researchers have been requested to report on problems related to translations and the student's understanding of the questions in their data collection report.

## 4.4 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 of the questionnaire started in the autumn of 2001, and proceeded in several stages through more than one year. Through the whole process, we had frequent discussions with students, teachers, ROSE partners and scholars from various academic fields (sociology, psychology, psychometrics, etc.). It would be too lengthy to go into detail on every stage of the process and on every consideration, discussion and decision we have made. The following is a rough review of the main steps towards the final version of the questionnaire.

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[38] *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 in the English language) into the national languages, and then translating them back to the source language and comparing with the original to identify possible discrepancies
- PISA 2000 used *double translation from two different languages* procedure with two parallel source versions (in English and French): PISA recommended 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)

### 4.4.1 Workshop with ROSE Advisory Group

In October 2001 we hosted a four-day 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 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) accepted to join the Advisory group as well, but they were unable to attend the workshop. This means that scholars from many continents were gathered in the workshop.

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. 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, some altered and some deleted, and with suggestions of introducing new questions. The seminar was followed up with cooperation by e-mail.

### 4.4.2 Preliminary studies in Norway

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 Norwegian 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 into the questionnaire through these studies of modern youth will improve our understanding of youth in more traditional 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 in grade 10. The students were not probabilistically sampled; hence the sample was not representative for the Norwegian population.

A rough report of some of our findings, concerning what the students were interested in learning about: 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 use and relevance, such as e.g. *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, journalism and chefs, while agronomy and science teaching were at the bottom.

**Discussion groups with students**

We arranged discussions within two different groups of students who 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 a 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 and twin-research on the influence from inheritance vs. environment on personality development. It was thought-provoking for us 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 facts they had learnt from science at school, because a situation might occur when it is "useful to know", for example in a quiz or in a discussion with friends or family. The same day they had learned about enzymes in saliva, which they found of use – because "now I know".

**Written lists of topics**

Through cooperation with science teachers for grade 10, students in four school classes were requested to write a list of science-related topics that 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 various encouraging and discouraging experiences with teaching science in lower secondary school. We also asked them in what way they would want their science teaching to prepare and equip young people for their young and adult lives.

### 4.4.3 First international trial

In April 2002 we had implemented responses and ideas from the preliminary studies into the questionnaire version from the workshop. The size of this first draft questionnaire was more than twice what it should be, but it was nevertheless distributed to the ROSE Advisory Group and to all researchers who had expressed interest in participating in the ROSE project.

Although the partners were asked to indicate which items they would suggest 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 pointed in very different directions. Again, we were confronted with the challenge of aiming to compare 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 subjects in the 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.

These examples may serve to illustrate some of the many challenges we have met, and the many compromises we have made.

### 4.4.4 Piloting

At the same time that the first draft questionnaire was on international trial, we translated the questionnaire into Norwegian and piloted it in five Norwegian school classes. The purpose of the pilot test was threefold: First, it was to gain experiences on procedural matters and practicalities of organising the survey, like establishing contact with coordinators at schools, instructing them in how to carry out the survey, the duration of the test run, collecting the questionnaires and coding data in the codebook. Second, 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. Third, 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. One particular critique of the questionnaire was very explicitly pronounced, in the feedback from both the students and 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 responses, and carried out some statistical analysis. Issues like design, measurement and 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 revision of the questionnaire.

### 4.4.5 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 to develop 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 presented the project and the questionnaire to the GRASSMATE group, and then jointly elaborated on the questionnaire items. We received some useful comments; in particular, emphasis was put on discussing the cultural balance and different values and worldviews in the Norwegian and African cultures.

### 4.4.6 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 a diversity of responses, and that comments from some nations contradicted 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 4.5.1), we had employed the following question for tapping into 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 including several questions for measuring SES (see 4.5.1). 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 facets 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, and less suggestions for which items to exclude. It was equally interesting to note that some partners characterised the questionnaire by having

> a western and middle-class orientation

while others indicated that it had a

> bias favouring developing countries

as well as an

> ideological orientation towards "alternatives" at the expense of "proper science"

Again, we had to make compromises to balance the diverse feedback.

### 4.4.7 Interviews

While the questionnaire was on its second trial, 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 understanding of the items matched our intention behind them.

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

### 4.4.8 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 finalised in the beginning of November 2002.

Through the whole process of developing the questionnaire, we have aimed at ensuring that nothing was unjustifiably emphasised at the expense of something else. We acknowledge that we can not possibly 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.

## 4.5 Questionnaire rationale and data coding

The questionnaire items are grouped under question headings (A-I). Under each of these, we have had several dimensions or categories in mind. Whether or not the items turn out to have satisfactory statistical properties for tapping into the intended dimensions can only be discussed on the basis of the data, as the internal consistency of 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 parts of the ROSE instrument are deemed to be function in some cultures, but not in others. It is certainly the case that it is easier to develop a reasonable and sound instrument for use in one culture only. But the purpose of ROSE was to make a cross-culturally suitable instrument. Issues of external validity and must be seen in this light.

In the following, I will address issues of why we were asking the questions we did, and how we intended to use the responses. (Such rationales are not given for question H, I and K, as I have not analysed data from these questions in the present thesis.) The ROSE questionnaire is reproduced in Appendix A.

### 4.5.1 Student background questions (cover sheet and question J)

There are many extra-curricular 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 and peer culture.

The cover sheet of the ROSE questionnaire contains three classification questions: survey country (coded in a string variable), sex (coded 1 for girls and 2 for boys) and age (coded as number of years). Missing responses for sex and age were coded 9.

Previous research has identified a relationship between educational achievement and the economic, social and cultural capital of the students' parents (Ho Sui-Chu & Williams, 1996; OECD, 2000a; Turmo, 2003). Such results are explained with factors such as e.g. that parents of higher SES are more involved in the education of their children than parents with lower SES, and that they thereby stimulate more positive attitudes and a general motivation to learn, provide better homework conditions, etc. which facilitate higher achievements.

For obvious reasons (see 4.4.6) such questions would be impossible to interpret when comparing across the different cultures represented in the ROSE sample. 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[39]. Nevertheless, because of the contemporary research interest in SES, we decided to include *one* question addressing this issue. At the end of the questionnaire, there is one question about the number of books 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.

This question has seven response categories: *None* (coded 1), *1–10 books* (coded 2), *11–50 books* (coded 3), *51–100 books* (coded 4), *101–250 books* (coded 5), *251–500 books* (coded 6) *and More than 500 books* (coded 7). Missing responses were coded 9.

This question is a true copy of the corresponding question in the PISA 2000 questionnaire. In addition, PISA asks a number of questions about parental education and occupation, home possessions, etc[40]. As the number of books in the home has turned out to be a good proxy for SES (Lie & al., 1997), the choice fell on this question. 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.

We suggested for our partners that they, if relevant for contrasting groups in their national analysis, might add some complementary questions (about region, type of school, mother tongue, SES, etc.). Some participating countries have added such variables. Details are given in the national data collection reports, which can be found on the ROSE website.

### 4.5.2 *What I want to learn about* (question ACE)

One underlying hypothesis for this question is that in spite of few students choosing an S&T education and career, and in spite of research finding that many students do not like school science, many young people find aspects of S&T interesting. The ACE question will give empirical data on what topics various groups of students[41] are interested in learning

[39] SES questions may complicate the official permission formalities. For example, in the Japanese version of the ROSE questionnaire, the question about number of books in the home was excluded, as Ogawa, our ROSE partner in Japan, thereby "prevented unwanted trouble in administering the survey" (p. 1 in Ogawa's report on how the ROSE survey was carried out in Japan, see the ROSE website).

[40] Some examples of PISA SES questions: parental education and profession, how often the family eats the main meal together, whether they have works of arts in the house, 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.

[41] When I in the following use the term *group of respondents*, *group of students*, etc. I allude to various ways of classifying the students into categories. The most obvious variables for stratifying the samples are by the classification variables such as sex, 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). Se more about ways of categorising respondents in section 6.1.

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. Asking the students how interested they are in various topics is one approach for getting in touch with science lessons' potential for engagement.

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 believe that if the teaching of school science can enliven, motivate, enrich, engage and inspire the students, the subject may promote many of the different purposes of science education discussed in the introduction.

As mentioned in chapter 3, there are several factors influencing the potential of science education to motivate and engage 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 do culture and sex 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, and with various wishes for their future job)?

There is a great variety of teaching methods and 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 for motivating students and attracting their interests. As all teachers know, the teaching method or pedagogy does indeed make a difference (e.g. Cerini & al., 2003; Mork & Jorde, 2004; 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. This 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 this does not guarantee the students' willingness to make an effort for achieving an intellectual understanding of the subject matter. 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.

Under 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. The extreme categories in the Likert scale are labelled *Not interested* (coded 1) and

*Very interested* (coded 4). Missing responses are coded 9. It is a rather lengthy question with totally 108 items. In order 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 in the above described study of Häussler & Hoffmann (2000). The structure is a two-dimensional system in which most of the items could be classified by *content* (subject matter areas) and *context*. (The *action* component (Häussler, 1985) is not addressed here.)

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 universe of subjects in the natural sciences; neither are they at the same level of detail and specification (the characters in brackets are abbreviations for the various entries. They correspond to the codes for each item in Table 4-1):

- Astrophysics, the universe (U)
- Earth/geo-science (G)
- Human biology (H)
- Zoology, animals (A)
- Botany, plants (P)
- Chemicals (C)
- Light, colours, 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)[42]
- 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)

[42] I have found it hard to make a good label covering topics related to everyday matters as e.g. *E25. Plants in my area*, *E26. Detergents, soaps and how they work* and *E28. How to use and repair everyday electrical and mechanical equipment*. Topics like mobile phones, body fitness, safe drinking water, chemicals, musical instruments and petrol and diesel engines are highly relevant for the modern everyday life too, although these are classified in other contexts...

- Science, Technology and Society, Nature of Science, etc. (X)
  (often undefined in terms of subject)

These contexts have derived from our reading of sociological theories about late modern youth culture; review of research in science education; the SAS instrument; preliminary studies with Norwegian students and teachers (see 4.4.2), and ROSE partners in other countries.

The classification by content and contexts could have been done in many ways, and the above lists only represent 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, since 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. Furthermore, we will find that items grouping together in one culture may group very differently in another. The classification scheme has not been applied strictly, but has functioned rather 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 4.4) we were left with 108 items. This number included 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.

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

Table 4-1 is an overview of how we at the outset classified the items.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A01:** | *U* | **A02:** | *C* | **A03:** | *G* | **A04:** | *G* | **A05:** | *G* | **A06:** | - |
| **A07:** | *H* | **A08:** | *H* | **A09:** | *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* |
| **C01:** | *CR* | **C02:** | *LT* | **C03:** | *LT* | **C04:** | *ST* | **C05:** | *T* | **C06:** | *T* |
| **C07:** | *T* | **C08:** | *UM* | **C09:** | *UMH* | **C10:** | *UM* | **C11:** | *HM* | **C12:** | *HQM* |
| **C13:** | *HM* | **C14:** | *M* | **C15:** | *HM* | **C16:** | *LUB* | **C17:** | *LGB* | **C18:** | *GB* |
| **E01:** | *PB* | **E02:** | *LGB* | **E03:** | *GW* | **E04:** | *GW* | **E05:** | *GW* | **E06:** | *TW* |
| **E07:** | *HQ* | **E08:** | *HQ* | **E09:** | *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 4-1: Contents and contexts in the ACE items. Item numbers (boldface) and intended connections to contents and contexts (italics). Abbreviations (see text): 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: Youth health; 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.

In a universe of thinkable topics to learn about, the item sample in this question is naturally small and unrepresentative. Still, data from these items may illuminate questions like:

- How does the context vs. the content issue influence students' interests?
- What kind of interests seem to be shared or universal, and what kind seems more influenced by their cultural background?
- Can the debate outlined above (in 2.5.4 and 2.5.5) about narcissistic and post-materialistic values deepen our understanding of the scores?
- How can we characterise different interest profiles for different groups of students (and 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. One example may be analysing question ACE together with question D:

- How do the interests of students who are empowered for environmental protection (see 4.5.4) differ from interests among students lacking concern for environmental problems?

### 4.5.3 *My future job* (question B)

This question provides information about some job priorities among the students. 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 for self-realisation and for fulfilling and developing personal talents and abilities (see section 2.5).

Under 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* (coded 1) to *Very important* (coded 4). Missing responses were coded 9. The question contains items meant to describe students' priorities in the following dimensions of their future work:

- Self-realisation (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)

One subject that can be illuminated through this question is:

- Is there a "modern profile" in the question? Can scores in some of the items reveal more concern about self-realisation among youth from modern societies than among youth from non-modern societies?

If this is the case, i.e. if we do 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-realisation" than others?
- What is the relationship between the items for "self-realisation" in B and the items for "empowerment" in D (see next paragraph)?
- How are scores on items for "self-realisation" related to scores for attitudes towards science classes and S&T in general (question F and G)?
- Can we find a pattern between scores on "self-realisation" and the categories for why they want to do the research on particular subjects in question I?

### 4.5.4 *Me and the environmental challenges* (question D)

Empowering students to deal responsibly with environmental issues 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 equip students to meet environmental problems. Research in science education has taught us a lot about students' conceptual understandings (and "misconceptions" or "alternative conceptions") of science content, but less about their attitudes, priorities and decision-making regarding environmental matters. This part of the questionnaire will deepen our understanding of how youth relate to some environmental issues, and we can interpret the results against perspectives from sociology and youth research.

We see empowerment as a prerequisite for action, which requires content-specific knowledge and cognitive skills, motivational patterns and personal value orientations. An empowered person combines his/her cognitive resources (knowledge and skills) with affective resources (motivation, attitudes, hope and visions) and feels capable of taking appropriate action to achieve what s/he aims for.

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

- be motivated for action towards the problems
- have hopes and visions for the future
- have a general feeling that s/he can influence the future development
- be interested and engaged in environmental issues
- believe 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, organisations, etc. But as ROSE does not assess this knowledge component of empowerment, I will not pursue this any further here.

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* (coded 1) to *Agree* (coded 4). Missing responses were coded 9. This question seeks to explore to what extent the students feel empowered to cope with the environmental problems. We are asking questions (negatively or positively stated) about whether they:

- have hopes 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; 1997) described in 2.5.4
- have a general feeling that they can influence the development (D6, D12)

- believe 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 also 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 and meaninglessness (e.g. Seeman, 1972) and measurement scales reviewed in Measures of Social Psychological Attitudes (Robinson & al., 1991). The last four items in this question (D15-D18) are related to quasi-religious views on nature and whether protection of nature is a goal in itself. These items are adapted from an international survey on values and environment (Skjåk & Bøyum, 1993).

Responses to these items 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 characterise differences in views on environmental protection between different groups of learners?
- Are scores on "empowerment" in 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?

### 4.5.5 *My science classes* (question 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* (coded 1) to *Agree* (coded 4). Missing responses were coded 9.

This question provides information about different aspects of the students' perception of their science classes, such as their motivation for school science, their confidence in their own abilities in science at school, what they get out of science at school, and their perceptions of the necessity of science education. 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.)

### 4.5.6 *My opinions about science and technology* (question 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* (coded 1) to *Agree* (coded 4). Missing responses were coded 9. The public Eurobarometer surveys (EU, 2001) and NSB (2004) have provided a useful background for the development of this question.

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[43] and similar surveys in other parts of the world. The responses can for example 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.

### 4.5.7 *Important goals for society* (question L)

The Norwegian version of the questionnaire has an additional question at the end probing students' perceptions of what they see as important goals for our society. The question is inspired by, and partly adopted from, the *Young in Norway 2002* survey (NOVA, 2002), a large-scale study of lifestyles and living conditions among Norwegian youth.

The question is introduced with:

> L. Below is a list of possible goals people may find important. In what degree do you find these goals important for our society?

The question is not included in the English version of the questionnaire in Appendix A, but contains the following items:

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. More 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 sex quotas to have more women in senior appointments
14. More emphasis on education and better schools
15. Give economic support to poor countries
16. Provide a society free from drugs

[43] http://europa.eu.int/comm/public_opinion/ (accessed 2005-09-08)

The students were requested to indicate how important they found each of the goals for our society by ticking the appropriate box in a Likert scale. While all other Likert scales in the questionnaire has four response categories (coded from 1 to 4), this question has ten (as in the NOVA questionnaire). Initially, the leftmost response category (*Not important*) was coded 1, the next 2, etc., and the rightmost category (*Not important*) was coded 10, while 99 indicated missing responses. In order to have the same data metric in this question as in the others, the categories were later recoded to 1, 1.33, 1.67, 2, etc. From this follows that responses in the 10th category was coded 4.

## 4.6 Instructions to participants

In cooperation with research partners, we developed 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 describes 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.

In a comparative research project like ROSE, it is 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 organising 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 operates on another scale. It is a low-cost undertaking based on cooperation between interested researchers in diverse cultures. Some researchers got some national external funding, but, in most cases, they did not receive any payments, and their involvement in the ROSE project had to enter into their present employment. Given these considerations and constraints, we were nevertheless interested in collecting high quality data from representative samples.

As ROSE is not a test, there are no correct answers. Hence, there is nothing like "cheating", and there was no need to be extremely strict about the guidelines for administration and data collection. The important thing has been to get reliable and honest data; so in fact, some help with language and understanding has been considered to be positive. It also implies that there was no need to put time constraints on the students when they filled in the questionnaire. We estimated that about 40 minutes was sufficient time. But if this was not enough – say, in cases with language problems – we asked the coordinators to ensure that the students had time to understand and answer all questions. One could also consider the possibility of completing the questionnaire as homework.

Appendix B is quotes from the *ROSE Handbook* with instructions to ROSE partners on how to define a target population and draw a sample. See Schreiner and Sjøberg (2004) for more information about translation of the questionnaire, coding and cleaning of the data, etc.

## Code books

We developed an empty data file for the coding of the responses to the closed questions A-H. (Responses to the open question I needed interpretations before coding. For practical reasons, this question was coded separately in another data file containing the pre-defined categories, see Schreiner and Sjøberg, 2004). Both data files were made available in two formats: SPSS (Statistical Programme for the Social Sciences) and Microsoft Excel.

As a general rule, the actual *position* of the respondents' tick corresponded to a coding value (a tick in the first box was coded 1, a tick in the second box was coded as 2, etc. and no response was coded 9). Each page shift in the questionnaire was coded with the letter *x* in order to ensure that a possible mistake (e.g. a shift in position) could be easily detected. All questionnaires were given a unique identification number for easy retrieval, to allow for corrections, etc., and the data files had one variable for entering the questionnaire identification number.

With both files followed code books with necessary details and explanations about the data entry (see the ROSE website, or Schreiner and Sjøberg, 2004).

## Data cleaning

Since only the coded files (and not the questionnaires) were returned to the ROSE organisers in Norway, the partners were encouraged to ensure that the data were properly cleaned for mistakes. In the instructions to the participants, we provided some advice on how to check the quality of the data before submitting the file to the ROSE organisers. When 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 procedure for data quality testing was developed and done by Kristján Ketill Stefánsson, and the details are as follows:

Additional national questions were deleted as well as the page break variables. Furthermore, the data was checked for illegal values. All illegal values were recoded 9, i.e. the missing value. 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 or containing variables with different data format.

In addition, when a new file was merged with the international data file, we performed some checks to see how well the data from the new country "behaved" on a selection of variables compared with other countries. Some emerging problems were resolved through correspondence with the national organiser. In some cases, we discovered problems that led to postponement of the merging of the file until a proper explanation was available.

For each country, a SPSS syntax file was developed for handling particular adjustments and/or mistakes. The national syntax files functioned also as logs, with records of all corrections and changes in each national data file. For each nation, the original data file and the national syntax file were saved and available for later reviewing.

**National reports on how the survey was organised**

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. All national reports are uploaded on the ROSE website.

The data collection reports address issues like: the national school system and science teaching, description of the process of translating the questionnaire, accounts for additional national background and/or survey questions (if any), experiences of pilot testing of the questionnaire (if any), permission needed from authorities with restrictions and difficulties (if any), specification of the target and accessible population, how the sample was drawn, response rate, possible weaknesses connected to the sample, how and when the data was collected, feedback and experiences and how the coding was done.

**Electronic collaboration**

As described earlier, we have arranged some international *in person* gatherings (workshops and seminars). The main channel for communication and collaboration has, however, been electronic, through e-mailing and access to websites.

The participants have shared ideas, and reflected on their own and others' work through e-mail discussions. When new documents (the questionnaire, hand book, code books, etc.) were finalised we uploaded them to the ROSE website, 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 organising the survey, papers, presentations, etc.) as attachments in e-mails.

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

## 4.7 ROSE in Norway

This section is a report of how the ROSE survey was organised in Norway:

**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 grades 1 to 7 and lower secondary school with grades 8 to 10. Through all grades in the 10-year compulsory school, there is one common subject addressing 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, one quarter of all lower secondary schools in Norway have twelve or less students at grade 10.

There is no streaming or grouping of students according to ability or sex, but there are a few private schools basing their teaching on particular religions, philosophies or alternative educational approaches. More than 98 percent of all children in Norway attend public schools (SSB, 2001), following the same state curriculum. 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 Norwegian population is relatively ethnically homogeneous. Historically, the only significant minority group in Norway has been the several thousand indigenous Saami, inhabiting the northern part of the country and going to Saami schools. In recent years, immigrants make up a larger part of the population. In 2002, 5.8 percent of the population of 13-15 year-olds were immigrants[44] from non-Western countries, and 0.7 were from Western counties[45] (SSB, 2005).

### Translation

Although the ROSE questionnaire was developed in Norway, the master version was in English, which is the project working language. As organisers of the study we did, however, develop the Norwegian and English versions in a kind of symbiosis, because changes in wording in one version were at the same time discussed in the context of the other language. In this way the process of developing the Norwegian version of the questionnaire functioned as checks of the English version as well.

These two languages are not too different, although Norwegian is closer to German than to English. Some of the difficulties we became aware of in the (relatively simple) process of translation are discussed in 4.3.7.

### National questions

We added one background variable for the name of the school. At the end of the questionnaire, we added two national questions. Question K was an open-ended question asking *What profession would you like to have when you are grown up?* (data from this question will not be analysed here). The other question, question L, is reproduced in 4.5.7.

### 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. The purpose of the interviews was to detect difficult sentences, concepts and wordings.

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

[44] I.e. with neither parents nor grandparents born in Norway.

[45] *Western countries* denotes the Nordic countries, Western, Central and Southern Europe (except Turkey), North America and Oceania. *Non-Western* countries means Eastern Europe, Asia, Africa, Central America, South America and Turkey (SSB, 2005).

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 defined as the cohort of 15 year old Norwegian students living in our country in 2002. Students going to Saami schools and schools for students with special needs were not included in the target population.

Since ROSE samples school classes and not individual students, the target population was more precisely defined as the students at the grade level at which 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.

**Sample and participation**

The Norwegian Ministry of Education and Research (UFD) has a database with records of all Norwegian schools. We got this database from the Norwegian TIMSS/PISA group – since they were about to draw the sample for PISA 2003, they had recently received it from UFD.

The database contained totally 1125 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 that randomly drew 70 schools from the database: All the students in the database were assigned a unique number (from 1 to 55 163), and the Excel algorithm picked randomly one student from the database. Once the student was drawn, the school to which this student belonged was transferred to the sample. This sampling routine implies that the probability of one school to be drawn corresponded 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 schools and invited them to participate in the ROSE survey. We received 58 affirmative and 12 negative answers. This gave us participation rate at 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 at the level of the students.

Since 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 in 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 another parallel class than the one suggested in our instructions. Besides this single feedback, we do not know of other schools carrying out the survey in a different class than the one we proposed.

My general impression is that the sample quality is satisfactory for my research focus and approach. If the proportion of immigrants in the Norwegian population biases

the comparative analysis in chapter 10, the significance of the differences between more and less modernised countries will probably be weakened rather than exaggerated.

### Carrying out in schools

At each school, the leadership came up with one person that could organise 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.

Together with the bunch of questionnaires, we attached a letter with instructions and descriptions of practicalities for conducting the survey, such as: 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, and the questionnaires should be kept unnamed and anonymous.

We also attached a letter addressed to the parents, which explained briefly the intention of the ROSE project and informed the parents 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 also the five remaining envelopes.

### Feedback and experiences

We sent a written acknowledgement for recognition of their work and their help to each participating school. 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 following are some quotes from the feedback from the teachers:

- the questions seemed clear and good
- a straightforward survey, but with a large number of items
- no questions had to be clarified on the way
- appropriate time constraint
- the students found the questions interesting
- they worked concentratedly through the questionnaire
- they were proud to join the survey – 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 all 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 into 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

Sjøberg's children Liv (18) and Are (16) coded all the Norwegian responses. They coded directly into SPSS, 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 were 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. In other instances, entire double pages were empty, like if the respondent had double-leafed and overlooked the pages. 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 data file.

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

I consider it likely that there still are some flippant responses and coding errors in the data file, but my overall impression is that the quality of the data file is relatively high.

### Norwegian sample

In the end of February 2003 the Norwegian SPSS file was finalised – with 1204 respondents, evenly distributed with 601 girls, 602 boys and 1 respondent with missing response for sex. 37 respondent (3 percent) were 14 years old, 1144 (95 percent) were 15 years old and 23 (2 percent) were 16 years olds.

## 4.8 ROSE in other countries

Issues of reliability and validity are connected with data quality and the relevance of inferences, rather than with the instrument as such. Therefore, analysis of international data calls for close inspections of the data quality in *all* countries. In chapter 10, I will briefly and superficially analyse the international data from the ACE question. The aim of the analysis is to produce some ideas about cross-national differences in students' interests, rather than to present convincing evidence. It would be far beyond the scope of this thesis

to describe all countries represented in the international sample in terms of the position of S&T in the country, the degree of modernisation, youth cultures, the school system, the science curriculum, the ROSE target population, sampling methods, sample weaknesses, issues of language, translation and coding difficulties, etc. National reports on how the survey was organised in each country, and qualitative descriptions of the sample, are available from the ROSE website[46]. Here, I will only give some brief quantitative characteristics of the samples and the countries.

ROSE partners in the participating countries were asked to apply random sampling methods. For various reasons, e.g. due to limited financial resources, some countries have not been able to comply with this request. This means that not all the participating countries have samples that, without reservation, can be regarded as representative for 15 year old students in the country. However, the analysis in chapter 10 will show that in spite of non-random sampling procedures, countries that are commonly put side by side (for example African, Baltic or Scandinavian countries) in most instances show similar or related response patterns. This can be seen as to some extent strengthening the external validity of the conclusions. In some diagrams in chapter 10, scores of a single country may differ from the overall patterns in the diagram. I will not go into detailed discussions of whether such peculiarities might have been caused by errors in the measurement, the coding, the translation, etc., or by particular cultural-, political- or school-related issues.

In February 2005, I decided not to wait for more countries to send their material, and closed my international data file. At this time, we had received data from totally 32 countries.

In many countries, the age span among the students was relatively large; ranging from 10 to 28 in the total sample[47]. This is interesting in itself, but as my results will be discussed against a background of youth research, I want to reduce the range of ages. In Norway, virtually all children start at school in the calendar year when they reach the age of six, and we have no repeaters. Thus, as most of the data was collected late in the year (in November and December), a huge majority of the respondents (95 percent) were 15 years old, and some few were 14 and 16 (see the section above). No Norwegian students were outside the age range of 14-16. In order not to make the cross-national comparisons more complex than necessary, I decided to have the same age range in all national samples. This means that respondents who were younger than 14 and older than 16, and respondents with missing value in the age variable, were excluded from my data file. Table 4-2 shows average age in each sample when these respondents were excluded, as well as the number of girls and boys and the total sample size for each country.

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[46] National reports on how the ROSE study was organised in each country can be found from the ROSE website: www.ils.uio.no/english/rose/ (accessed 2006-02-01). The reports contain details about the national school system, the science curricula, translations of the questionnaire, possible national questions, possible piloting, official permissions, target population, sampling procedure, response rate, how it was carried out in schools, feedback and experiences from students and teachers, coding, etc.

[47] There might as well have been some 9-year-olds in the sample, but because 9 also was the code for missing responses, one cannot distinguish what is 9 years old and what is missing response. This is a weakness of the coding procedure, but it has no practical implications for my analysis.

| country | sample size | girls | boys | mean age |
|---|---|---|---|---|
| Bangladesh | 1669 | 647 | 1014 | 15.0 |
| Botswana | 644 | 388 | 255 | 15.7 |
| Denmark | 520 | 268 | 251 | 15.0 |
| England | 1266 | 653 | 612 | 14.5 |
| Estonia | 640 | 331 | 308 | 15.4 |
| Finland | 3550 | 1765 | 1782 | 15.4 |
| Ghana (Central) | 782 | 374 | 408 | 15.0 |
| Greece | 547 | 284 | 263 | 14.6 |
| Iceland | 618 | 310 | 308 | 15.2 |
| India (Gujarat) | 1136 | 508 | 627 | 14.7 |
| Ireland | 640 | 313 | 327 | 15.4 |
| Japan | 560 | 268 | 291 | 14.9 |
| Latvia | 1041 | 611 | 426 | 15.4 |
| Malaysia | 1527 | 724 | 793 | 16.0 |
| Northern Ireland | 832 | 410 | 422 | 14.7 |
| Norway | 1204 | 596 | 607 | 15.0 |
| Philippines | 4434 | 2922 | 1506 | 15.9 |
| Poland | 615 | 343 | 272 | 15.8 |
| Portugal | 523 | 273 | 250 | 14.7 |
| Russia (Karelia) | 707 | 346 | 361 | 14.7 |
| Swaziland | 534 | 336 | 197 | 15.4 |
| Sweden | 746 | 356 | 390 | 15.5 |
| Trinidad & Tobago | 638 | 362 | 276 | 14.6 |
| Uganda | 758 | 408 | 349 | 15.3 |
| Zimbabwe | 533 | 310 | 222 | 15.6 |
| **total** | 26664 | 14106 | 12517 | 15.3 |

Table 4-2. International sample descriptions: Total sample, number of girls, number of boys and average respondent age in the age range 14-16 for the 25 countries in the international data material used in chapter 10. In some countries, the ROSE target population is defined as the students in one *region* of the country: Karelia in Russia, Gujarat in India and Central region in Ghana.

Seven countries were deleted from the international sample due to data quality that did not meet my requirements. For example, in some cases, exclusion of the youngest and the oldest students lead to considerable reduction of the sample size. Only samples with more than 500 respondents were retained for the international analysis. I also deleted countries which had defined a target population that was clearly uncharacteristic of the national population (the reason for deleting these will be evident from the text below). These and other reasons lead me to exclude the following countries from the sample:

- *Lesotho, India (Mumbai)* and *Egypt:* Less than 500 respondents at age 14-16
- *South Africa (Western Cape):* The sample is stratified for racial groups
- *Israel:* Sampled from only secular Jewish schools in rural areas
- *Turkey:* Sampled from large cities only
- *Spain:* Did not include question C and E in the questionnaire

Russia, India and Ghana defined the target population as students in a *region* of the country (Karelia, Gujarat and the Central region respectively). These samples are, however, retained in the international data file.

Since I will discuss my results by drawing on theories addressing the modernisation of societies, I need to classify countries according to degree of modernisation. Such a classification is not a straightforward matter, as modernity is complex, multi-dimensional and not precisely defined. Some processes associated with modernisation are economic growth, urbanisation, gender equity, social welfare, and increasing proportion of the labour force employed in services vs. agriculture and industry (see chapter 2). The concept of modernisation of societies is much broader and more complex than any summarised measure can capture. There is no concrete measure of a country's level of modernisation, and there is no scale on which the degree of modernisation can be defined. Degree of modernisation is a construct that cannot be unambiguously measured, even when supplemented by several indexes.

Annually, the United Nations Development Programme (UNDP) publishes a Human Development Report (HDR). *Human development* is not synonymous with *modernisation*, but qualitative descriptions of the meaning of human development are nevertheless relatively similar to aspects of modernisation of societies, such as detraditionalisation, cultural liberation and self-realisation (see chapter 2). Human development is

> about creating an environment in which people can develop their full potential and lead productive, creative lives in accord with their needs and interests. People are the real wealth of nations. Development is thus about expanding the choices people have to lead lives that they value. And it is thus about much more than economic growth, which is only a means – if a very important one – of enlarging people's choices (http://hdr.undp.org/hd/ accessed 2005-09-12)

In each HDR, the countries are ranked according to a Human Development Index (HDI). The index is monitoring average national achievement in three dimensions of human development: income, education and health[48]. Naturally, the HDI does not measure the broad and complex construct *human development*, because important aspects like gender equity and people's ability to participate in decisions affecting their lives, are not included in the index. It is rather seen as a useful starting point, that has to be supplemented by other indexes. (UNDP, 2004).

Furthermore, the HDI is by no means a measure of degree of modernisation, but this is nevertheless how it will be applied in my analysis. I have two reasons for this: First, there does not, to my knowledge, exist any international index or numeric indicator for degree of modernisation, and second, I find that the HDI dimensions do meet some of the most central aspects of modernisation. (Also the PISA study applies HDI as a measure for a country's degree of development, Kjærnsli & al., 2004.) Many of the modernity characteristics described in chapter 2 have emerged from the three dimensions in HDI: economic growth, social welfare and access to education and information.

[48] Definition: HDI is a summary measure of human development based on the weighted average of three indices: (1) a long and healthy life, as measured by life expectancy at birth, (2) education, as measured by the adult literacy rate (two-thirds weight) and the combined primary, secondary and tertiary education gross enrolment ratio (one-third weight), and (3) a decent standard of living, as measured by GDP per capita (PPP US$). (For details on how the index is calculated, see e.g. Technical note 1 in UNDP, 2004)

Table 4-3 show some statistical data that can be seen as indicators for the level of modernisation of the countries in the sample (all figures are from UNDP, 2005):

- *Gross Domestic Product* (GDP) *per capita:* Given in Purchasing Power Parity (PPP) in US dollars.
- *Life expectancy at birth:* Number of years a newborn child would live if prevailing patterns of mortality rates at the time of birth were to stay the same throughout the child's life.
- *Net secondary enrolment ratio:* The proportion of the population of official school age for secondary level that are enrolled in secondary education.
- *Urban population*: Percentage of the total population living in areas classified as urban.
- *The Gender-related Development Index* (GDI): While HDI measures average national achievement, the GDI adjusts the average achievement to show *inequalities* between men and women in the same three dimensions as for HDI.
- *Employment in agriculture, industry and services: Agriculture* refers to activities in agriculture, hunting, forestry and fishing, *industry* refers to mining and quarrying, manufacturing, construction and public utilities (gas, water and electricity), *services* refer to wholesale and retail trade, restaurants and hotels, transport, storage and communications, finance, insurance, real estate and business services, community, social and personal services. (The reason for separate figures for women and men is simply that this is the way the statistics were given in HDR 2005.)

The last column shows the HDI values for 2003 (UNDP, 2005), while the boldface values are HDI for 2001 (UNDP, 2003). It is the boldface values that are applied in the analysis in chapter 10[49]

Although there is some discrepancy in the figures in the table, the overall picture is that the countries with the highest HDI values also are the countries that show the most modern traits in the other indexes. For the three first columns, this reasoning would be a circular argument, as the figures in these columns are involved in the calculation of the HDI values. However, also the indexes that are not drawn into the HDI calculations, i.e. gender equity, urbanisation and employment rates in services vs. agriculture and industry, point in more or less the same direction – with more modernised countries at the top of

[49] Naturally, I should have used the HDI values for 2003 (launched 7 September 2005) or 2002 in my analysis, since most countries collected their data during 2003. The cause for the 2001 values in the analysis in chapter 10 is simply an initial confusion on my part. In Table 4-3, the countries are sorted according to descending HDI 2001 rank, while the italicised column shows the order number for each country if they were ranked according to the 2003 values. We see that there are no large differences between the 2001 and the 2003 rankings. Ireland has shifted rank three positions upwards from 2001 to 2003, and Swaziland has shifted three positions downwards, while the remaining countries have undergone even smaller changes in relative HDI values. Since my research approach aims at robust findings, I do not believe that these small differences in the 2001 and the 2003 HDI values make an important difference for my results. Therefore, I have decided not to rewrite chapter 10 for including results from analysis with the HDI 2003 values.

the table, where we find the highest HDI values. The countries at the top of the table are recognised by economic wealth, good health, more people living in urban areas, gender equity, less employment in agriculture, etc.

| | GDP per capita *PPP US$* | life expectancy *age* | net secondary enrolment *%* | urban population *% of total* | GDI value 2003 | employment in agriculture female *% of female labour force* | agriculture male *% of total* | industry female *% of female labour force* | industry male *% of total* | services female *% of female labour force* | services male *% of total* | **HDI value 2001** | *2003 HDI rank* | HDI value 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway | 37 670 | 79 | 96 | 79 | .960 | 2 | 6 | 9 | 33 | 88 | 58 | **.944** | *1* | .963 |
| Iceland | 31 243 | 81 | 86 | 93 | .953 | 3 | 12 | 10 | 33 | 85 | 54 | **.942** | *2* | .956 |
| Sweden | 26 750 | 80 | 100 | 83 | .947 | 1 | 3 | 11 | 36 | 88 | 61 | **.941** | *3* | .949 |
| Japan | 27 967 | 82 | 100 | 66 | .937 | 5 | 5 | 21 | 37 | 73 | 57 | **.932** | *5* | .943 |
| Denmark | 31 465 | 77 | 96 | 85 | .938 | 2 | 5 | 14 | 36 | 85 | 59 | **.930** | *7* | .941 |
| Finland | 27 619 | 79 | 95 | 61 | .940 | 4 | 7 | 14 | 40 | 82 | 53 | **.930** | *6* | .941 |
| Ireland | 37 738 | 78 | 83 | 60 | .939 | 2 | 11 | 14 | 39 | 83 | 50 | **.930** | *4* | .946 |
| UK | 27 147 | 78 | 95 | 89 | .937 | 1 | 2 | 11 | 36 | 88 | 62 | **.930** | *8* | .939 |
| Portugal | 18 126 | 77 | 85 | 55 | .900 | 14 | 12 | 23 | 44 | 63 | 44 | **.896** | *10* | .904 |
| Greece | 19 954 | 78 | 86 | 61 | .907 | 18 | 15 | 12 | 30 | 70 | 56 | **.892** | *9* | .912 |
| Poland | 11 379 | 74 | 83 | 62 | .856 | 19 | 19 | 18 | 40 | 63 | 40 | **.841** | *11* | .858 |
| Estonia | 13 539 | 71 | 88 | 70 | .852 | 4 | 10 | 23 | 42 | 73 | 48 | **.833** | *12* | .853 |
| Latvia | 10 270 | 72 | 88 | 66 | .834 | 12 | 18 | 16 | 35 | 72 | 47 | **.811** | *13* | .836 |
| Trinidad &T | 10 766 | 70 | 72 | 75 | .796 | 3 | 11 | 13 | 36 | 84 | 53 | **.802** | *14* | .801 |
| Malaysia | 9 512 | 73 | 70 | 64 | .791 | 14 | 21 | 29 | 34 | 57 | 45 | **.790** | *15* | .796 |
| Russian F | 9 230 | 65 | .. | 73 | .. | 8 | 15 | 23 | 36 | 69 | 49 | **.779** | *16* | .795 |
| Philippines | 4 321 | 70 | 59 | 61 | .755 | 25 | 45 | 12 | 18 | 63 | 37 | **.751** | *17* | .758 |
| Botswana | 8 714 | 36 | 54 | 52 | .559 | 17 | 22 | 14 | 26 | 67 | 51 | **.614** | *19* | .565 |
| India | 2 892 | 63 | .. | 28 | .586 | .. | .. | .. | .. | .. | .. | **.590** | *18* | .602 |
| Ghana | 2 238 | 57 | 36 | 45 | .517 | .. | .. | .. | .. | .. | .. | **.567** | *20* | .520 |
| Swaziland | 4 726 | 33 | 32 | 24 | .485 | .. | .. | .. | .. | .. | .. | **.547** | *24* | .498 |
| Bangladesh | 1 770 | 63 | 45 | 24 | .514 | 77 | 53 | 9 | 11 | 12 | 30 | **.502** | *21* | .520 |
| Zimbabwe | 2 443 | 37 | 34 | 35 | .493 | .. | .. | .. | .. | .. | .. | **.496** | *23* | .505 |
| Uganda | 1 457 | 47 | 17 | 12 | .502 | .. | .. | .. | .. | .. | .. | **.489** | *22* | .508 |

Table 4-3. Indicators for degree of societal modernisation and human development (see explanations in the text). The countries are sorted after descending HDI 2003 values, and the italicised column shows the order number for each sample country if they were ranked according to the 2003 values (see footnote 49). Country abbreviations: Trinidad & T: Trinidad and Tobago; Russian F: Russian Federation; UK: United Kingdom (England and Northern Ireland in the ROSE sample). Empty cells means no data available. (Sources: UNDP, 2003 (the boldface column only); UNDP, 2005)

These considerations have lead me to conclude that I will use the HDI as an indicator for a country's degree of modernisation. More issues related to data quality and the soundness of linking HDI to a country's degree of modernisation will be discussed in chapter 10.

# 5 ANALYSIS METHODS AND INTERPRETATIONS

This chapter describes some methodological issues related to survey research in the social sciences in general and to my study in particular. The emphasis will be on complexities, uncertainties and considerations rather than on the mathematical formulas for the statistical algorithms and coefficients.

The statistical analysis software SPSS (Statistical Programme for the Social Sciences)[50] will be used in the analysis. Widely used statistical parameters such as frequency, mean, standard deviation, variance and the bivariate correlation coefficient (I will use Pearson's *r* as measure of linear association) will not be described here. These are thoroughly described in literature on quantitative methodology (see for example Pedhazur & Schmelkin (1991), the Sage series *Quantitative Applications in the Social Sciences*[51] and SPSS manuals). Instead, I will refer to some overall issues related to reliability and validity, and describe the most central algorithms in my analysis, which are to a lesser extent applied and described in other studies.

Although I aim at straightforward and commonsense explanations, the incontestable fact is that the underlying mathematics *is* complicated. For example, the n-dimensional room, which forms the basis for some of the algorithms described here, is undeniably remote to any everyday understanding of reality. Therefore, one can hardly describe such statistical algorithms without introducing relatively advanced mathematical terms and concepts.

## 5.1 General issues of research quality

In any research, a key concern is about the quality of the data, the results and the interpretations.

### 5.1.1 Reliability

Reliability is related to equivalent measurements and random measurement errors. High reliability is not an inherent property of the instrument, but of the data that is collected. In reliability assessments, one may ask: How trustworthy, or how consistent, stable and exact, have we measured? (Kleven, 2002). Given that it was possible to ask the students again on equivalent basis (for example the day after the survey was carried out), or given that other persons were involved in carrying out the study (other survey organisers, coders, etc.) – would one end in the same data?

There are several means of estimating the reliability of a measurement (see Kleven, 2002), but in the ROSE context, as in many other research contexts, reliability issues call for rational analysis, rather than calculations. For obvious reasons, I will not have the opportunity estimate the reliability of the questionnaire questions by conducting any

[50] www.spss.com (accessed 2005-10-15)

[51] www.sagepub.com/series.aspx?sid=486&sc=2 (accessed 2005-10-15)

equivalent survey. This means that in my research, reliability cannot be measured or calculated (except internal consistency among variables, see 5.6.2). It involves personal judgement, and it can only be addressed in concrete cases where the instrument has been used in a specific setting.

### 5.1.2 Validity

While reliability address *how* the test measures and *random* measurement errors, validity is connected with *what* the test measures and *systematic* measurement errors (Kleven, Hjardemaal & Tveit, 2002). According to Shadish, Cook and Campbell (2002), validity refers to the truth of the inferences drawn from the analysis, i.e. to what extent the empirical evidence supports the interpretations. From this follows that the validity of the measurement depends on the conclusions one draws from it. Validity is a key concern in any research. Research that is invalid is by definition of no value.

Validity is not a simple term. It has many aspects, and there are many possible ways to consider validity. Validity is always a matter of degree and it always implies some element of personal judgement. Shadish et. al. (2002) suggest a validity typology, in which each validity type is connected with one specific type of inference. These are:

(1) *Construct Validity:* This concerns inferences about what constructs the questionnaire items represent. This will be discussed in more detail in 5.6.4.

(2) *Internal Validity:* Inferences about causal relationships. The major casual inference in my research concerns whether young people's orientation towards science and science education is influenced by the late modern zeitgeist. This will appear as an issue in almost all discussions, since this is embedded in the background for my study.

(3) *External Validity:* The validity of inferences about whether differences, similarities or relationships can be generalised to other settings, e.g. from one student type to another, or from Norway to other countries. In Norway, the sample was drawn by probability sampling, the response rate was good and I have no reasons for having doubts about the coding process. This means that I perceive the quality of the Norwegian data as satisfactory for my research aims. However, I have touched upon this earlier (in section 4.8), and it will be touched upon again (in chapter 10): there are some weaknesses in the *international* data. For example, there are countries that did not draw a random sample for a defined target population (only easily accessible schools participated); some countries could not offer the amount of paper required for a questionnaire on 13 pages, and arranged therefore the survey differently; in some countries the survey language differed from the mother tongue of the students; and very low response rates was a problem in some countries. Such matters, due to limited financial resources or other practical obstacles, will unquestionably weaken the quality of the data and threaten the external validity of the results.

(4) *Statistical Conclusion Validity:* This concerns inferences about generalisations from the sample to the population. With a high quality sample (probabilistic sampling method and high response rate), the sample can be perceived as representative for the population. Given some conditions, this allows the researcher to make generalisations from the sample to the population.

*Statistical significance testing* implies asking whether the result occurred in the sample by chance, or whether it exists in the population as well. Null hypothesis significance testing gives the probability that a difference or a relation between variables occurred in the sample by chance, while it is non-existent in the population. When a researcher claims a difference or a relation between variables for a population, the statistical significance test gives the probability that the claim was false. Although the result of a significance test is a *probability*, it is custom to describe the result dichotomously; as statistically significant if the result is below a certain cut-off value (e.g. 1 or 5 percent, noted $p < .01$ or $p < .05$) and non-significant otherwise.

There are different ways of assessing statistical significance. With a *t-test,* one can for example[52] determine whether there is a statistically significant difference between variable means for two groups of respondents. In this case, the *null hypothesis* ($H_0$) says that there is no difference between the population means. If the significance test gives $p < .01$, there is less than 1 percent likelihood that the difference occurred in the sample by chance. When the researcher rejects $H_0$, i.e. claims that there is a difference in the population, there is 1 percent likelihood that the claim is false (Shadish & al., 2002). Analogous considerations apply to inferences about correlations in the sample vs. in the population.

In this thesis, statistical significance will also be communicated through *error bar diagrams with 95 percent confidence intervals*. The interval mid-point shows the sample mean and the interval shows within which range the population mean is likely to fall. There is 95 percent likelihood that the confidence interval includes the population mean. One can do a "visual" statistical significance test by comparing two error bars. If the confidence intervals for two groups of students do not overlap, one can interpret that the difference between the student groups probably has not occurred in the sample by chance. When comparing more than two error bars (as will be the case in my analysis), we have to deal with the issue of multiple tests. The error bars will nevertheless give a rough idea about where we may find the population differences.

The larger effect size[53] and sample size, the larger capacity the test has to detect results that exist in the population. Since the Norwegian sample is relatively large, I will use a strict significance limit ($p < .01$). It is important to have in mind, that although results are found to be statistically significant, they may still be perceived as insignificant in the everyday meaning of the word. Even *statistically significant* results may be *practically insignificant*, in terms of being weak or trivial, and without any educational relevance or interest.

### 5.1.3 Credibility: Does it make sense?

My key concern regarding the research quality will be the *credibility*. I see credibility as closely related to, and almost the synergy of, validity and reliability. In the forthcoming

[52] An independent-samples t-test compares mean values for two different samples, while a one-sample t-test compares a sample mean with a specified constant.

[53] The effect size is the magnitude of a relationship, e.g. the correlation coefficient or the standardised difference between two means (Shadish & al., 2002).

analysis, I will ask myself: Does the study make sense? Do people grasp the meaning of the concepts, the analysis and my interpretations? Are there sufficient details on the way to see how I arrived at my results? Will people believe me, trust me and have confidence in my data as well as in my results and my inferences?

These considerations are obviously relative, and they carry a strong element of individual and subjective judgement. In order to make my inferences credible and trustworthy, I will aim to be explicit about what I have done and how it was done. In principle, everybody should be able to replicate my analysis and check and verify the details and the results. In order to make my results and interpretations as credible as possible, issues of reliability and validity will be addressed continuously through my analysis and discussions, although I may not always use the terminology from this section.

## 5.2 Likert scales as quasi-interval scales

As stated above, I will not describe the most commonly used tools in quantitative research, as these are widely described in methodology textbooks. This section is an exception. Here, I will mention one issue regarding Likert scale measurements. It is included because although this is widely described in the literature, it involves some judgements and approximations.

In chapter 4.5, I described the Likert scales that are used in the instrument (for responses on interests, agreement, etc.) and how responses in the Likert scales have been assigned numbers through the coding process. These values are arbitrary in the sense that one does not know the exact *amount* of the interest, agreement, etc. The values simply indicate *less* or *more* of a quality.

In an interval scale, the origin is arbitrary, but the distances between each of the categories are equal sized intervals. This means that the distance from category 1 to category 2 is identical to the distance from category 2 to category 3, etc. In a Likert scale, one cannot tell whether the intervals between each response category are equally sized. However, in accordance with common practice, and although it involves approximations, I will assume equal distances between the categories in the scales. This means that I will regard the Likert scales as quasi-interval scales. In methodology literature, issues like these are debated, but is seems to be a wide acceptance to use Likert scales as indicated here, at least for my pragmatic research approach (Ary & al., 1996). One advantage with data in interval scales, is that these can be manipulated by addition and subtraction, and therefore be used in the most common statistical procedures (Ary & al., 1996).

## 5.3 Factor analysis

The purpose of *exploratory factor analysis* is to discover patterns of relationships between variables (questionnaire items). The algorithm assumes that some of the observed variables have in common some latent variables, or unobserved *factors*.

The factor analysis algorithm is based on the assumption that the observed variables measure something that is unique and particular and something that is shared

with some of the other variables. The number of common factors is assumed to be much smaller than the number of observed variables.

There is never one single definitive factor solution for a set of observed variables. If one alters the input variables slightly or the desired number of factors, one will get different factor solutions. Furthermore, there are a variety of different factor analysis methods based of different conditions and criteria, and different methods may give somewhat different results. However, especially with large samples, one will often find that most methods produce more or less the same results (Kim & Mueller, 1978).

The data must be at interval level. In addition, the responses are supposed to be normally distributed in each variable. But the algorithm has turned out to be robust for this criterion, ant to function well also for variables that do not meet this requirement. Non-normal distributions can affect the stability of the solutions, but with large sample sizes, this is not seen as a problem.

The factor analysis algorithm operates in two steps. First, it extracts initial factors. This gives factor loadings for all variables on each factor. Next, the algorithm "rotates" the factors to a final solution. The purpose of the rotation is to achieve the simplest possible factor structure by maximising the high loadings and minimising the low loadings. The factor analyses in this thesis are based on the correlation matrix, and use Principal Axis Factoring extraction method, and Oblimin rotation method with Kaiser normalisation (delta equals zero). Principal Axis Factoring is a commonly used extraction method for variables that cannot be assumed normally distributed. The reason for choosing Oblimin rotation is that it is widely used, and that it is an oblique rotation method allowing the final factors to be correlated, although the Kaiser normalisation means that the rotation attempts to keep the factor structure orthogonal.

A factor analysis with $k$ variables can result in maximum $k$-1 factors. When running a factor analysis, one has to decide on, in addition to extraction and rotation methods, the number of factors. Either one can require a specific number of factors, or one can give a criterion so that the algorithm decides on the number of factors. Here, the most commonly used criterion is to retain factors with eigenvalues greater than 1 in the correlation matrix. The background is that all factors have different eigenvalues, and the eigenvalues represent the variance explained by each factor. In a factor solution with $k$ variables, the sum of all eigenvalues will be $k$. Although there are several theoretical reasons for this *eigenvalue above 1* criterion, "its acceptance is still based on heuristic and practical grounds" (Kim & Mueller, 1978, p. 43). As I will aim at a data-driven approach to the analysis, I will use this criterion and thereby let the algorithm and the data decide on the number of factors.

Except from the first factor, the factors may be bipolar; i.e. the factor loadings may be positive and negative. Mathematically, opposite signs means that the variables have projections on the same reference axis (factors), and that the negative and positive values are on opposite sides of the origin. Although the sign itself has no substantial meaning, the signs have meanings when studied relative to each other. When variables load with different signs on one and the same factor, it means that "the variables are related to that factor in opposite directions" (Kim & Mueller, 1978, p. 77). One can avoid opposite signs in

one factor by, prior to the factor analysis, recoding for example negatively worded statements into positive statements.

The SPSS default setting is to exclude cases (respondents) with missing responses listwise. This means that that cases that do not have data in all variables will be excluded from the factor analysis (SPSS, 2003). Unless otherwise is given, I will use this criterion for the handling of missing responses.

## 5.4 K-means cluster analysis

The k-means cluster analysis can be seen as analogous to factor analysis: like the factor analysis groups *variables* into *factors*, the k-means cluster analysis groups *cases* into *clusters*.

K-means cluster analysis identifies relatively homogeneous cases without any preconceived notion of *what* they have in common. K-means cluster can handle large number of cases.

In k-means cluster analysis, the researcher has to decide the number of clusters that should be developed by the algorithm; for example *k* clusters. In a data file with N cases, the algorithm starts out with searching through the cases from the top of the data file[54], and finds the *k* first cases with no missing data. These constitute *k cluster centres*. Next, the algorithm assigns each of the remaining N-*k* cases to the cluster with the centre that lies nearest to the case. The distances are calculated by using *simple Euclidean distance* as proximity measure (the square root of the sum of the squared differences between the centre and the variables) (SPSS, 2003). This proximity measure is a property of the algorithm, and not a subject for the researcher's choice. Next, in each of the *k* clusters, the cluster centre is updated to be represented by the mean value across the cases in the cluster, including the initial cluster centre. Then, the N cases are again associated to the nearest cluster centre, and again, the new cluster means form a set of new cluster centres. This iteration process continues until the cluster centres are no longer altered by the iterations (Everitt, Landau & Leese, 2001).

The variables must be in the same unit scale. In SPSS, the default is to exclude cases with missing responses listwise. Unless otherwise is given, I will use this criterion for the missing responses.

## 5.5 Hierarchical cluster analysis

While k-means cluster analysis *divides* the cases into different clusters, the hierarchical clustering algorithm *combines* cases and clusters until there is only one meta-cluster left. It starts with combining the two nearest or most similar cases into one cluster, and then it continues to join cases to cases, cases to clusters or clusters to clusters. Hierarchical clustering functions well for a relatively small number of cases.

[54] This means that the result is sensitive to how the cases are ordered in the data file. I will come back to this in chapter 6.

Olsen (2005) suggests a set of procedures for identifying stable and robust cluster solutions. One means is to run the cluster analysis with different *proximity measures* and *clustering methods*. The proximity measures and clustering methods described here will be used for developing cluster structures and scrutinising the cluster stability.

For defining the closeness between cases and clusters, the researcher has to decide on a proximity measure. *Squared Euclidean distance* (the sum of the squared differences between the item values) is the most commonly used metric for interval data (Norusis, 1988). Since the differences are squared, large differences are weighted heavier than small differences. The *Pearson correlation* proximity measure measures the distance in the product-moment correlations (see more on this measure in Olsen, 2005).

Furthermore, the researcher has to decide on a clustering method, i.e. how the cases should be combined in the cluster or how the cluster distances should be measured. Again, there are several options. *Between-groups linkage* is the SPSS default clustering method. This method makes cluster pairs of cases, in which the pair members belong to different clusters. The distance is calculated from the arithmetic averages of all possible pairs: the distance between two clusters is the average of the distances between all inter-cluster pairs. One advantage of between-group linkage over simpler clustering methods (e.g. *nearest neighbour* or *furthest neighbour*) is that this method uses data from *all* involved cases and is thereby less sensitive to single variable scores. A variant of this method is *within-groups linkage*. Here, the distance is measured in the *new* cluster as the average of all distances between all possible intra-cluster pairs. The new cluster with the smallest distance is maintained. *Centroid* clustering is a somewhat different method. Here, the cluster means are calculated, and the new cluster is formed from the two clusters that have the smallest distance between cluster means. While the centroid method requires squared Euclidean distances, between-groups linkage and within-groups linkage can use different proximity measures (Norusis, 1988).

Results from the hierarchical cluster analysis will be presented in *dendrograms*. A dendrogram shows how similar or close the cases and clusters are to each other: The branches illustrate how clusters are formed at different stages in the analysis and the distances between the clusters. While the ratios of the distance sizes are preserved, the distance values are rescaled so that all dendrograms have the same left-right extent. (The distances are scaled to range from zero to 25, but this scale will not be shown in my dendrograms.)

## 5.6 Composite variables

The reporting of the students' responses will take place in several forms. In many instances I will report at single item level. This is the way the data often are reported for example in opinion polls in newspapers and magazines, in the Eurobarometer surveys and in many research articles and dissertations. One advantage of reporting at single item level is that the connection between the questions that were asked and the responses that were given are straightforward and easy to understand. However, there are also advantages associated with combining items to composite variables, or *indexes*. This section addresses the

rationale for constructing composite variables, how the indexes will be checked and formed, and issues related to the index reliability and validity.

### 5.6.1 Rationale

The use of composite variables is, among other things, a means for reducing and simplifying the data material. When a number of questionnaire items with more or less the same characteristics are combined in one index, the index can represent condensed characteristics of the various single items. In a composite variable, the item's common characteristics will be so to say distilled and strengthened so that their qualities appear more clearly (Hellevik, 2002).

A second important argument for forming composite variables is that index data are more reliable than single item data. All measures are to some degree infected by random errors, because some respondent may have misunderstood the question, the coder may have misprinted some responses, etc. These random errors reduce the reliability of the data. As these errors are random and not systematic, the formation of composite variables will more or less even out the errors. Therefore, composite variables often give more reliable data (Hellevik, 2002).

In addition, the construct validity of a composite variable might be better than that of a single item. One obvious reason is that with more reliable data, one has a more valid measurement. Another factor is that a composite variable has a wider scope than a single item. While a single item can only address one single aspect of an issue, a composite variable can cover a wider concept including several facets of an issue. The composite variable may therefore be more appropriate for describing the concept one aims at measuring (Hellevik, 2002). Composite variables allow the researcher to lift the discussion from the level of the single items to a more general level.

Every data reduction means loss of information. For example, average item scores imply loss of information about the individual respondents and about response frequencies. Also data reduction into composite variables implies information loss, as they hide single item means, standard deviations, etc. Another disadvantage is related to the credibility of the results. As long as the results are reported at single item level, one can easily examine the exact questions that were asked, while composite variable scores are to some extent detached from the original item texts. The results may therefore be less straightforward to understand and accept.

### 5.6.2 Internal consistency

One condition for benefiting from composite variables as described above is that the items forming the index are indicators on the same issue. If the items constituting one index measure very different issues and have little in common, the index will lack a concept that unifies the items. If the index is supposed to tap into one specific trait, a condition for a meaningful and high-quality index is that the items function as homogenous indicators, which tap into the same trait. The items need to show some degree of *internal consistency*.

There are several ways of scrutinising the internal consistency for a group of variables. For example, one can assess the internal consistency for a group of items by

examining the inter-item and the item-total correlations, i.e. how well the items correlate with each other and with the index (Hellevik, 2002). An alternative measure for estimating internal consistency is *Cronbach's alpha* (from now called alpha or α). Alpha is used for describing the internal consistency for a group of items, i.e. the reliability of the index and how well the items function as equivalent measures. Because a larger number of items in one composite variable can give a more reliable measure in terms of smaller random errors, the alpha formula takes account of the number of items in the scale, and gives higher alpha value with increasing number of items (Pedhazur & Schmelkin, 1991). Heterogeneity among the items, random measurement errors and few items weaken alpha.

In this study, the number of items forming one index will vary from one index to another. Because alpha increases with increasing number of items, we may find that indexes formed by only two items have lower alpha than indexes formed by a larger number of items. This uneven number of items can be an argument for using inter-item and item-total correlations rather than alpha, as suggested by Hellevik (2002), or by applying a formula for removing the item number effect from alpha.

Alpha is more commonly used than correlations as a measure of internal consistency, and I will consequently use alpha. Because it will not be important for my research to compare alphas for different indexes on equal basis, I will not correct alpha for number of items. SPSS offers a standardised and an ordinary alpha coefficient. The ordinary alpha, which is the one I will use, allows the items to have different variances.

When all possible inter-item correlations are zero, alpha will be low (zero). The larger the inter-item correlations are, the larger the alpha value can be. The maximum value of the alpha coefficient is 1. Because cognitive skills tend to be more stable than affective qualities, cognitive measures often report alphas in the high .80s or low .90s, while .70 is one widely accepted cut-off point for alpha in affective instruments (Gable & Wolf, 1993; Nunnally, 1978). With an alpha at .70, one can interpret that 30% of the index variance is due to heterogeneity among the items, while 70% is related to the quality the items have in common (called *true variance)*.

### 5.6.3 Procedure

Composite variables will be developed on the basis of exploratory factor analysis and testing of internal consistency, combined with the original intention of the items from when the questionnaire was developed (see section 4.5) and my interpretation of the substantial meaning of the item texts.

I will start out with exploratory factor analysis (with Principal Axis Factoring extraction method and Oblimin rotation method with Kaiser normalisation and eigenvalue 1) including all items in one question. The purpose will be to uncover underlying patterns and structures in the set of variables. If the emerging factors make substantial meaning (with or without support from the questionnaire frameworks described in section 4.5), the items groups from the factor analysis will be tested for *unidimensionality* and *internal consistency*.

The unidimensionality test of a group of items (testing whether the items still tap into different factors), involves bringing one group of items from the initial factor analysis into another factor analysis (with the same criterion and methods as the first). The items

may split into several factors. Only items that form a single-factor solution will be used in an index.

After this test of unidimensionality, I will test the items' internal consistency with the alpha. If the coefficient is in line with the cut-off points defined in the previous paragraph, the items will be merged into an index. The index will be developed from the mean item scores.

### 5.6.4 Construct validity

When the indexes are constructed, they must be given appropriate names. The names should convey what the index items have in common. The factor analysis indicates that the items have *something* in common, but it is, however, up to the researcher to interpret *what* this something is. Adequate and accurate naming is of paramount importance for valid interpretations of results based on composite variables, so the label must convey a good representation of what the items have in common. The labelling is a major challenge connected to the use of composite variables, as once they are labelled, the labels tend to be uncritically used in later analysis, and thereby, the labels start living a life on their own. Screwed labels will bias the subsequent interpretations and discussions.

One can directly measure how late a student is for the science lesson or how many kilos of paper s/he has made use of during the classes. Also qualities like sex, age and nationality are straightforward to assess. In contrast to such quantities, constructs such as *attitudes*, *interest* and *concern* are more unobservable and cannot be directly measured. Such abstract qualities must be inferred from observable indicators.

For example, one may wish to measure students' interest in learning about a specific topic. This concept can be operationalised (given an operational definition), and one may develop a number of items that shall function as observable indicators for the concept. In the universe of possible items that are relevant for the topic, the researcher samples items so that they jointly make a good representation of the concept. When combined into one composite variable, the variable can be seen as a valid measure of the concept.

This approach to the questionnaire development 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" [55], or with Pedhazur's and Schmelkin's words (1991): "Constructs [...] are theoretical constructions, abstractions, aimed at organising and making sense of our environment". *Construct validity* concerns the validity of inferences about the unobserved construct on the basis of the observed indicators (Shadish & al., 2002). For assessing the construct validity, one asks how useful or meaningful the items are for measuring the intended construct. Alternatively, one may ask how valid the composite variable label is for representing the indicators.

The ROSE questionnaire has not emerged in this way. As described in the previous chapter, the project and the instrument did not emerge from the idea of measuring strictly

[55] Microsoft Encarta Premium Suite 2005. Microsoft Corporation.

pre-defined theoretical constructs. Contrary to the above described procedure for indicator development, item groups in this study have emerged from exploratory data analysis. The indexes used in this study have above all grown out of exploratory factor analysis and reliability analysis, combined with the initial ideas behind the items and my conceptual understanding of the items.

When the indexes in this study are developed, they are given a label which represents the common factor of the index items. 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 index. Because of the above-described data-driven method for forming the indexes, the underlying items do naturally not represent all facets of the corresponding construct. The items forming the index are probably not the best possible sample of indicators from the universe of indicators relevant to the name of the index. It would consequently be a fallacy to consider the indexes in this study as constructs. They should rather be seen as purposeful groupings of the items, with labels that hint about what the items have in common. The items should be regarded as *representatives* of the index label, but not as *representative* for the label concept.

The data-driven emergence of the indexes does not excuse me from addressing the construct validity issue. Adequate and accurate naming of the variables is crucial for valid interpretations for the results, and thus a decisive step in the data analyses. When using the index names in this study, one must be aware of the pitfall of generalising the index name to the theoretical construct represented by the label. The indexes ought to be employed with thoughtful caution and the inferences must always bring this validity issue into consideration and always have in mind what items that actually form the indexes.

# 6 FIVE NORWEGIAN STUDENT TYPES

This chapter refers to research objective

*I Develop a student typology based on the Norwegian students' orientation towards science*

No two identical persons exist. ROSE addresses a very limited set of personal characteristics: With closed pre-structured questions, ROSE taps into *some* facets of *some* affective aspects of the students' relation to science and science education. However, even among these very narrow portraits of young people, there are no two Norwegian respondents with identical responses through the questionnaire. Not even through the ACE-part (*What I want to learn about*) of the questionnaire, there are two persons with identical responses.

Nevertheless, the goal of this chapter is to develop a set of Norwegian *student types*, or a student *typology*, by classifying students with common characteristics. One disadvantage of generalising to student types is the loss of information about individual diversity, while an advantage is that some patterns appear more clearly. My focus here is on the typical rather than on the particular.

## 6.1 Consideration of methods and criteria

Quantitative survey data facilitates dividing the respondents into groups and characterising them in terms of differences and similarities. For example, we often see research publications reporting differences between boys and girls, races, age cohorts, people of different nationality, people living in rural and urban areas, and people from homes of different socioeconomic status. I have made several presentations at conferences, seminars, etc. in which I have characterised two groups of respondents in the Norwegian ROSE sample; namely *girls* and *boys*. Advantages of establishing sex-specific respondent groups are that sex is an obvious and extensively applied descriptor for persons, that most comparisons of boys and girls give some interesting differences and that the ROSE questionnaire has a background variable for sex. Due to different socialisation processes for girls and boys and/or due to biological differences between the sexes[56], notable and interesting sex differences are frequently found in the social sciences; so also in the ROSE material.

On the other hand, when examining the Norwegian questionnaires, I saw that (naturally) not *all* respondents within one sex group shared the same view. For example, although one noticeable result was girls' relatively high interest in health issues and boys' interests in technology, *some* girls actually did express interests in technology, and *some*

[56] I choose not to dive into this multifaceted and thorny discussion here. There is, however, a massive body of literature suggesting sociological as well as biological arguments for why girls and boys are different. A review of literature addressing models for explaining gender differences in science education is given in Sinnes (2004).

boys seemed to be interested in learning about health issues. Other response patterns also became apparent to me as I looked through the questionnaires. For example, some students had ticked the leftmost response categories (*Not interested*) through virtually the entire ACE question. At first, I suspected that these respondents had not accepted the premises of the survey[57]. I surmised that the respondents had not carefully read the item texts, and cautiously given an answer that reflected their own thinking. I considered excluding them from the sample. However, other factors spoke against leaving these respondents out. First, not *all* the leftmost boxes were checked. For some single items, the respondents had used other categories in the scale. Second, in some parts of the questionnaire, for example question B. *My future job* and question D. *Me and the environmental challenges*, there were no right- or left-patterns. Third, there were more than a few questionnaires with this kind of response pattern. Jointly these factors indicated that the respondents actually had reflected their own thinking through their responses, namely that they had little interest in learning about the majority of the 108 ACE topics.

Considerations of this kind made me reluctant to force the students into categories of sex that would neglect their particular views. The fruitfulness of considering girls only in comparison to boys and vice versa has been questioned elsewhere. For example, Brickhouse et al. wonder whether research that considers girls only in comparison to boys has exaggerated the differences between the sexes and overlooked the diversity within the groups. They argue that "... we need to know more than that they are girls. We need to know what kinds of girls they are" (Brickhouse & al., 2000, p. 457). In order to do more justice to the diversity of views among the students, I searched for ways of grouping the respondents that allowed the respondents to be classified according to their *views* rather than to their inborn sex. The possibilities were innumerable, with respect to both method and categorisation variables.

For example, I have a personal commitment to the environmental issue (as may be apparent from Schreiner, 1996; Schreiner, 2004; Schreiner & al., 2005; Schreiner & Sjøberg, 2003, 2004a, 2005a). Should I categorise the respondents on the basis of their responses in question D. *Me and the environmental challenges*? On the other hand, I aim to understand my results against a background of perspectives on late modernity and modern youth culture. Since question B. *My future job* may be the one closest related to some values of late modernity – should I take departure in these items for grouping the respondents? There are of course several other options, for example categorising the students by what future profession they are aiming at (item F14 and F16, and question K) and their attitudes to school science (question F).

One method for categorising the students could be to define score criteria for "Personal involvement in the environmental issue" and "Lack of concern for the environmental issue" from the question D (e.g. based on the composite variables developed in Schreiner & Sjøberg, 2005a) or for "modern" and "traditional/less modern" values in

[57] Given on the cover of the questionnaire; for example in the phrase: "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."

question B. The respondents could be categorised by scores below or above a pre-defined cut-off value (as in e.g. Krogh & Thomsen, 2005). Alternatively, I could establish a two-dimensional model like in Ogawa and Shimode's analysis of Japanese ROSE-data (Ogawa & Shimode, 2004). As can be seen from these considerations, the options are innumerable, in terms of categorisation variables, categorisation criteria and categorisation methods.

*I have decided to categorise the students by using k-means cluster analysis on the ACE part of the questionnaire*. (See description of the k-means cluster analysis algorithm in section 5.4.) I see several reasons for clustering the students by their responses in the ACE question, rather than by any other part of the questionnaire:

First, my research aim *II* is related to students' interests. Establishing coherent and stable clusters on the basis of students' interest may be crucial for coming up with interesting results.

Second, there are several weaknesses in question B, D and K. The items in the B question do not constitute an adequate span for identifying "modern" or "traditional" values among the students. Especially items for tapping into the traditional values[58] are weakly represented in the questionnaire. When it comes to the D question, regarding the environmental issue, I have found responses to some of the items hard to interpret, and I can hardly draw valid inferences related to some of these items (Schreiner & Sjøberg, 2004a, 2005a). Due to the large number of missing responses in the open-ended question K, clustering on the basis of this question would have lead to exclusion of too many respondents.

Third, the k-means analysis gives more stable results with a higher number of variables. As the ACE question is the part of the ROSE questionnaire with the largest number of variables, this question would probably give the most stable cluster solutions[59].

Finally, I see this thesis as a contribution primarily to science education, and to a lesser extent to fields like environmental education and sociological youth research. I regard the capacity of the ACE question as broader and more relevant for science education, while question B and D may be closer related to sociology and environmental education respectively.

## 6.2 Number of clusters

In the SPSS k-means cluster analysis, the researcher has to define a number of clusters, and SPSS then produces the number that is ordered. With a sample of 1204 respondents, it is possible to order from two to 1204 clusters (with 1204 clusters there would be one respondent in each "cluster"). This means that whichever number I order from SPSS, the algorithm will fulfil my request.

[58] For instance, items addressing issues like easy access to the labour market, a safe job and stable income.

[59] This hindrance could not have been avoided by using e.g. the D, B, F and G items altogether, as the GIGO rule applies also here: *garbage in, garbage out*. One should not just throw a whole load of divergent variables into the k-means analysis and expect to get something sensible out of it.

This involves a certain amount of trial and error in choosing the number of clusters. Considering that the clusters will be brought into further analysis in the forthcoming chapters, ordering a large number of clusters would make the subsequent analysis too complex and extensive. Moreover, a large number of clusters would lead to few respondents in each cluster, and thereby low power (for statistical tests of significance) of my analysis. I aimed at finding a number of clusters that was controllable and manageable, and settled on a maximum of six or maybe seven clusters.

In numerous trial k-means analysis, involving from two to seven clusters, I studied the mean scores of the clusters through all ACE variables. Two main criteria were applied for considering the ACE mean score profiles: First, each cluster should show a unique and distinctive profile; and second, each profile should be substantially interpretable. With seven clusters, the profile of one of the clusters was rather similar to a neighbouring cluster, which indicated that I could reduce the number of clusters. With six clusters, there were some interesting features for all of the profiles. Further reduction of the number of clusters would imply loss of information about the groups of respondents. However, when this six-cluster solution was compared to the solution of five clusters, the sixth cluster appeared like a sub-cluster of the fifth cluster in the five-cluster solution; both in terms of cluster sizes and mean score patterns. This led me to settle on the five-cluster solution, keeping open the possibility of dividing the fifth cluster into two sub-clusters at a later stage (see 8.2.1). A smaller number of clusters (two, three or four) involved flatter profiles and unwanted loss of information.

## 6.3 Exclusion of cases

The SPSS default is to exclude cases with missing values listwise, which means that cases with a missing value in any of the 108 variables would not be assigned to any cluster. I chose to exclude cases pairwise, which implies that the case was assigned to a cluster on the basis of the variables in which the case had non-missing values. The reason for modifying the missing criteria was that a cut-off point at zero missing values is very strict in a question containing as much as 108 items.

However, in order not to assign cases to clusters on a scanty material, I excluded the 49 cases with more than 12 missing values in the ACE question[60]. Among the remaining cases, there were only 15 cases with five or more missing values, 313 cases with one to four missing, while 827 respondents had no missing responses.

Inevitably, some respondents did not fit into any of the five groups. There could be several reasons for this. Some respondents might have very particular interests, different

[60] In most instances, it looks like the high number of missing values is caused by the student turning two pages in the questionnaire instead of one, as whole questionnaire pages were lacking tick marks. 49 cases with the following questionnaire identification numbers were excluded from the k-means analysis due to high missing rate (number of missing values in brackets). 3 (43), 15 (18), 19 (18), 30 (21), 54 (18), 76 (21), 94 (24), 120 (19), 143 (15), 157 (19), 308 (25), 346 (18), 356 (18), 362 (18), 395 (18), 416 (18), 434 (19), 463 (18), 476 (25), 490 (23), 500 (41), 503 (22), 618 (18), 629 (25), 641 (25), 643 (108), 646 (108), 715 (25), 796 (18), 1012 (19), 1048 (18), 1055 (25), 1123 (40), 1177 (23), 1187 (27), 1233 (42), 1294 (42), 1300 (19), 1318 (18), 1322 (18), 1326 (42), 1330 (14), 1340 (19), 1342 (42), 1347 (25), 1357 (18), 1388 (28), 1399 (30) and 1406 (26).

from all other respondents in the sample. These are maybe the ones Lyng (2004b) would categorise as the *Typeless* students (see 2.4.2). Other respondents might have checked the categories randomly, without reading and taking any position on the item text. In both instances, the responses cause "noise" in the data, wiping out or weakening cluster response patterns. While the latter group of respondents is unwelcome in the sample, the respondents with particular interest profiles may be thought-provoking and worthwhile studying. However, their responses are not suitable for my research interest of describing the typical.

Consequently, I aimed to single out and exclude such peculiar responses. I used a two-stage process for identifying the cases: inspection of the Euclidean distance between each case and its cluster centre, and identifying cases appearing in minute clusters. The following is a description of the outcome of these two approaches.

Because the k-means algorithm assigns cases to cluster centres that are widely separated, it is possible to identify outliers by ordering a relatively high number of clusters. Distinct response patterns may appear in clusters with few cases. I ran the k-means analysis several times with 10–20 clusters; and each time I noted the questionnaire identification numbers of cases appearing in clusters of one to three respondents (typically six cases in each test).

Furthermore, I ran a dozen k-means analysis with different numbers of clusters (five–seven) and with the cases sorted by different variables[61]. For each test, I noted the questionnaire identification numbers appearing with larger than 12.0 distance from the cluster centre. A cut-off point at 12.0 was pragmatically decided. The decision was based on the number of respondents exceeding the threshold value: With this value, the typical number of cases was 35. As I was not willing to exclude a large number of cases, it was no point in lowering the limit. (A lower cut-off point would not have had any practical implication for the results anyway; see below.)

Conclusively, I compared the lists of identification numbers, and excluded cases that repeatedly occurred on the lists. It turned out that cases with a larger distance from the cluster centre than 12.5 were reoccurring in almost all lists, while cases with smaller distances did not that consistently display a distinct response pattern. This led me to exclude all cases with distance larger than 12.5 from the cluster centre. Altogether 23 cases were deleted from the data file[62].

[61] Unless otherwise specified, SPSS k-means cluster analysis uses the first *k* cases in the file that have non-missing data as initial centres (see 5.4). This means that the analysis gives slightly different results, depending on how the data file is sorted.

[62] 23 cases with the following questionnaire identification numbers were excluded due to large distance to the cluster centre (distance in brackets): 29 (12.8), 121 (14.3), 127 (12.8), 163 (12.7), 168 (13.9), 187 (14), 233 (14.3), 245 (13), 329 (12.8), 403 (15.4), 431 (12.9), 471 (13.3), 572 (13.2), 657 (14.1), 714 (14.9), 718 (14.1), 778 (13.7), 1082 (13.6), 1286 (12.7), 1302 (12.9), 1307 (12.9), 1394 (15) and 1405 (14.8).

## 6.4 Stability analysis

As described in section 5.4 the initial cluster centres in the k-means algorithm are the *k* first cases in the file that do not have any missing values in the variables. Consequently, to some extent the result of the analysis will vary with the way the data file is sorted.

I tried to investigate the stability of the clustering result by running the k-means analysis several times with the data file sorted by different variables. No two runs produced exactly the same result. In each cluster, no less than five cases shifted from one group to another on a new analysis. This demonstrates the ambiguousness in the method, the data and the idea of dividing the cases into five clusters. There are not five distinctive and clearly defined response patterns, and not all students can consistently be categorised into one specific cluster. The deviating results indicate that some of the students have blurry profiles, and that only a small change of cluster centre makes them shift to another cluster.

Cases appearing as unstable with respect to the five-cluster solution could easily have been identified and excluded from the analysis. However, I am by principle hesitant towards this idea. The forthcoming analysis will aim at characterising the response patterns in these five clusters, e.g. in terms of *differences* between them. In order to purify the cluster design, I could delete cases that did not go well with the other respondents in the cluster. This would, however, have led to a circular argumentation when discussing the results: Did the differences between the clusters appear because the cases weakening the cluster distinctions were initially excluded from the analysis? Furthermore, leaving out such respondents would have weakened the representativity of the data. Consequently, no cases were excluded due to unsteadiness with respect to cluster membership.

## 6.5 K-means cluster analysis of ACE

In summary, the k-means cluster analysis was processed on the data file with the cases sorted by ascending questionnaire identification number. 49 cases were deleted from the data file due to more than 12 missing responses in the 108 ACE variables. Subsequent to the analysis, 23 cases with a distance to cluster centre larger than 12.5 were excluded. The number of respondents in the sample is then 1132. *Through the following data analysis, I will use data of these 1132 respondents.* The students are divided into five clusters. This number is not given from the data; I chose it.

Table 6-1 and Figure 6-1 show the total number of respondents in each cluster and how girls and boys are distributed between them. Cluster 1 and 5 are somewhat larger than cluster 2, 3 and 4. We see that the exclusion of the 72 cases affected both sexes equally; there is still a balance in the numbers of girls and boys. Regarding the number of girls and boys within each cluster, cluster 2 and 3 have more boys than girls, but particularly cluster 1 and 5 are uneven with respect to sex. Cluster 1 has a predominance of boys, and cluster 5 consists mainly of girls.

| | 1 | | 2 | | 3 | | 4 | | 5 | | tot |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **total** | 231 | *100* | 173 | *100* | 198 | *100* | 209 | *100* | 321 | *100* | 1132 |
| **girls** | 8 | *3* | 64 | *37* | 79 | *40* | 111 | *53* | 302 | *94* | 564 |
| **boys** | 223 | *97* | 108 | *62* | 119 | *60* | 98 | *47* | 19 | *6* | 567 |

Table 6-1 Percentages (italicised) and number of respondents, girls and boys in the five clusters. (Due to one missing response in the sex-variable in cluster 2, the number of girls and boys do not add up to the total number of respondents.)

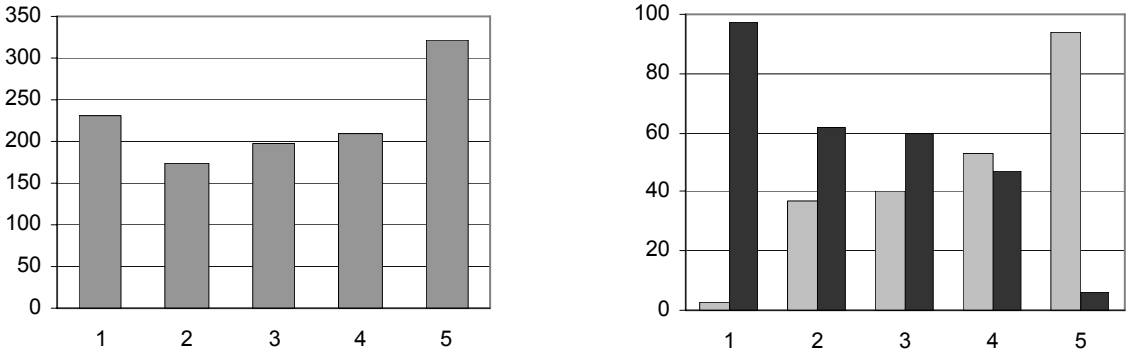



Figure 6-1. Visualisation of Table 6-1: Left: total number of respondents in each of the five clusters. Right: Percentages of girls (grey bars) and boys (black bars) in each of the five clusters.

## 6.6 1132 students – five student types

I will perceive the five clusters as representing different *student types*. Through the forthcoming data analysis, I will follow these five student types, and describe them in terms of their average scores in various parts of the questionnaire. This means that students within one cluster will be described as one and the same student type.

I recognise that the students constituting one cluster are diverse. Dividing the 1132 students into five clusters, and describing cluster typicalities, will inevitably do injustice to the individuals in the sample. The analysis in paragraphs 8.2.1 and 8.3.4 can be seen as examples illustrating this point, since in these paragraphs some of the clusters are divided into sub-clusters. The sub-clusters show distinctive and meaningful response profiles, indicating that the students constituting one cluster are heterogeneous and unlike each other. If it were possible to gather all the students from one cluster in one room, they would possibly meet somebody they consider in many respects as similar to themselves, but also many they would look upon as very different. Most of them would probably have felt unfairly treated, when being described in the same breath as all the other students in the room. On the other hand, the quantitative research paradigm describes and compares groups of students, rather than individuals. Furthermore, the focus of my study is on the *typical,* rather than on individual peculiarities. Thus, this injustice to the individuals is the compromise that this study will make.

A *student type* is neither an *individual identity* nor a *social identity* or a *youth subculture*. A student type is rather a component of the identity of the student, and one facet of her/his youth subculture. For example, we know that late modern youth subcultures and identities are tightly connected to sex (Frønes, 1998; Lyng, 2004b). Hence, cluster 2, 3 and 4, which are sex-mixed (Figure 6-1), cover at least two different subcultures; one for girls and one for boys.

From this follows that a study of students' type characteristics is not a study of identifiable youth identities or particular youth subcultures. The typologies should rather be understood as signs or facets of their identities.

### 6.6.1 Introducing the five student types

Mean responses in the 108 ACE items for the five student types are shown in Figure 6-2 and Figure 6-3 (and in Appendix C).

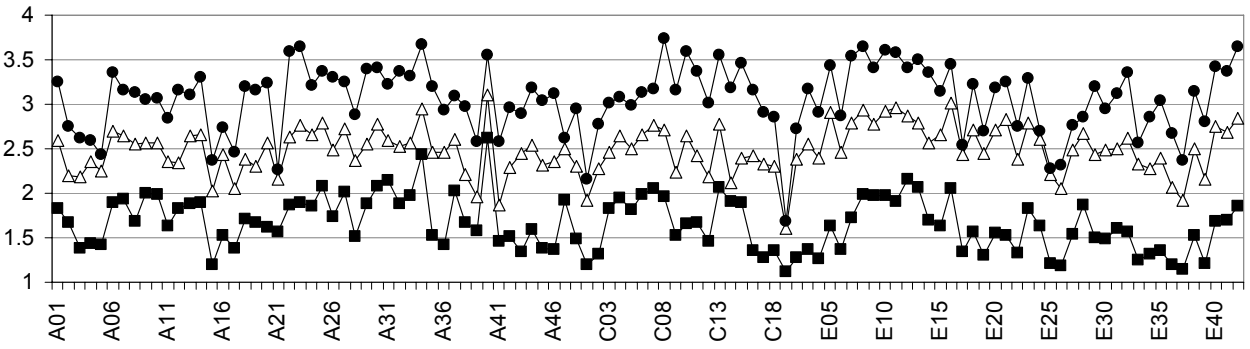



Figure 6-2. Profiles of mean scores for cluster 2 (filled squares), cluster 3 (blank triangles) and 4 (filled circles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

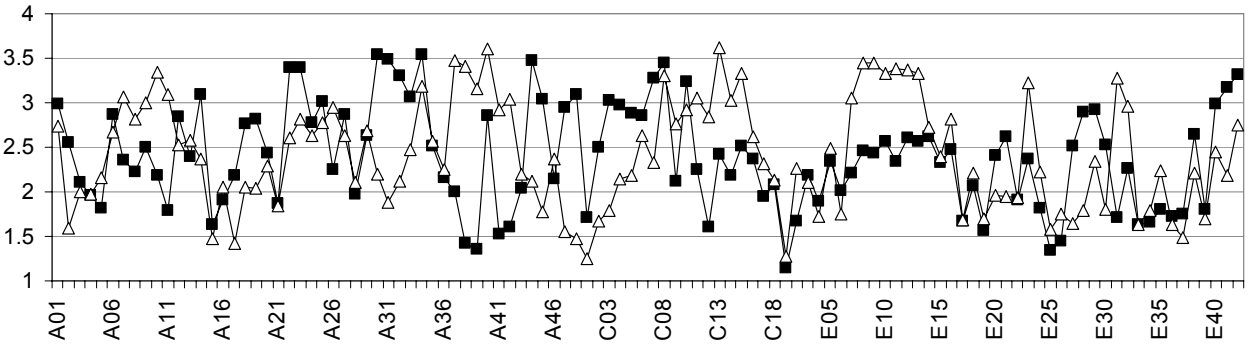



Figure 6-3. Profiles of mean scores for cluster 1 (filled squares) and cluster 5 (blank triangles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

The most salient feature of the profiles in cluster 2, 3 and 4 (Figure 6-2) is the regular pattern showing a general *level* of interests. Cluster 2 and 4 form the extremes of low and high interest, while cluster 3 lies between. The average score across all 108 items (from now called *the grand ACE mean*) is 1.66, 2.49 and 3.06 in cluster 2, 3 and 4 respectively (Table 6-2). Close inspection of the diagram points towards that the three lines are almost parallel displacements of each other. The three lines seem to oscillate more or less in the same pace and phase, but in the high, medium and low parts of the scale.

| | 1 | 2 | 3 | 4 | 5 | tot |
|---|---|---|---|---|---|---|
| **mean** | 2.39 | 1.66 | 2.49 | 3.06 | 2.42 | 2.43 |
| **std.dev.** | .58 | .30 | .27 | .38 | .61 | .37 |
| **variance** | .34 | .09 | .07 | .14 | .37 | .13 |

Table 6-2. Grand ACE mean, standard deviation and variance for each of the five clusters and for the total sample.

The variance for each of these three clusters is small compared to the variance of cluster 1 and 5 (Table 6-2). This indicates that the responses of the three clusters are more concentrated around the cluster mean. Figure 6-4 shows the proportion of responses in each of the four response categories, from *Not interested* (left response category) to *Very interested* (right response category) for each cluster. 82 percent of the answers from the students in cluster 2 are given in the two leftmost response categories. Cluster 3 has 73 percent of the responses in the two middle categories, and cluster 4 has 73 percent in the two categories to the right.

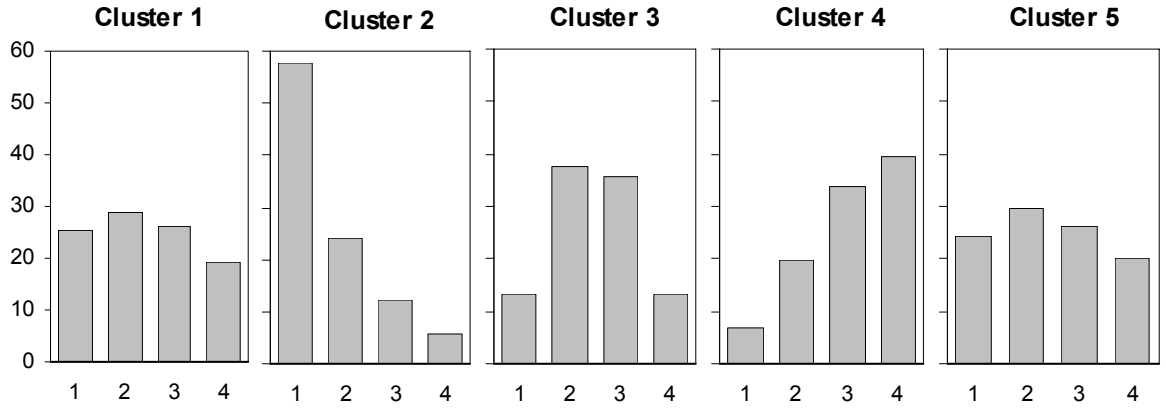



Figure 6-4. Percentage response frequencies in item all 108 ACE items for the four response categories 1 (not interested) to 4 (very interested).

The items in question ACE address a range of different topics, related to very diverse subject areas – from atoms, supernovas and cloning of animals to dinosaurs, human health and thought transference. In spite of the differing nature of the topics, these three student types display uniform and regular profiles with *unselective* interests. I will label cluster 2, 3 and 4 the *Unselective Reluctant*, the *Unselective Undecided* and the *Unselective Enthusiast* (or, in short, the Reluctant, the Undecided and the Enthusiast) student types respectively.

Still, Figure 6-2 shows that for example item A40 achieves noticeable high scores from all three clusters, while all clusters, including cluster 4, have given very low scores to item E01[63]. The fact that there are no missing bars in the diagrams in Figure 6-4 imply that the respondents in the three clusters have utilised the whole scale. For example, the students in the Reluctant cluster have given *some* responses in the rightmost categories as well.

The interest profiles of the two remaining clusters, cluster 1 and 5, stand in sharp contrast to the regular and stable response pattern of the Reluctant, the Undecided and the Enthusiast. The most striking trait of these two clusters is their fluctuating profiles, and thereby their *selective* interest (see Figure 6-3). For both cluster 1 and 5, the grand ACE mean is close to the middle value of the scale (2.39 and 2.42 respectively), while the average item scores of these two clusters range from the lowest to the highest parts of the scale. The differentiated responses lead to relatively large cluster variance in the mean ACE scores (Table 6-2). Apparently, there is no specific relationship between the two

[63] The purpose of this section is to achieve a general idea about the response patterns of the student types. Student interests in specific subject matters will be the focus of a later chapter (chapter 8).

cluster profiles: in some places they coincide, and in other places they are out of phase and far apart from each other. As cluster 1 and 5 are virtually sex-specific, these will be called the *Selective Boy* and the *Selective Girl* respectively.

### 6.6.2 Different response styles

We have seen from Figure 6-2 and Figure 6-3 in the previous paragraph that the five student types show remarkable differences in their response styles.

Different response styles are known from other studies, especially from cross-cultural analysis (Fischer, 2004; Lee, Jones, Mineyama & Zhang, 2002; Lie & Turmo, 2005). It is debatable how such differences should be understood. Fischer (2004) summarise three approaches to understanding the patterns: The characteristic response patterns may reveal "true" differences in student's attitudes, values, interest, etc. For example, it may be that the Enthusiast actually is more interested and engaged than the Reluctant. Alternatively, the response patterns may be effects of different communication styles related to different cultures (in this case to different youth cultures and social identities). It may be that the Reluctant does not express her/himself by superlatives. "Modest" in her/his terminology may correspond to "superb" in the vocabulary of the Enthusiast. The patterns may also be understood as characteristics of politeness, and a concern about leaving a favourable impression on the teacher and the ROSE researchers.

According to the sociocultural perspective, student responses will carry traces of the context in which the survey is situated. How people behave and act in a specific situation is indeed influenced by background factors such as sex, race and age, but also by factors that are unique to the individual and unique to the occasion (Lemke, 2001). The ROSE survey was carried out at *school*, in a *science lesson* and probably by the *science teacher*. Student' different perceptions of school, school science and the science teacher will inevitably influence their responses. If the survey was carried out in another context, for example at a youth computer summer camp, the results might have come out differently. Imagining the school context with the teacher lecturing about ghosts, life in space and what our night dreams may mean (these are examples of topics addressed in the ACE items), is very different from imagining free-time speculations with friends about such issues. According to this school of thought, one can hardly make any meaningful comparisons of respondent scores, as the response context is different from one student to another and from one questionnaire item to another, and we do not know from which contexts the various responses originate.

None of these alternative ways of understanding the response patterns are false, neither are any of them true enough to have the capacity to explain the entire response style phenomena. Probably, all mechanisms influence the responses of the students; and probably, the scope of the different mechanisms varies from one part of the questionnaire to another and from one student to another. I cannot see how it would be possible with my data material to detect which mechanisms come into play for which students in which parts of the questionnaire. The pragmatic approach, which is the one I choose, is to aim at an integrated understanding of the response patterns embracing all such mechanisms.

A natural and exciting continuation of the results in this chapter is to study *which* items that receive the various levels of interest scores among the students in the five

clusters. But first, in the next chapter, I will describe and explain some characteristics of the ACE items, and how the items "behave" or function in various bivariate and multivariate analysis. I will group the ACE *variables* (items) into *factors*. This process is not very different from the way the *cases* (respondents) have been grouped into *clusters* in the current chapter. I regard this as an important basis for validating the items and for understanding and interpreting the forthcoming results.

# 7 VALIDATING AND GROUPING THE ACE ITEMS

Through the process of developing the ACE question, we systematised the items by linking them to different themes specified as *content* and *context* (see 4.5.2). These assisted and structured our thinking; and the categories did function as a fruitful framework during the questionnaire development. However, when we developed the items, we realised that the topics in each item could hardly be categorised simply and uniquely by the two dimensions of *content* and *context*, and we recognised that the distinction between the two categories was unclear or non-existent. Therefore, our understanding of the topics addressed in each item has to be deepened and validated by post hoc analysis. In the following, I will use the label *theme* as a common term for *content* and *context*.

One may question to what extent the items categorised within the various themes actually do measure students' interests in one common underlying theme. With *common underlying themes*, I have in mind the kind of themes employed in 4.5.2. Do there, in the mind of the students, exist concepts such as *Spectacular phenomena* and *Everyday relevance* and *STS*? Do the items constituting the themes *Geo science*, *Technology* and *Environmental protection* actually measure students' interest in the same underlying theme? Does the data support our idea behind the framework in Table 4-1? How is the internal consistency between the items within one theme? Should a group of items within one theme be divided into sub-groups with sub-themes? Or, are some items actually misplaced, and should rather be categorised in a different item group?

Scores in one single variable cannot say anything about what associations the students had in mind, or what connotations the item may have evoked. For example, when asking whether the students are interested in learning about *How it feels to be weightless in space* (item A34) – to what extent is this a question about their interest in learning about Newton's laws of gravity? About space enigmas? Or about man's ability to fly like a bird? The item *Why we can see the rainbow* (item C17) – to what extent is this about light, wavelengths and scattering of light? About the beauty of nature? Or about meteorology?

There is not one answer to these questions. Items may provoke associations about several issues, and the associations may vary from one student to another – depending on the cultural background, experiences, imagination, interests, etc. of the student. Factor analysis (see 5.3) of the items will, however, bring us somewhat closer to an understanding of how the items in general are understood by the respondents. Such validation of the ACE items is the purpose of this chapter.

It may be that I owe the project, the items and the reader a systematic report of the degree of unidimensionality and internal consistency (see 5.6) of the items within each theme in Table 4-1. On the other hand, I want to spare the reader from repetitive and tiring reading. I have elaborately analysed each of the 20 groups of items constituting the themes, and can reveal that (not surprisingly) the framework fell apart. I will not go through all the 20 themes here, but exemplify how the ACE items within one theme "behaved" with a relatively arbitrary selected theme.

## 7.1 The theme U: The Universe

According to Table 4-1, the 12 items in Table 7-1 are all sorted under the same content, *Astrophysics, universe*. Most of the items are also categorised within different context dimensions in the framework. Full item texts with all associated themes are given in the table.

| item | themes |
|---|---|
| A01. Stars, planets and the universe | U |
| A22. Black holes, supernovas and other spectacular objects in outer space | UZ |
| A23. How meteors, comets or asteroids may cause disasters on earth | UZ |
| A34. How it feels to be weightless in space | UM |
| A35. How to find my way and navigate by the stars | UM |
| A44. Rockets, satellites and space travel | UT |
| A45. The use of satellites for communication and other purposes | UT |
| C08. The possibility of life outside earth | UM |
| C09. Astrology and horoscopes, and whether the planets can influence human beings | UMH |
| C10. Unsolved mysteries in outer space | UM |
| C16. Why the stars twinkle and the sky is blue | ULB |
| E29. The first landing on the moon and the history of space exploration | UX |

Table 7-1. All items categorised under the theme *Astrophysics, universe* in Table 4-1. Abbreviations: U: Universe, L: Light, etc., T: Technology, Z: Hullabaloo, H: Human biology, M: Mystery, B: Beauty, W: Environmental protection, X: STS, NOS, etc.

In the total sample, the minimum and maximum correlation coefficients between these items are .20 and .71 respectively, the mean correlation is .43, and alpha is .90 (Table 7-2). These relatively high values indicate that the internal consistency of these items is relatively good. However, when studying the corresponding coefficients *within the five clusters*, the values come out quite differently (Table 7-2).

| | 1 | 2 | 3 | 4 | 5 | tot |
|---|---|---|---|---|---|---|
| **mean corr.** | .29 | .26 | .23 | .21 | .29 | .43 |
| **min corr.** | .06 | .03 | -.01 | -.03 | .08 | .20 |
| **max corr.** | .72 | .68 | .56 | .58 | .56 | .71 |
| **alpha** | .83 | .81 | .79 | .76 | .83 | .90 |

Table 7-2. The mean, minimum and maximum correlation coefficients and alpha for all 12 items in the U theme. Calculated in the five clusters and in the total sample.

As the number of items is relatively large, alpha is acceptably high (above the cut-off value of .70) in all sub-samples. However, the relatively low mean and minimum correlation coefficients in the clusters indicate that the internal consistency of the 12 items shows some weaknesses in all the clusters. After studying the mean correlation, the degree of unidimensionality with exploratory factor analysis (with eigenvalue 1), and the internal consistency with alpha, one suggestion might be to divide these 12 items into two factors (Table 7-3). Item A35, C09 and C16 are not included in any factor, as they showed unclear loading patterns and weakened alpha.

| factor | items | mean corr. | | | | | | alpha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | tot | 1 | 2 | 3 | 4 | 5 | tot |
| 1 | A01, A22, A23, A34, C08, C10, E29 | .34 | .36 | .27 | .24 | .36 | .49 | .78 | .79 | .73 | .69 | .80 | .87 |
| 2 | A44, A45 | .51 | .44 | .48 | .58 | .51 | .69 | .66 | .59 | .64 | .73 | .66 | .82 |

Table 7-3. Items constituting two factors categorised in the theme *Astrophysics, universe* in Table 4-1. The factors are reported with alpha and (mean) correlation coefficients.

By comparing the two factors with the themes in Table 7-1, we see that the items in factor 2 were initially categorised in the *Technology* theme, while the seven items in factor 1 were not categorised in a common theme (apart from all being in the *Universe* theme).

Factor 2 is indeed in the framework, but factor 1 cannot be justified by theme classifications from Table 4-1. The internal consistency varies from one cluster to another, indicating that some factors function well for some groups of respondents, but not for others. For example, in cluster 4 alpha is low for the items in factor 1.

Furthermore, I have still not investigated whether there are other items in the ACE question that show good statistical properties for unidimensionality and internal consistency with some of the items in the *Astrophysics, universe* theme.

Considerations like these suggest that the data only to a limited extent support the framework from section 4.5.2 and our ideas about resemblances between items within each theme.

By studying the substantial meaning of the items, one may understand on what basis the factors in Table 7-3 were formed. However, *I cannot on the basis of the framework understand or explain why the items grouped this way*. In section 7.4, all ACE variables will jointly be entered into one factor analysis. The section will show numerous examples of item groups deviating from the framework in Table 4-1. For example, all plant-items show unclear factor loading patterns. This indicates that, among Norwegian students, the theme *Botany, plants* does not exist as one latent variable in the ROSE questionnaire.

This closes the discussion about the framework and the themes in Table 4-1. The following analysis will be disconnected from the framework. The ACE items will rather be analysed in a more data-driven manner. I conclude that the framework was a useful tool for developing the ACE items, but not an interesting point of departure for the data analysis[64]. (I may, however, utilise the framework theme terminology when I find it useful.)

## 7.2 Factor analysis of ACE raw data

The ACE question requests the students to indicate *how interested* they are in learning about something. Consequently, there is a shared factor in the ACE items representing students' *general degree of interest* in learning about something. All the ACE items have

[64] This does not mean that the concepts and the contexts in the framework are not able for use, or that the items do not tap into the intended themes. In many instances, the grouping of variables in this thesis will be relatively consistent with the framework themes. I will not, however, discuss how or in what degree my composite variables fit the themes suggested in Table 4-1.

this in common. This comes into view as a *positive* correlation coefficient in virtually all item couples.

However, this applies to the total sample, but not to the same extent to samples of the single clusters. Table 7-4 reports correlation coefficients from the grand ACE correlation matrix for various parts of the sample: for each of the five clusters, for the total sample, for the sample constituted by cluster 2, 3 and 4 jointly (from now called cluster 2-3-4), and for the sample developed from cluster 1 and 5 (called cluster 1-5). The parameters are the extreme values in the matrix and the average value for each grand ACE correlation matrix (except from the diagonal).

The table demonstrates that the correlation coefficients change considerable from one sample to another. For example, the grand ACE correlation mean is close to zero within each cluster, whereas the value is .21 and .35 in the total sample and cluster 2-3-4 respectively. Furthermore, the minimum values in the separate clusters 2, 3 and 4 are lower than the minimum value in cluster 2-3-4. In cluster 2-3-4 nearly all item couples are *positively* correlated and most of them are *statistically significantly correlated* at the .01-level. The general inclination of positive correlations in this part of the sample can be explained by the tendency towards some students being interested in learning about "everything" and others about "nothing" (Figure 6-2). In contrast, cluster 1-5 gives statistically significant *negative* correlation coefficients as well, since it does not have the same "everything"/"nothing" response effect.

| | 1 | 2 | 3 | 4 | 5 | tot | 2-3-4 | 1-5 |
|---|---|---|---|---|---|---|---|---|
| **mean corr.** | .07 | .09 | .04 | .06 | .06 | .21 | .35 | .06 |
| **min corr.** | -.33 | -.39 | -.29 | -.40 | -.22 | -.27 | -.06 | -.55 |
| **max corr.** | .76 | .71 | .68 | .74 | .75 | .77 | .78 | .79 |

Table 7-4. Mean, minimum and maximum values for the correlation matrix of all ACE items in the five clusters, the total sample, cluster 2-3-4 and cluster 1-5.

The statistical implication of this shared factor is that alpha and factor analysis (which vary with correlation patterns among the items) will lead to higher alpha values and to fewer factors in the factor solution. In a sense, alpha gets "too" high and less suitable for discriminating variables. For example, if Table 7-2 (correlations and alpha for the *Universe* theme in section 7.1) is extended with one column calculated from cluster 2-3-4, the mean correlation would be .53, the minimum correlation .31 and alpha .93. Again, this is higher than the corresponding values for the single cluster samples.

The factor analysis algorithm requires a certain number of cases; a rule of thumb is five times as many cases as variables. This means that the number of cases in each cluster is too small (Table 6-1) for running factor analysis with all 108 items in each clusters separately. However, the sample is large enough for conducting factor analysis in one half of the sample, for example in cluster 2-3-4 (580 respondents) and cluster 1-5 (552 respondents). Factor analysis in these two sub-samples gives two somewhat different factor structures. Factor analysis in the total sample gives 18 factors, while in cluster 1-5 it gives 25 factors, and in cluster 2-3-4 the factor structure is compressed to 17 factors. In particular, items appearing with an unclear pattern tend to shift factor relationship from one sample to another.

This effect was expected. The students within one cluster are relatively similar to each other. In a homogeneous sample, the true variance is smaller than in a more diverse sample, and alpha is consequently lower. The main point from this section and section 7.1 is that one cannot transfer conclusions about factor structures and alpha from the total sample to the clusters. If there were enough respondents to run factor analysis of all the 108 variables in each cluster separately, the factor structures would have been different from one cluster to another. Different factor structures for each cluster would, however, have made comparison of the clusters, and the associated discussions, very complex. Another way of meeting this problem is to remove the shared factor from the data. In the following section, I will calculate residual scores for each cluster standardised by cluster means.

## 7.3 Residual data

The reason for the positive correlation coefficients in the total sample is the tendency for some students to be interested in "everything" and others in "nothing". This trait is evident from Figure 6-2. Besides affecting the factor and alpha analysis, this tendency makes item-wise comparisons of relative interest scores across clusters inaccessible, at least across cluster 2, 3 and 4.

To resolve these problems, I standardised the data file for all 1132 respondents at the level of clusters. The raw data was transformed into new *residual data*, for each respondent, by subtracting the grand ACE mean for the associated cluster (Table 6-2). In other words: Each response profile through all ACE items was parallelly displaced downwards on the scale. The size of the displacement was equal to the grand ACE mean for the cluster to which the respondent belongs. This means that respondents in cluster 1 were adjusted by 2.39, respondents in cluster 2 by 1.66, etc. (see Table 7-5). The range of 3 in the initial 1-4 scale is maintained within each cluster in the recoded scales.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| value 1 | -1.39 | -.66 | -1.49 | -2.06 | -1.42 |
| value 2 | -.39 | .34 | -.49 | -1.06 | -.42 |
| value 3 | .61 | 1.34 | .51 | -.06 | .58 |
| value 4 | 1.61 | 2.34 | 1.51 | .94 | 1.58 |
| replace. dist. | 2.39 | 1.66 | 2.49 | 3.06 | 2.42 |

Table 7-5. Recoded values for the initial 1-4 scale in each of the five clusters when the replacement distance for each cluster is subtracted. The replacement distance is the grand ACE mean score for the associated cluster (from Table 6-2).

From this follows that in the residual data the grand ACE mean for each cluster is zero, and that the mean value for the various items is fluctuating around zero. Zero mean residual item score in one cluster means that the student types are averagely interested in the topic. Negative mean cluster scores imply that the students in the cluster are less than averagely interested, and positive values means that the item achieves higher than average interest scores. *Averagely* in this context means averagely within the frames of the ACE question in the ROSE questionnaire.

In the residual data, the shared factor described above is removed from cross-cluster analysis (there may still be traces of it within one cluster, though). An alternative

method for dealing with the shared factor problem would be to standardise the data at the level of individuals, i.e. to subtract from each respondent the grand ACE mean for the respondent. This method leads to slightly different correlation patterns, and thereby to somewhat different factor loadings and alphas, but the differences are small and therefore of little or no consequence. At this stage in my analysis, I decided to standardise at the level of clusters because I regarded this method as more consistent with the international residual data transformation in chapter 10[65].

We have already noted the general different *levels* of interest in the clusters. The residual data facilitate analysis of relative interests among the student types.

A table corresponding to Table 7-4 for the residual data file would (logically) have identical values for single cluster samples, while the values for merged cluster samples would be altered. The mean correlation coefficient for all ACE items in cluster 2-3-4 is .06 in the residual data, while it was .35 in the raw scores. The equivalent value for the total sample is .06 in the residual data, whereas the corresponding value for the raw scores was .21. The parallel displacement of cluster 1 and 5 were of the same magnitude (2.39 and 2.42 respectively), so the differences in cluster 1-5 are not interesting.

The factor analysis algorithm applies the correlation matrix for the variables. Therefore, the results are affected by the residual data calculations. Factor analysis of all ACE items in the raw data gave 18 factors, while in the residual data the number is 23. We see that when the shared factor (especially in cluster 2-3-4) is removed, the factor structure is more sensitive to variations in the data.

## 7.4 Factor analysis of ACE residual data

Factor analysis attempts to identify latent variables, or factors, underlying a set of observed variables. This section reports results from exploratory factor analysis with Principal Axis Factoring extraction method and Oblimin rotation method. Factors with eigenvalue greater than 1 have been retained (see section 5.3).

SPSS default setting for missing responses is to exclude cases listwise. This means that cases (respondents) that miss data in any of the variables will be excluded from the factor analysis. Expecting no missing responses in a question containing ca. a hundred items is a very strict criterion. Furthermore, there are few missing values in the ACE items, as cases with many missing responses have been excluded from the data file (see 6.3). Therefore, in the factor analysis of the ACE items, cases are deleted pairwise. This implies that as long as there are non-missing values in an variable, the data will be used by the factor analysis algorithm.

[65] With hindsight, I believe that the data rather should have been standardised on the level of individuals. In the analysis in chapter 10, the *countries* are the units, while here, the units are the *individual students*. For most practical purposes, these two alternative ways of standardising the data makes little difference. The factor structure is largely the same, the hierarchical cluster analysis in chapter 8 gives (logically) identical results, and so does calculations of mean item scores across respondents within one cluster. However, at a later stage, I will need residual data transformed at the level of individuals. I will return to this point later.

Eight of the 108 ACE items were excluded from the SPSS variable input. This analysis gave 21 factors. The purpose of the following detailed reporting of the results is fourfold:

1. To validate the items. By studying the groups of items in the various factors, we may achieve a better understanding of what the different items tap into. In instances where items are loading on more than one factor, this may help us to understand what other dimensions might possibly lie in the items. We may also find that some of the items are hard to validate. These will be considered excluded from further analysis.
2. To provide pegs to hang the ACE items on. The items are numerous and the material needs to be simplified and condensed into categories. The pegs will also structure the forthcoming discussions of the results from the ACE data analysis.
3. To make a base for index construction. In a later section, I will transform groups of ACE items into indexes according to the procedure described in 5.6. The results of the factor analysis described below function as the first step in preparing the items for being merged into indexes.
4. To explain this way of exploring the data. The factor structure discussed here is not my final version of the factor solution. The final version is given in Appendix E. The version presented here is a step on the way towards the factor structure reported in the appendix. As the explorative analysis is an important part of my research approach, I wish to give a detailed account of my way through the data. Therefore, I have decided to discuss this version instead of the final.

In the following discussion of the results, *high* loadings denote absolute values close to and above .50, *medium* loadings refer to values between .50 and .25, and loadings between .25 and .15 are perceived as *low*. Absolute values below .15 are regarded as discountable and therefore suppressed from the tables.

In each factor, the items are ordered by descending loading sizes. This means that the item at the top of the list is the one with the highest loading on the specific factor. Items are placed in the factor in which they have their highest factor loading (some exceptions are commented in footnotes). Some items are showing an unclear factor profile by having only medium and/or low factor loadings on several factors.

The factor solution suggested below is not the one and only factor solution. Items showing low and multiple loadings attest the instability of this solution. Especially items with unclear profiles are sensitive to small changes in the requisition to SPSS. As for the raw data, we would find that different sub-samples give somewhat different factor structures. Furthermore, another extraction method, rotation method or excluding some more/fewer/other variables, would lead to a somewhat different result, in which particularly the items with unclear profiles could have come out differently. At the same time, items with high factor loadings would probably appear as very robustly placed in one specific factor, and reappearing in the same factor together with the same items in every trial analysis.

As mentioned above, eight items were excluded from the factor analysis. The reason is that I wished to present a comprehensible factor structure. The excluded items are:

A12. Cloning of animals
A16. How people, animals, plants and the environment depend on each other
A19. Light around us that we cannot see (infrared, ultraviolet)
A21. How different musical instruments produce different sounds
A47. How petrol and diesel engines work
C01. How crude oil is converted to other materials, like plastics and textiles
E01. Symmetries and patterns in leaves and flowers
E22. How different sorts of food are produced, conserved and stored

These items showed loading patterns that I found unclear and hard to understand. The items emerged after several trials and errors. In the factors reported below, items marked with an asterisk (*) show similar unclear patterns. There is no particular reason for the items above being excluded, while the asterisked items are not. I simply wished to exclude as few items as possible from the factor analysis, and stopped leaving out items at the moment the analysis gave a factor structure that I to some extent was able to comprehend.

There are no practical implications of excluding the items. It is simply a matter of communicating an intelligible account. I could have exchanged some of these items with some others. In that case, the factor structure would have been somewhat altered, but with most of the fundamental features maintained.

The following is a report of the SPSS output for the 21 factors. For each factor, I will discuss what *theme* the items possibly have in common. In spite of the labelling pitfall described in 5.6.4, I will associate a *theme label* to each factor.

In most instances, I will comment on the factors and the item loadings, in order to validate the ACE items and the factor labels. The discussion is done factor-wise rather than item-wise. This means that item loadings are discussed under the heading of the factor in which the loading occurs. However, not all loadings can be understood on the basis of this factor analysis. I will not aim at commenting *all* items and *all* loadings. Some are more or less self-evident and some will turn out to be complicated to understand. In factor 14, 20 and 21 there are some loadings with opposite signs from the main loading, but since all are small, I will not try to interpret the meaning of these.

### 7.4.1 Factor 1: The *Fit/sculptured body* theme

| | **1** | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A39 | **-.65** | | | | | | | | | | | | | | | | | | | | |
| A37 | **-.62** | | | | | | | | | | | | | | | | | | | | |
| A40 | **-.58** | | | | | | | | | | | | | | | | | | | | .17 |
| A42 | **-.55** | | | | | | | | | | | | | | | | -.16 | | | | |
| A41 | **-.46** | | | | | | | | | | | | | | | | | | | | -.17 |
| A38 | **-.42** | | | | | | | | | | | -.17 | | | | | | | | .16 | |

Table 7-6. Loadings of items with main loading on factor 1 in a 21-factor solution of the ACE items. The largest item loading is in boldface. (Item loadings below .15 are suppressed, see text.)
A39. The ability of lotions and creams to keep the skin young
A37. What to eat to keep healthy and fit
A40. How to exercise to keep the body fit and strong
A42. How radiation from solariums and the sun might affect the skin
A41. Plastic surgery and cosmetic surgery
A38. Eating disorders like anorexia or bulimia

These items may have in common an issue of body shaping. The factor also has medium and low loadings from item C12 (alternative therapies, see factor 8 below) and E31 (abortion, see factor 10). These two items are not related to body shaping, but possibly these have in common with the items in this factor 1 that they address some public controversies. This may indicate that the factor has a component of opposing viewpoints and current topics of dissension in the Norwegian social discourse.

### 7.4.2 Factor 2: The *Environmental protection* theme

| | 1 | **2** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E04 | | **.74** | | | | | | | | | | | | | | | | | | | |
| E03 | | **.74** | .15 | | | | | | | | | | | | | | | | | | |
| E05 | | **.49** | | | | | | | | | | -.21 | | | | | | | | | .15 |
| E06 | | **.27** | | | | | | | | | | | | | .16 | .25 | | | | | |

Table 7-7. Loadings of items with main loading on factor 2 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E04. The greenhouse effect and how it may be changed by humans
E03. The ozone layer and how it may be affected by humans
E05. What can be done to ensure clean air and safe drinking water
E06. How technology helps us to handle waste, garbage and sewage

The items in this factor are related to local and global environmental protection. In addition, item E02 (sunset, in factor 5) has a low loading on this factor. There is a close connection between the sunset colours and the environmental issue, as air pollution contributes to a redder sunset sky. However, I doubt that 15 year old students are familiar with this connection, and do not think this is a plausible understanding of the loading of item E02 on this factor. Even though it may be hard to grasp the meaning of this item in the context of this theme, other items loadings on this factor supports the environmental protection theme. These are item E19 (ecological farming), E20 (saving energy) and E21 (new energy sources), all in factor 15.

### 7.4.3 Factor 3: The *Universe and enigmas* theme

| | 1 | 2 | **3** | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C08 | | | **.62** | | | | | .25 | | | | | | | | | | | | | |
| C10 | | | **.58** | | | | | .31 | | | | | | | | | | | | | |
| A22 | | | **.52** | | | | | | | | | | .16 | | | | | | | | |
| E29 | | | **.50** | | | | | | .19 | | | | | | | | | | | | |
| A23 | | | **.48** | | | | | | | | | | | | | | | -.24 | | | |
| A44 | | | **.47** | | | | -.23 | | | | | | | -.15 | | | | -.18 | | | |
| A01 | | | **.46** | | | | | | | | | | | | | | | | .25 | | |
| A45 | | | **.38** | | | | -.29 | | | | | | | | .15 | | | | | | |
| A35 | | | **.34** | | .26 | | -.23 | | | | | | | | | | | | | | |
| A14 | | | **.32** | | | .29 | | | | | | | | -.17 | | | | | | | |
| A34 | | | **.29** | | | | -.17 | | | | | | | | | | | | | | |
| A06 | | | **.25** | | | | | | | | | | | | | | | | .21 | | |

Table 7-8. Loadings of items with main loading on factor 3 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
C08. The possibility of life outside earth
C10. Unsolved mysteries in outer space
A22. Black holes, supernovas and other spectacular objects in outer space
E29. The first landing on the moon and the history of space exploration
A23. How meteors, comets or asteroids may cause disasters on earth
A44. Rockets, satellites and space travel
A01. Stars, planets and the universe
A45. The use of satellites for communication and other purposes
A35. How to find my way and navigate by the stars
A14. Dinosaurs, how they lived and why they died out
A34. How it feels to be weightless in space
A06. The origin and evolution of life on earth

Most of these items are related to space, except item A14 (dinosaurs) and A06 (origin of life on earth).

To understand the representation of these two items in this factor, I will draw on some student texts from one open-ended question (question I). The students were asked *what* they would like to do research on if they were grown up and worked as scientists, and *why* they would like to do research on that particular matter. (As I have not yet analysed these data, results are not reported here.) It is evident from the student writings that many would like to do research on issues related to the universe, as out there, there are *still some mysteries* and unsolved questions left. Dinosaurs, fossils, archaeology, the origin of life on earth, the great ocean depths, etc. were also topics occurring in the student texts that seemed related to the great enigmas on earth and to issues that are not yet fully explained and understood.

My interpretation of this factor is that these items, including A14 (dinosaurs) and A06 (origin of life on earth) bring associations about unrevealed phenomena. Due to the large representation of items related to space, the theme label contains both the universe and other enigmas.

Item C09 (astrology and horoscopes) in factor 8 and E42 (phenomena scientists cannot explain) in factor 13 load on this factor too, and are also related to matters that are not yet proven, known or understood, and support thereby this theme label. Item E03 (ozone layer, in factor 2) loading on this factor can possibly be understood as stratospheric ozone conveying a component of space.

### 7.4.4 Factor 4: The *Technology* theme

| | 1 | 2 | 3 | **4** | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C05 | | | | **.87** | | | | | | | | | | | | | | | | | |
| C04 | | | | **.83** | | | | | | | | | | | | | | | | | |
| C06 | | | | **.72** | | | | | | | | | | | | | | | | | |
| C03 | | | | **.69** | | | | | | | | | | | | | | | | | |
| C07 | | | | **.61** | | | | | | | | | | | | | | | | | |
| C02 | | | | **.40** | | | -.20 | | | | | | | | | | | | | | -.21 |

Table 7-9. Loadings of items with main loading on factor 4 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
C05. How things like radios and televisions work
C04. How cassette tapes, CDs and DVDs store and play sound and music
C06. How mobile phones can send and receive messages
C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.)
C07. How computers work
C02. Optical instruments and how they work (telescope, camera, microscope, etc.)

All items in this factor are addressing issues of advanced technology. There are two other items loading on this same factor, namely item E28 (repair everyday electrical equipment) and E27 (electricity in homes) in factor 16. Also these items may be seen as having a component of technology, and supports thereby the label suggestion.

### 7.4.5 Factor 5: The *Geo, aesthetics* theme

| | 1 | 2 | 3 | 4 | **5** | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C17 | | | | | **.74** | | | | | | | | | | | | | | | | |
| C16 | | | | | **.69** | | | .16 | | | | | | | | | | | | | |
| C18 | | | | | **.44** | | | | | | | | | | | | | | | -.17 | |
| E02 | | .26 | | | **.43** | | | | | | | | | | | | | | | .17 | |

Table 7-10. Loadings of items with main loading on factor 5 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
C17. Why we can see the rainbow
C16. Why the stars twinkle and the sky is blue
C18. Properties of gems and crystals and how these are used for beauty
E02. How the sunset colours the sky

These items may be related to aspects of nature that people often look upon as beautiful. Item A35 (find my way by stars, in factor 3) also loads on this factor, and supports the notion of this factor being related to man admiring nature.

### 7.4.6 Factor 6: The *Animals* theme

| | 1 | 2 | 3 | 4 | 5 | **6** | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E24 | | | | | | **.63** | | | | | | | | | | .24 | | | | | |
| A13 | | | | | | **.59** | | | | | | | | | | | | | | | |
| E16 | | | | | | **.51** | | | | | | -.18 | | | .22 | | | | | | |
| A27 | | | | | | **.49** | | | | | | | | | | | -.22 | | | | |
| A20 | | | | | | **.46** | | | | | | | | | | | | | | | |

Table 7-11. Loadings of items with main loading on factor 6 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E24. Animals in my area
A13. Animals in other parts of the world
E16. How to protect endangered species of animals
A27. Brutal, dangerous and threatening animals
A20. How animals use colours to hide, attract or scare

The items in this factor are all about animals. Item A14 (dinosaurs, in factor 3) loads on this factor as well.

The loading of item E25 (plants in my area, in factor 16) on this factor is harder to interpret. The explanation may lie in the relationship between item E25 and E24 (animals in my area) (correlated by .55). The relatively strong correlation between these two items may be due to the local surroundings expressed by "in my area" in both items. The low loading from item A28 (poisonous plants in my area) may also be a hint of the same. This means that this factor may have a component of not only animals, but also of the local and surrounding environment.

### 7.4.7 Factor 7: (Untitled)

| | 1 | 2 | 3 | 4 | 5 | 6 | **7** | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A36 | | | | | | | **-.51** | | | | | | | | | | | | | | |
| A43 | | | | | | | **-.48** | | | | | | | | | | | | | | |
| A46 | | | | | | | **-.30** | | | | | -.16 | | | | | | | | | -.26 |

Table 7-12. Loadings of items with main loading on factor 7 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A36. How the eye can see light and colours
A43. How the ear can hear different sounds
A46. How X-rays, ultrasound, etc. are used in medicine

I find this factor hard to define. A46 (x-rays in medicine) has an unclear factor loading pattern, so one suggestion could be to disregard item A46 and label the factor after the two remaining items, for example "Eye and ear". However, the other items with loadings on this factor (item A44 (rockets), A45 (satellites), A35 (find my way by stars), A34 (weightless in space) in factor 3, C02 (optical instruments) in factor 4 and A17 (atoms and molecules) in factor 21) expand my confusion rather than deepen my understanding. Consequently, I will leave this factor undefined.

### 7.4.8 Factor 8: The *Mysteries* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **8** | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C15 | | | | | | | | **.71** | | | | | | | | | | | | | |
| C14 | | | | | .16 | | | **.62** | | | | | | | | | | | | | |
| C11 | | | | | | | | **.60** | | | | | | | | | | | | | |
| C13 | | | | | | | | **.58** | | | | | | | | | | | | | |
| C12 | -.25 | | | | | | | **.40** | | | | | | | | | | | | | |
| C09 | | | .31 | | | | | **.39** | | | | | | | | | | | | | |

Table 7-13. Loadings of items with main loading on factor 8 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
C15. Thought transference, mind-reading, sixth sense, intuition, etc.
C14. Ghosts and witches, and whether they may exist
C11. Life and death and the human soul
C13. Why we dream while we are sleeping, and what the dreams may mean
C12. Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are
C09. Astrology and horoscopes, and whether the planets can influence human beings

These items, although touching on very different topics, may have in common that they stimulate reasoning based on incomplete information. Other items loading on this factor are C08 (life in space) and C10 (unsolved mysteries in space) from factor 3, C16 (why the

stars twinkle) in factor 5 and E42 (phenomena scientists cannot explain) in factor 13. I believe that all these items can support the factor label.

### 7.4.9 Factor 9: The *Science and scientists* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | **9** | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E36 | | | | | | | | | **.59** | | | | | | | | | | | | |
| E39 | | | | | | | | | **.57** | | | | .21 | | | | | | | | |
| E37 | | | | | | | | | **.53** | | | | | | | | | | | | -.16 |
| E34 | | | | | | | | | **.51** | | | | | | .16 | | | | | | |
| E38 | | | | | | | | | **.45** | | | | .39 | | | | | | | | |
| E35 | | | | | | | | | **.27** | | | | | | .17 | | -.16 | | | | |

Table 7-14. Loadings of items with main loading on factor 9 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E36. Why scientists sometimes disagree
E39. How scientific ideas sometimes challenge religion, authority and tradition
E37. Famous scientists and their lives
E34. Why religion and science sometimes are in conflict
E38. Big blunders and mistakes in research and inventions
*E35. Risks and benefits of food additives

Item E35 at the bottom of this list seems somewhat different from the others. As the item has low loading on the factor and has additional loadings on two other items, I will disregard it.

The remaining items are related to what scientist do and how science works. Other items loading on this factor are E29 (first moon landing, in factor 3), E40 (inventions that have changed the world, in factor 13) and E33 (modern farming methods, in factor 15). These, combined with item E35 in this factor, point towards an underlying theme in the area of STS and NOS. However, I consider "STS/NOS" to be a too broad and ambitious label for this small collection of items, and have therefore chosen a narrower label intending to cover the five items with the largest factor loadings.

### 7.4.10 Factor 10: The *Human conception and maturing* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | **10** | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A09 | | | | | | | | | | **.79** | | | | | | | | | | | |
| A10 | | | | | | | | | | **.66** | | | | | | | | | | | |
| A11 | | | | | | | | | | **.55** | | | | | | | | | | .19 | |
| E23 | | | | | | | | | | **.44** | | -.15 | | | | | | | | | .18 |
| A07 | | | | | | | | | | **.41** | | | | | | | | | .19 | | |
| A08 | | | | | | | | | | **.38** | | | | | | | | | | | -.21 |
| E31 | -.20 | | | | | | | | | **.29** | | -.20 | | | | | | | | .20 | |

Table 7-15. Loadings of items with main loading on factor 10 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A09. Sex and reproduction
A10. Birth control and contraception
A11. How babies grow and mature
E23. How my body grows and matures
A07. How the human body is built and functions
A08. Heredity, and how genes influence how we develop
E31. Biological and human aspects of abortion

Items in this factor cover subjects of human biology, such as sexual matters, the growing and maturing young body and how it functions. One additional item loads on this factor, item E09 (sexually transmitted diseases) in factor 12. This seems consistent with the theme label.

### 7.4.11 Factor 11: The *Youth health, drugs* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | **11** | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E12 | | | | | | | | | | | **.68** | | | .24 | | | | | | | |
| E13 | | | | | | | | | | | **.63** | | | .24 | | | | | | | |

Table 7-16. Loadings of items with main loading on factor 11 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E12. How alcohol and tobacco might affect the body
E13. How different narcotics might affect the body

In addition to these two items, the following items load in this factor: E11 (HIV/AIDS) and E09 (sexually transmitted diseases) in factor 12 and E14 (radiation danger of mobiles) in factor 14.

These items may have in common risks related to youth lifestyles and youth health. Such topics are often addressed at schools, in homes and in media in order to create awareness about youth health risk behaviours such as drug abuse, unprotected sexual activity and extensive mobile use. The two items in this factor are more specifically related to intoxicants.

### 7.4.12 Factor 12: The *Health* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | **12** | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E08 | | | | | | | | | | | | **-.77** | | | | | | | | | |
| E07 | | | | | | | | | | | | **-.73** | | | | | | | | | |
| E11 | | | | | | | | | | | .23 | **-.62** | | | | | | | | | |
| E10 | | | | | | | | | | | | **-.51** | | | | | | | | | |
| E09 | | | | | | | | | | .31 | .21 | **-.43** | | | | | | | | | |
| E32 | | | | | | | | | | | | **-.31** | | | | | | | | | -.23 |

Table 7-17. Loadings of items with main loading on factor 12 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E08. Cancer, what we know and how we can treat it
E07. How to control epidemics and diseases
E11. What we know about HIV/AIDS and how to control it
E10. How to perform first-aid and use basic medical equipment
E09. Sexually transmitted diseases and how to be protected against them
E32. How gene technology can prevent diseases

All these items are related to matters of human health. Other items supporting this theme label by loading on this factor are A38 (eating disorders) in factor 1, A46 (x-rays in medicine) in factor 7, E31 (abortion) in factor 10, E18 (medicinal use of plants) in factor 15 and A26 (epidemics causing large losses) in factor 17.

Item E16 (protect endangered animals) with a low loading on this factor is harder to interpret. It may be that the item and this factor have in common an element of general care and concern. This may also be the case for item E05 (clean air, safe drinking water, in factor 2) loading on this factor. This latter item may also touch into aspects of health by

addressing safe drinking water and clean air, which may be seen as essential conditions for human health.

### 7.4.13 Factor 13: The *Science in the making* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | **13** | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E40 | | | | | | | | | .19 | | | | **.67** | | | | | | | | |
| E41 | | | | | | | | | | | | | **.61** | | | | | | | | |
| E42 | | | .26 | | | | | .17 | | | | | **.43** | | | | | | | | |

Table 7-18. Loadings of items with main loading on factor 13 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E40. Inventions and discoveries that have changed the world
E41. Very recent inventions and discoveries in science and technology
E42. Phenomena that scientists still cannot explain

Like factor 9, this factor may also be related to aspects of STS and NOS. Besides the three items listed here, items loading on this factor are for example E39 (scientific ideas challenging authority) and E38 (blunders in research and inventions) in factor 9, E30 (electricity in society) in factor 16, and E20 (saving energy) and E21 (new energy sources) in factor 15. (In fact, the latter item has its main loading on this factor, see factor 15.)

The items with main loadings on this factor seem to be related to the progress of science and to scientific discoveries and inventions, hence the theme label.

### 7.4.14 Factor 14: The *Youth health, noise/mobiles* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | **14** | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E15 | | | | | | | | | | | | | | **.61** | | | | | | | |
| E14 | | | | | | | | | | | .18 | | | **.60** | | | | | | | |

Table 7-19. Loadings of items with main loading on factor 14 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E15. How loud sound and noise may damage my hearing
E14. The possible radiation dangers of mobile phones and computers

Besides these two items, the two items in factor 11 *Youth health, drugs* load on this factor. Item E15 may be related to loud music at parties and concerts, and the hearing damage this may cause. Music, mobile phones and computers are central elements in youth lifestyles[66]. The comments to factor 11 apply to this factor too: Public discussions about loud music and mobile use are often related to youth health risk behaviours.

[66] The mobile phone is one central means for youth' s communication and interaction with each other. Mobile phones are also commonly seen as a means for youth's identity expression (Alexander, 2000; Graves, 2004).

### 7.4.15 Factor 15: The *Farming and advancing nature* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | **15** | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E17 | | | | | | | | | | | | | | | **.60** | | | | | | |
| E19 | | .16 | | | | | | | | | | | | | **.56** | | | | | | |
| E33 | | | | | | | | | .21 | | | | | | **.49** | | | | | | |
| E18 | | | | | | | | | | | | -.19 | | | **.48** | | | | | | -.15 |
| E20 | | .19 | | | | | | | | | | | .24 | | **.33** | .27 | | | | | |
| E21 | | .22 | | | | | | | | | | | **.29** | | .28 | .19 | | | | | |

Table 7-20. Loadings of items with main loading on factor 15 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E17. How to improve the harvest in gardens and farms
E19. Organic and ecological farming without use of pesticides and artificial fertilizers
E33. Benefits and possible hazards of modern methods of farming
E18. Medicinal use of plants
*E20. How energy can be saved or used in a more effective way
*E21. New sources of energy from the sun, wind, tides, waves, etc.[67]

The three first items in this factor are related to farming, while E18 (medicinal use of plants) represents another way of utilising plants and nature. Also the two last items in this list, item E20 (saving energy) and E21 (new energy sources), are about advancing natural resources. (These two items addressing the energy issue show similar but unclear factor-loading patterns with loadings almost equally divided between four factors.)

Item E06 (handling waste, in factor 2) and E16 (protect endangered animals, in factor 6) load on this factor as well. From the loadings of these two items, combined with the fact that three items in this factor load on factor 2 *Environmental protection*, I infer that this factor also has components of valuing and caring for nature.

### 7.4.16 Factor 16: (Untitled)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | **16** | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E27 | | | | .17 | | | | | | | | | | | | **.58** | | | | | |
| E26 | -.19 | | | | | | | | | | | | | | | **.47** | | | | | |
| E28 | | | | .26 | | | | | | | | | | | | **.44** | | | | -.15 | |
| E30 | | | | | | | | | | | | | .20 | | | **.42** | | | | | |
| E25 | | | | | | **.37** | | | | | | | | | .15 | .34 | | | | | |

Table 7-21. Loadings of items with main loading on factor 16 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
E27. Electricity, how it is produced and used in the home
E26. Detergents, soaps and how they work
E28. How to use and repair everyday electrical and mechanical equipment
E30. How electricity has affected the development of our society
*E25. Plants in my area[68]

[67] This item was initially placed in factor 13 *Discoveries and inventions*, because the loading on factor 13 is slightly higher than the loading on factor 15. I moved it to this factor, as I regard the substantial meaning of the item text to make more sense here together with item E20. The transfer is only a matter of classification and has no practical implication. The item has nevertheless a very unclear loading pattern.

[68] Due to the substantial meaning of this item, it is transferred from factor 6 *Animals* (its loading on factor 6 is slightly higher than its loading on factor 16). As described in footnote 67, this has no practical implications for my analysis.

According to the framework applied for developing this ACE question (section 4.5.2), most of these items have in common the "everyday relevance" theme (Table 4-1). Three of the items are also connected to electricity. However, as accounted for earlier, I find this label problematic. Mobile phones, fit body, safe drinking water, chemicals, musical instruments, petrol and diesel engines, etc. are highly relevant for the modern everyday life too. Another title suggestion could be "Everyday relevant traditional textbook topics".

Several items in other factors have loadings on this factor. Also, they may have a component of the "traditional everyday" issue, e.g. item E06 (handling waste) in factor 2, E24 (animals in my area) in factor 6, and E20 (saving energy) and E21 (new energy sources) in factor 15. I regard the number of items as too small, and the substantial meaning of the items as too unclear to form a theme label. Consequently, I leave the title open-ended.

### 7.4.17 Factor 17: The *Health threats* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | **17** | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A29 | | | | | | | | | | | | | | | | | **-.52** | | | -.29 | |
| A28 | | | | | | .16 | | | | | | | | | | | **-.48** | | | | |
| A26 | | | | | | | | | | | | -.31 | | | | | **-.38** | -.18 | | | |

Table 7-22. Loadings of items with main loading on factor 17 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A29. Deadly poisons and what they do to the human body
A28. Poisonous plants in my area
A26. Epidemics and diseases causing large losses of life

These three items may have in common that they are all critical and maybe horrifying threats to human health. This is supported by loadings from item A27 (dangerous animals) in factor 6, A42 (radiation from solariums) in factor 1, E35 (risks of food additives) in factor 9 and A33 (strong electric shocks) in factor 20.

### 7.4.18 Factor 18: The *Geo, volcano and tornado* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | **18** | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A24 | | | | | | | | | | | | | | | | | | **-.80** | | | |
| A25 | | | | | | | | | | | | | | | | | | **-.72** | | | |

Table 7-23. Loadings of items with main loading on factor 18 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A24. Earthquakes and volcanoes
A25. Tornados, hurricanes and cyclones

These two items are related to somewhat dramatic geophysical phenomena. This is supported by item A23 (meteors causing disasters, in factor 3) and A03 (inside of earth) loading on this factor as well. The dramatic aspect of item A26 (epidemics causing large losses, in factor 17) may be the cause of this item loading on this factor. The reason for the small loading of item A44 (rockets) in factor 3 is not easy to grasp. It might be that this factor, as factor 3, brings association of spectacular phenomena which man still cannot control.

### 7.4.19 Factor 19: The *Geo* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | **19** | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A04 | | | | | | | | | | | | | | | | | | | **.64** | | |
| A05 | | | | | | | | | | | | | | | | | | | **.56** | | |
| A03 | | | | | | | | | | | | | | | | | | -.20 | **.39** | | |
| A15 | | | | | | .18 | | | | | | | | | .18 | | | | **.25** | | -.17 |

Table 7-24. Loadings of items with main loading on factor 19 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A04. How mountains, rivers and oceans develop and change
A05. Clouds, rain and the weather
A03. The inside of the earth
*A15. How plants grow and reproduce

Like the previous factor, also this factor is related to topics in the geosciences. Other items loading on this factor are item A01 (stars, planets, universe) and A06 (origin of life) in factor 3.

Item A15 (how plants grow, in this factor) and item A07 (how the body functions, in factor 10) load on this factor, even though these items are not in the geosciences. I see no obvious reason for why these two items are related to the other items in this factor. It may be the traditional and general angling and wording of the items that connects them. (Many items in the ACE question may be perceived as strange and unconventional. Compared to such items, the items in this factor are more like standard school science textbook subjects.)

### 7.4.20 Factor 20: The *Explosions and shocks* theme

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | **20** | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A32 | | | | | | | | | | | | | | | | | | | | **-.70** | |
| A31 | | | | | | | | | | | | | | | | | | | | **-.69** | |
| A30 | | | | | | | | | | | | | | | | | | | | **-.64** | |
| A33 | | | | | | | | | | | | | | | | | -.16 | | | **-.51** | |
| A18 | | | | | | | | | | | | | | | | | | | | **-.50** | |
| A48 | | | | | | | | | | | | | | | | | | | | **-.50** | |

Table 7-25. Loadings of items with main loading on factor 20 in a 21-factor solution of the ACE items. The largest item loading is in boldface.
A32. Biological and chemical weapons and what they do to the human body
A31. Explosive chemicals
A30. How the atom bomb functions
A33. The effect of strong electric shocks and lightning on the human body
A18. How radioactivity affects the human body
A48. How a nuclear power plant functions

These items address explosive and spectacular matters. The appearance of item A18 (radioactivity) and A48 (nuclear power plant) in this factor may be due to the controversiality of nuclear power as an energy source. The issue provokes heated national and international public debates and demonstrations, for example lately related to discharges from the Sellafield plant into the sea (claimed drifting north and affecting marine life in Scandinavia). People also remember the Chernobyl accident in our neighbouring country causing diseases, deaths and environmental damage. Such issues may explain why the students associate item A18 and A48 with the other explosive or spectacular items.

There are several other items loading on this factor: A01 (stars, planets, universe) and A06 (origin of life) in factor 3, A07 (how the body functions) in factor 10 and A02 (chemicals and how they react) in factor 21. The unclear message from these items indicate that this factor may be somewhat ambiguously defined.

### 7.4.21 Factor 21: (Untitled)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | **21** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A02 | | | | | | | | | | | | | | | | | | | .17 | **-.41** | -.34 |
| A17 | | | | | | | -.22 | | | | | | | | | | | | | -.35 | **-.39** |

Table 7-26. Loadings of items with main loading on factor 21 in a 21-factor solution of the ACE items.
*A02. Chemicals, their properties and how they react
*A17. Atoms and molecules

This last factor is unclear and almost seamless to factor 20 above. In fact, item A02 has its highest loading on the previous factor. Although I am assuming that the substantial meanings of the two items are relatively clearly defined and understood, at least in a school science context, I find their relationship to other ACE items incomprehensible.

This means that I will rather refer to these two items as single items than as a part of a theme. Therefore, I shall leave this factor unlabelled.

## 7.5 19 indexes in six interest orientations

In the previous section, I divided the ACE items into themes. The next chapter presents the top- and bottom-scoring items in the clusters, and the discussion of the results will be structured by referring to the themes developed above. In the next chapter, I will also compare scores of composite variables, or *ACE indexes*, calculated from items in the themes. Discussion of these will be structured around six *interest orientations.*

This section gives accounts for the index calculations and for the interest orientations. Besides providing a framework for structuring the forthcoming analysis and discussions, this section can be seen as a further validation of the ACE items.

### 7.5.1 ACE indexes

The indexes are calculated from average item scores. Before merging the items from one theme into an index, the group of items was tested for unidimensionality and internal consistency, according to the requirements specified in 5.6. In instances where the items from one theme did not meet these requirements, the item composition was altered – either the group of items was divided into two sub-groups or/and some items were excluded from the group of items. These analysis aimed at distilling the characteristics of the themes, and excluding items that did not strengthen the internal consistency of the items within one theme.

| ACE index | items | α | comment |
|---|---|---|---|
| Fit/sculptured body | A37, A38, A39, A40, A41, A42 | .85 | |
| Environmental protection | E03, E04, E05, E06 | .72 | |
| Universe and enigmas | A01, A06, A14, A22, A23, C08, C10, E29 | .82 | divided into two indexes (next raw); A34 A35 excluded (weakened alpha) |
| Satellites and rockets | A44, A45 | .82 | offshoot of *Universe and enigmas* |
| Technology | C03, C04, C05, C06, C07 | .86 | C02 excluded (weakened alpha) |
| Geo, aesthetics | C16, C17, E02 | .72 | C18 excluded (weakened alpha) |
| Animals | A13, A20, A27, E16, E24 | .71 | |
| Mysteries | C09, C11, C12, C13, C14, C15 | .81 | |
| Science and scientists | E34, E36, E37, E38, E39 | .73 | |
| Human conception and maturing | A07, A08, A09, A10, A11, E23, E31 | .80 | |
| Youth health, drugs | E12, E13 | .87 | |
| Health | E07, E08, E09, E10, E11, E32 | .82 | |
| Science in the making | E40, E41, E42 | .73 | |
| Youth health, noise/mobiles | E15, E14 | .77 | |
| Farming and advancing nature | E17, E18, E19, E33 | .72 | divided into two indexes (next raw) |
| Energy, saving and new sources | E20, E21 | .83 | offshoot of *Farming and advancing nature* |
| Geo, volcano and tornado | A24, A25 | .82 | |
| Explosions and shocks | A30, A31, A32, A48 | .85 | A33 A18 excluded (weakened alpha) |
| Geo, mountain and weather[69] | A04, A05 | .67 | A03 excluded (weakened alpha) |
| (Health threats) | A26, A28, A29 | .58 | low alpha, index not calculated |

Table 7-27. ACE indexes with associated items. Third column shows alpha as measure of internal consistency. Indexes differing from the themes in section 7.4 are commented in the right column.

In Table 7-27, the outcome of this testing is summarised, and the indexes comprise the items listed in the second column in the table. The items in the theme *Universe and enigmas* disintegrated in the unidimensionality test (see 5.6.3), and resulted in one additional offshoot factor: *Satellites and rockets*. This factor contains item A44 (rockets) and A45 (satellites). A corresponding divergence took place for the *Farming and advancing nature* theme: Item E20 (saving energy) and E21 (new energy sources) formed an additional factor which I labelled *Energy, saving and new sources*.

These two latter items were the only among the asterisked items that showed good enough qualities to be reassigned to an index. The remaining asterisked items in the previous section are not included in any of the indexes. Furthermore, none of the items in the three untitled themes (in 7.4.7, 7.4.16 and 7.4.21) are involved in any index.

### 7.5.2 ACE interest orientations

The Oblimin rotation in 7.4 is an oblique rotation method, which allows the factors to correlate. In this paragraph, I will study the relationship between the indexes and organise

[69] Alpha for this index is below the cut-off value .70 (see 5.6.2). I have two justifications for merging them into one index in spite of the low alpha value: First, alpha increases with increasing number of items. Since this index is only based on two items, an alpha value at .67 indicates that the items are relatively homogeneous. Second, I think the substantial meaning of these items support that they can be merged into one index.

them into six interest orientations. The interest orientations are means of structuring later discussions about interest scores of the clusters and for further validation of the ACE items. They have appeared from explorative factor analysis of the 19 ACE indexes; in other words, a *second-order factor analysis* of the ACE question.

The factor structure reported in Table 7-28 derives from factor analysis with Principal Axis Factoring extraction method and Oblimin rotation method. Factors with eigenvalue larger than 1 were retained. This resulted in six factors. Values below .17 are suppressed. (In the previous section, I sat the cut-off point at .15. In this second order factor analysis the loading patterns are more indistinguishable. In order not to make the table too messy and the discussion too long, the cut-off value was slightly increased.)

| | factor 1 ***Body*** | factor 2 ***Concern*** | factor 3 ***Puzzles*** | factor 4 ***Techno*** | factor 5 ***Ponder*** | factor 6 ***Nature*** |
|---|---|---|---|---|---|---|
| Health | **-.73** | .17 | | | | |
| Youth health, drugs | **-.73** | | | .19 | | |
| Human conception and maturing | **-.71** | | | | | |
| Fit/sculptured body | **-.62** | -.20 | | | | |
| Farming and advancing nature | | **.69** | | | | |
| Energy, saving and new sources | | **.61** | | .20 | | |
| Environmental protection | | **.56** | | | | |
| Science and scientists | | **.39** | .35 | | | -.17 |
| Universe and enigmas | | | **.72** | | | .28 |
| Science in the making | | .18 | **.64** | | | |
| Technology | | | | **.62** | | |
| Youth health, noise/mobiles | -.37 | | | **.44** | | |
| Satellites and rockets | .27 | | .37 | **.40** | | |
| Explosions and shocks | .19 | | .25 | **.38** | -.26 | |
| Geo, aesthetics | | | | | **.79** | |
| Mysteries | -.26 | | .31 | -.31 | **.44** | |
| Geo, volcano and tornado | | | .21 | | | **.54** |
| Animals | | .21 | | -.26 | | **.41** |
| Geo, mountain and weather | | | | | | **.37** |

Table 7-28. Second order factor analysis of question ACE. Loadings of ACE indexes in a six-factor solution. The largest loading of an index is in boldface. The shading shows how the indexes are divided into the interest orientations.

As for the factor analysis in 7.4, it is important to be aware that this is not the only possible result of exploratory factor analysis of the indexes. I have experienced that, when applying different methods and criteria, loadings changed. However, the overall pattern remained the same, so that for most practical purposes this factor structure is robust and convincing, but one should not put too much emphasis on the exact size of the factor loadings.

Furthermore, it is important to note that these six interest orientations do not represent all possible S&T interest orientations held by Norwegian youth. These are the interest orientations that have emerged from my analysis of the data collected in Norway with the ROSE instrument. Another instrument, for example with an expanded version of question ACE, would probably come out with different interest orientations.

I have labelled the factors *Body, Concern, Puzzles, Techno, Ponder* and *Nature*. As described in section 5.6, this is a risky point, since labels tend to start "living a life on their own", and unfair labels may easily bias the discussions. The labels are, however, meant as

keywords and reminders of the factors or the interest orientations, rather than covering or all-inclusive characterisations of the underlying variables. More proper factor descriptions will be suggested in the following.

For understanding the results of the second order factor analysis, one must have in mind the specific items forming each index as well as the first order factor structure and item loadings. Table 7-29 is a summary of the altogether 78 items and 19 indexes that are involved in the second order factor analysis. The first order factor structure of the 78 items is reported in Appendix E. (The factor structure discussed in 7.4 is somewhat altered, since some of the theme items were excluded from the indexes, see Table 7-27.)

Some factor loadings show opposite signs in the same factor. In the previous section, values with opposite signs were small, and therefore neglected in the discussions. Here the negative loadings are more difficult to overlook, and the discussion of their meaning is consequently impossible to evade. The substantial interpretation of this is, however, less straightforward. The loadings mean that the variables tap into the same dimension, but with opposite expressions. However, a discussion about what is "the opposite of" interest, in for example humans, technology or the environment, will raise epistemological questions regarding the nature of interest and the nature of the subject matters. I will superficially touch on this issue in the discussion of each factor.

| | |
|---|---|
| **The *Body* interest orientation** | |
| Health | E07. How to control epidemics and diseases<br>E08. Cancer, what we know and how we can treat it<br>E09. Sexually transmitted diseases and how to be protected against them<br>E10. How to perform first-aid and use basic medical equipment<br>E11. What we know about HIV/AIDS and how to control it<br>E32. How gene technology can prevent diseases |
| Youth health, drugs | E12. How alcohol and tobacco might affect the body<br>E13. How different narcotics might affect the body |
| Human conception and maturing | A07. How the human body is built and functions<br>A08. Heredity, and how genes influence how we develop<br>A09. Sex and reproduction<br>A10. Birth control and contraception<br>A11. How babies grow and mature<br>E23. How my body grows and matures<br>E31. Biological and human aspects of abortion |
| Fit/sculptured body | A37. What to eat to keep healthy and fit<br>A38. Eating disorders like anorexia or bulimia<br>A39. The ability of lotions and creams to keep the skin young<br>A40. How to exercise to keep the body fit and strong<br>A41. Plastic surgery and cosmetic surgery<br>A42. How radiation from solariums and the sun might affect the skin |
| **The *Concern* interest orientation** | |
| Farming and advancing nature | E17. How to improve the harvest in gardens and farms<br>E18. Medicinal use of plants<br>E19. Organic and ecological farming without use of pesticides and artificial fertilizers<br>E33. Benefits and possible hazards of modern methods of farming |
| Energy, saving and new sources | E20. How energy can be saved or used in a more effective way<br>E21. New sources of energy from the sun, wind, tides, waves, etc. |
| Environmental protection | E03. The ozone layer and how it may be affected by humans<br>E04. The greenhouse effect and how it may be changed by humans<br>E05. What can be done to ensure clean air and safe drinking water<br>E06. How technology helps us to handle waste, garbage and sewage |
| Science and scientists | E34. Why religion and science sometimes are in conflict<br>E36. Why scientists sometimes disagree<br>E37. Famous scientists and their lives<br>E38. Big blunders and mistakes in research and inventions<br>E39. How scientific ideas sometimes challenge religion, authority and tradition |
| **The *Puzzles* interest orientation** | |
| Universe and enigmas | A01. Stars, planets and the universe<br>A06. The origin and evolution of life on earth<br>A14. Dinosaurs, how they lived and why they died out<br>A22. Black holes, supernovas and other spectacular objects in outer space<br>A23. How meteors, comets or asteroids may cause disasters on earth<br>C08. The possibility of life outside earth<br>C10. Unsolved mysteries in outer space<br>E29. The first landing on the moon and the history of space exploration |

| | |
|---|---|
| **Science in the making** | E40. Inventions and discoveries that have changed the world<br>E41. Very recent inventions and discoveries in science and technology<br>E42. Phenomena that scientists still cannot explain |
| **The *Techno* interest orientation** | |
| Technology | C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.)<br>C04. How cassette tapes, CDs and DVDs store and play sound and music<br>C05. How things like radios and televisions work<br>C06. How mobile phones can send and receive messages<br>C07. How computers work |
| Youth health, noise/mobiles | E14. The possible radiation dangers of mobile phones and computers<br>E15. How loud sound and noise may damage my hearing |
| Satellites and rockets | A44. Rockets, satellites and space travel<br>A45. The use of satellites for communication and other purposes |
| Explosions and shocks | A30. How the atom bomb functions<br>A31. Explosive chemicals<br>A32. Biological and chemical weapons and what they do to the human body<br>A48. How a nuclear power plant functions |
| **The *Ponder* interest orientation** | |
| Geo, aesthetics | C16. Why the stars twinkle and the sky is blue<br>C17. Why we can see the rainbow<br>E02. How the sunset colours the sky |
| Mysteries | C09. Astrology and horoscopes, and whether the planets can influence human beings<br>C11. Life and death and the human soul<br>C12. Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are<br>C13. Why we dream while we are sleeping, and what the dreams may mean<br>C14. Ghosts and witches, and whether they may exist<br>C15. Thought transference, mind-reading, sixth sense, intuition, etc. |
| **The *Nature* interest orientation** | |
| Geo, volcano and tornado | A24. Earthquakes and volcanoes<br>A25. Tornados, hurricanes and cyclones |
| Animals | A13. Animals in other parts of the world<br>A20. How animals use colours to hide, attract or scare<br>A27. Brutal, dangerous and threatening animals<br>E16. How to protect endangered species of animals<br>E24. Animals in my area |
| Geo, mountain and weather | A04. How mountains, rivers and oceans develop and change<br>A05. Clouds, rain and the weather |

Table 7-29. Summary of the items forming each index, and how the indexes are sorted under the six interest orientations.

### 7.5.3 Factor 1: The *Body* interest orientation

Most indexes regarding the human body and health have their main loading on this factor. (*Health, Youth health, drugs, Human conception and maturing* and *Fit/sculptured body*) *Youth health, noise/mobiles* is almost equally divided between this factor and factor 4.

*Body,* the label of this factor, should be associated with both the biology of the human body, how to maintain and develop a fit body, and different kinds of health issues. The *Mysteries* index, loading on this factor too, has items addressing issues such as thought transference, the human soul, why we dream while we are sleeping and alternative therapies. Such issues, less related to the human body and biology, and more to some other and maybe more general aspects of humanity, are involved in this interest orientation as well.

Two indexes have loadings of opposite signs: *Satellites and rockets* and *Explosions and shocks*. This means that these indexes tap into the same dimension as those above, but with opposite expressions. Although I cannot grasp what the "opposite" of the human body might be, one can perhaps understand that an interest in humans is a very different concern than interests in satellites and explosions. It is somewhat more difficult to grasp the underlying variable connecting these indexes.

### 7.5.4 Factor 2: The *Concern* interest orientation

Factor 2 has the label *Concern*, but I also considered *Surroundings*, *Society* and *Care*. Most indexes in this factor are related to social or surrounding matters, often with a dimension of care and for making things better (in *Farming and advancing nature, Energy, saving and new sources* and *Environmental protection*). The *Health* index has a small loading on this factor as well. In the *Animal* index, there is an item for protecting endangered species. This item, combined with the general component of concern for animals and the local surroundings (see 7.4.6), may be an explanation for the loading from this index.

As discussed in 7.4.9 and 7.4.13, the two indexes *Science and scientist* and the *Science in the making* themes involve items in the area of STS and NOS. Both of these indexes load on this factor. The *Science and scientist* index is almost equally divided between this factor and factor 3, while the *Science in the making* index has its main loading on factor 3 and only a small loading on this interest orientation. This may, in line with the indexes above, describe an interest (or lack of such) in science situated in society.

The index *Fit/sculptured body* loads on this factor with opposite sign. Some items in this index are related to public discussions about controversial matters, such as plastic surgery and the commercial focus on the young and artificial body (see 7.4.1). It may be that this index has in common with the others a connection to social matters, but opposes the others by lacking the component of care and concern for one's surroundings. If there is any sense in this reasoning, the negative sign of this index may indicate an aspect of narcissism; seen as the opposite of concern and care for one's surroundings and the society.

### 7.5.5 Factor 3: The *Puzzles* interest orientation

In this factor, there are only two indexes with main loadings, and several with medium or low loadings. This unclear pattern makes the factor complicated to understand and label. It holds dimensions of spectacular phenomena and mysteries, discoveries and experiments, and it is not obvious what unites these into one common factor.

The two indexes *Universe and enigmas* and *Science in the making* have their main loading in this factor. Both indexes have a dimension of still unsolved scientific mysteries or puzzles. The two indexes have in common an interest (or lack of such) in recent scientific theories, inventions, discoveries and events, and in phenomena that are still not fully explained and understood.

The loading from the *Mysteries* index supports the notion of unsolved scientific puzzles, as this index also raises questions about the unexplained. The *Science and scientists* index loads on this factor too. According to the discussions and the factor loadings in 7.4.9 and 7.4.13 (and in Appendix E), this index has much in common with the *Science in the making* index, which may explain the loading from this index.

The *Satellites and rockets* index is loading on this interest orientation as well. As seen from 7.4.3 and Appendix E there is no clear boundary between this index and the *Universe and enigmas* index. The *Satellites and rockets* index is related to space issues, and evokes therefore also (unsurprisingly) some puzzling connotations.

The indexes *Explosions and shocks* and *Geo, volcano and tornado* are both referring to spectacular issues. Through items addressing black holes, supernovas, spectacular objects, asteroids causing disasters, etc., the theme *Universe and enigmas* has a component of dramatic phenomena too. Such aspects may link them together with factor loadings on the same interest orientation.

In this factor, there are no loadings with opposite signs.

### 7.5.6 Factor 4: The *Techno* interest orientation

The only index with a strong loading on this factor is the *Technology* index. Also *Explosions and shocks*, *Satellites and rockets* and *Youth health, noise/mobiles* have their main loadings on this factor, but with almost equally sized loadings on additional factors. The *Energy, saving and new resources* and *Youth health, drugs* indexes have small loading on this factor as well.

The main attribute of this interest orientation is possibly the technology issue. Many of the items in the *Technology* index are in addition related to components of youth lifestyles, such as use of computers, mobiles and music on DVDs. This may be the link from the technology subject to the subjects of the two *Youth health* indexes. As discussed in 7.4.11 and 7.4.14, these may have in common some issues connected to youth lifestyles. The *Youth health, noise/mobiles* index has a higher loading than the *Youth health, drugs* index. This may be due to the closer relationship to technology in the first index. The excitement and action in the *Explosions and shocks* index may be seen as an element of the youth culture too, for example as demonstrated in excitement- and action-packed movies and media.

According to these interpretations, keywords of this interest orientation may be new technology, youth lifestyles, excitement and action, united in a component of modern youth culture. This is of course only one side of youth lifestyles. For example, the two indexes *Animals* and *Mysteries,* loading on the same factor, but with opposite sign, may represent elements of youth lifestyles too, although with different concerns. The negative signs of the loadings of these indexes may indicate that the factor represents some tough "male" values of youth culture, while the two latter indexes speak for the softer values.

Also the index *Energy, saving and new sources* loads on this factor. This can hardly be understood in the context of youth lifestyles or youth culture. It may be that there is a component of new technology in this index that links it to the factor, but as I find it hard to interpret, I will not go further into this discussion.

The *Techno* label of this interest orientation should convey the technology part of the factor, and some aspects of macho or boyish youth lifestyles, with health risks, exciting events and *action*[70]. One should bear this in mind, during later usage of the label.

### 7.5.7 Factor 5: The *Ponder* interest orientation

I have labelled this interest orientation *Ponder*. The two indexes with their main loadings in this factor are *Mysteries* and *Geo, aesthetics*. These two themes may have in common traits like mentally calm pondering or contemplation about some unconfirmed questions (in *Mysteries*), and aspects of the beauty of nature (in *Geo, aesthetics*).

The *Explosions and shocks* index loads on the same factor, but with the opposite sign. Given that this interpretation of what *Mysteries* and *Geo, aesthetics* have in common is reasonable and sound, it makes sense that the more spectacular index *Explosions and shocks* convey an opposite expression. The loading of this index also indicates that the index has an underlying variable in common with *Mysteries* and *Geo, aesthetics*. May this be some imaginative aspects, as opposed to the more fact-oriented subjects that are found in the other interest orientations?

There is a remarkable relationship between the loading patterns of the indexes *Explosions and shocks* and *Mysteries*. Through the whole factor structure, these two indexes are loading on exactly the same four factors, and in all instances but one (the *Puzzles* interest orientation), the loadings have opposite signs. The meanings of the various loadings are discussed for each factor, but a general understanding of this relationship may be that they both represent puzzles (with positive loadings on the interest orientation *Puzzles*), but that they in all other senses represent related, but diametric opposite, expressions.

### 7.5.8 Factor 6: The *Nature* interest orientation

The themes *Geo, mountain and weather*, *Geo, volcano and tornado* and *Animals* have their main loading on this factor. There is also a loading from the index *Universe and*

[70] As explained in Microsoft Encarta dictionary for *action movie*: "a film in which the plot moves quickly from one dramatic event to another […] Character development and love interest are of secondary or no importance" (Microsoft Encarta Premium Suite 2005. Microsoft Corporation).

*enigmas* with the same sign. These indexes may have in common some aspects of investigating the natural world; hence the label *Nature*.

There is a negative loading on this factor from the index *Science and scientists*. This loading is small, and therefore not worth much notice. One attempt of an interpretation would however be that the index has, in common with the others, a traditional textbook quality. The negative sign indicates that the index measures "the opposite of" the natural world – maybe represented by the man-made world of science and technology.

## 7.6 Excluded items

Prior to the factor analysis in 7.4, eight items were excluded due to unclear factor loading pattern in exploratory factor analysis of the entire ACE question. In the factor analysis in 7.4, some items (the asterisked) appeared with unclear loading profiles and were thereby hard to categorise into themes. These items, except the two asterisked items E20 (saving energy) and E21 (new energy sources), were excluded from the indexes. In addition, some items grouped into factors that I was unable to label and define. Totally, these are the following 20 items:

A02. Chemicals, their properties and how they react
A12. Cloning of animals
A15. How plants grow and reproduce
A16. How people, animals, plants and the environment depend on each other
A17. Atoms and molecules
A19. Light around us that we cannot see (infrared, ultraviolet)
A21. How different musical instruments produce different sounds
A36. How the eye can see light and colours
A43. How the ear can hear different sounds
A46. How X-rays, ultrasound, etc. are used in medicine
A47. How petrol and diesel engines work
C01. How crude oil is converted to other materials, like plastics and textiles
E01. Symmetries and patterns in leaves and flowers
E22. How different sorts of food are produced, conserved and stored
E25. Plants in my area
E26. Detergents, soaps and how they work
E27. Electricity, how it is produced and used in the home
E28. How to use and repair everyday electrical and mechanical equipment
E30. How electricity has affected the development of our society
E35. Risks and benefits of food additives

From the testing of unidimensionality and internal consistency (in 7.5.1), ten more items were excluded:

A03. The inside of the earth
A18. How radioactivity affects the human body
A26. Epidemics and diseases causing large losses of life
A28. Poisonous plants in my area
A29. Deadly poisons and what they do to the human body
A33. The effect of strong electric shocks and lightning on the human body
A34. How it feels to be weightless in space
A35. How to find my way and navigate by the stars
C02. Optical instruments and how they work (telescope, camera, microscope, etc.)
C18. Properties of gems and crystals and how these are used for beauty

This means that altogether 30 of the 108 items in the ACE question are not included in any index.

There may be several causes for items showing an unclear profile in the factor structure:

One reason may be that items evoke different connotations for different students. For example item A12 (cloning of animals) may trigger the image of Frankenstein and the "mad scientist", the image of the pitiable animal suffering man's brain waves, the image of progress and cutting-edge and innovative research, etc. Such ambiguous item meaning may give a different correlation pattern from one group of students to another, and thereby an unclear factor pattern.

A second explanation may be that items are lacking contour, provoking no more than a shrug from virtually all the respondents. Maybe item E22 (food production and conservation) is an example of this – with medium or low interest scores in all clusters, and showing no clear correlation pattern or relationship to any other variables in any theme.

Furthermore, for some items, the responses might have been so unison that the item do not discriminate the respondents. The item functions thereby as a constant, rather than as a variable. This may for example apply for the extremely low-scoring item E01 (symmetries in leaves and flowers). Among the 108 ACE items, this item has by far the lowest variance (see Appendix C).

Finally, one reason may be that the questionnaire lacks items with a similar latent variable. This may be the case for e.g. item A47 (petrol and diesel engines). If the questionnaire had contained more items in a theme of mechanics, this item could possibly have formed a well-defined factor with such items.

In the factor analysis reported in 7.4, only eight of the totally 30 items were excluded. Alternatively, I could have reported and discussed the output of a factor analysis with all the 30 items excluded. One advantage of this would have been a clearer factor structure from the start, and thereby a tidier discussion, easier for the reader to follow. My rationale for presenting the whole path to the results is, as mentioned earlier, that I see this process of validating the ACE items as an important part of my analysis. The ACE items constitute the main focus of my research interest and the foundation of my division of respondents into clusters (in chapter 6). The explorative nature of the study calls for close inspection of the instrument and the data, in order to avoid misinterpretations of the items and the results, leading to poorly substantiated conclusions.

Factor analysis of the 78 remaining ACE items gives 17 factors. Among these, one has only minor loadings, leaving us with 16 substantial meaningful factors. Output from factor analysis resulting in 16 factors is reported in Appendix E. Generally, the main loading of the 78 items suggests the same factor structure as summarised in Table 7-27 (or Table 7-29)[71].

[71] The factor structure in Appendix E is similar to the indexes in Table 7-27 when taken into account that the following three index couples occur in joint factors: *Universe and enigmas* together with *Satellites and rockets*, *Farming and advancing nature* together with *Energy, saving and new resources*, and a joint factor for the two *Youth health* indexes, i.e. *Youth health, drugs* and *Youth health, noise/mobiles*. Unidimensionality tests of the items from these three factors split the items into the indexes suggested in Table 7-27.

# 8 INTERESTS OF THE STUDENT TYPES

This chapter refers to research objective

*II Describe the interests of the student types* [72]

Here, I will characterise the student types by their responses in the ACE question. In chapter 6, I used the ACE question to divide the sample into five clusters. As accounted for above, I will perceive the clusters as representing five distinctive student types: the Selective Boy (cluster 1), the Unselective Reluctant (cluster 2), the Unselective Undecided (cluster 3), the Unselective Enthusiast (cluster 4) and the Selective Girl (cluster 5).

In this chapter, I will first present lists of top- and bottom-scoring items among the 108 ACE items for the student types. In 6.2, I decided to maintain only five clusters, although the cluster analysis hinted that there might be a sixth interesting cluster in the sample. The profile of this sixth cluster appeared to be related to the profile of the Selective Girl. Therefore, in this chapter, I will divide the Selective Girl into two sub-clusters, and study the top-scoring items of the two sub-clusters separately.

In 6.6 I claimed (based on Figure 6-2 and Appendix C) that the profiles of the Enthusiast, the Undecided and the Reluctant have a couple of common characteristics. First, they are all unselective in sense that they relatively consistently show one specific level of interest through virtually all ACE items. Second, their profiles apparently vary in more or less the same phase. Here, I will have a closer look at the three Unselective student types and investigate whether their profiles actually are in phase, and then present top- and bottom-scoring items for the combined cluster 2-3-4 (the Unselective student types). Section 8.3 describes why and how these three clusters are combined.

I have decided to include 30 items in each top- and bottom-score list. Although this choice is somewhat arbitrary, there are several reasons for why I ended up with this number: The total number of items in the ACE part of the questionnaire is unmanageable for an organised discussion. Therefore, the number of items has to be considerably reduced. On the other hand, the number should not be reduced too much, since a too small number of items would constrict my opportunities to portray the student types by ACE responses. Furthermore, the top- and bottom-score lists should in truth be items with high and low interest scores. By this I mean that that the average score for the items in the top- and bottom lists should be considerably above or below the grand ACE mean for the cluster.

Altogether, these considerations led me to end up with Top 30 and Bottom 30 lists (in short Top and Bottom lists). This is a manageable number of items and still large enough to facilitate characterful portraits. The mean values in the Top/Bottom lists for the Selective Girl and the Selective Boy are noticeably different from the grand ACE mean in the clusters. However, for the Unselective student types some item means in the Top 30 and Bottom 30 lists lie just below ±.2 from the grand ACE mean. This gives a distance

[72] The term *the interests of the student types* denotes the topics listed in question ACE in the questionnaire. Naturally, many topics are not addressed by this question.

shorter than .4 from the bottom- to the top-list, which is relatively small. Nevertheless, one-sample t-tests (see 5.1.2) gave that the mean score of all items in the Top and Bottom lists are statistically significantly different ($p < .01$) from the grand ACE mean of the cluster.

Allowing the data to determine the size of the Top/Bottom lists would have been more faithful to the data-driven approach of my analysis. For example, I could have delimited the lists at plus/minus one standard deviation from the grand ACE mean for the cluster. If the item mean scores in a cluster is normally distributed around the mean, 16 percent of the items will fall above and 16 percent below one standard deviation from the mean, while 68 percent of the items fall within one standard deviation from the mean. (The item mean scores are, however, not perfectly normally distributed.) This way of demarcating items to the Top/Bottom lists would have reduced some of the Top/Bottom lists to half their present size, and thereby led to a meagre material for studying and characterising the interests of the student types.

In order to meet this argument for a data-directed definition of the Top/Bottom lists, I have asterisked (*) items that lie within one standard deviation from the mean. (The standard deviation for each cluster is given in Table 6-2 and/or in the captions.) In the discussion of the results, more emphasis will be given to items lying beyond one standard deviation from the mean than to items lying within one standard deviation from the mean.

Later in this chapter, I will compare the scores of the Unselective student types. In order to make the discussion meaningful, I have to use the residual scores. The Selective Girl and the Selective Boy will be studied separately; and consequently, I could have used the raw data of these student types. However, in order to have these scores in the Top/Bottom lists in the same metric as for the Unselective student types, residual scores are applied also for the Selective student types.

The Top/Bottom lists are sorted by mean values, with the extreme high/low scores at the top of the tables. The discussions will be connected with the themes from section 7.4.

## 8.1 The Selective Boy

### 8.1.1 More interesting

The 30 highest scoring items for the Selective Boy among the 108 ACE items are reported in Table 8-1.

| Top 30 items for the Selective Boy | mean |
|---|---|
| A30. How the atom bomb functions | 1.15 |
| A34. How it feels to be weightless in space | 1.15 |
| A31. Explosive chemicals | 1.09 |
| A44. Rockets, satellites and space travel | 1.08 |
| C08. The possibility of life outside earth | 1.05 |
| A22. Black holes, supernovas and other spectacular objects in outer space | 1.01 |
| A23. How meteors, comets or asteroids may cause disasters on earth | 1.00 |
| E42. Phenomena that scientists still cannot explain | .92 |
| A32. Biological and chemical weapons and what they do to the human body | .91 |

| Top 30 items for the Selective Boy | mean |
|---|---|
| C07. How computers work | .88 |
| C10. Unsolved mysteries in outer space | .85 |
| E41. Very recent inventions and discoveries in science and technology | .77 |
| A14. Dinosaurs, how they lived and why they died out | .70 |
| A48. How a nuclear power plant functions | .69 |
| A33. The effect of strong electric shocks and lightning on the human body | .67 |
| A45. The use of satellites for communication and other purposes | .64 |
| C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.) | .64 |
| A25. Tornados, hurricanes and cyclones | .62 |
| A01. Stars, planets and the universe | .60 |
| E40. Inventions and discoveries that have changed the world | .59 |
| C04* How cassette tapes, CDs and DVDs store and play sound and music | .58 |
| A47* How petrol and diesel engines work | .56 |
| E29* The first landing on the moon and the history of space exploration | .52 |
| E28* How to use and repair everyday electrical and mechanical equipment | .50 |
| C05* How things like radios and televisions work | .49 |
| A06* The origin and evolution of life on earth | .48 |
| A27* Brutal, dangerous and threatening animals | .48 |
| C06* How mobile phones can send and receive messages | .46 |
| A40* How to exercise to keep the body fit and strong | .46 |
| A12* Cloning of animals | .45 |

Table 8-1. Top score ACE items for the Selective Boy. Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .58.

The most outstanding result from this table may be the number of items addressing the universe, spectacular issues, inventions and technology:

From the *Universe and enigmas* theme we find item A34 (weightless in space), A44 (rockets), A45 (satellites), E29* (first moon landing), C08 (life in space), A22 (black holes, supernovas), A23 (meteors causing disasters), C10 (unsolved mysteries in space), A01 (stars, planets, universe), A06* (origin of life) and A14 (dinosaurs). Most of these items have scores higher than one standard deviation from the mean, and the only item from this theme that is not represented in this list is item A35 (find my way by stars).

Furthermore, almost all items from the theme *Explosions and shocks* are found in this list too, also these with scores above one standard deviation from the mean: A30 (atom bomb), A31 (explosive chemicals), A32 (chemical weapons) and A33 (strong electric shocks) and A48 (nuclear power plant). Item A18 (radioactivity affects body) is the only item from this theme that is not in the list.

The part of the Top 30 list with items scoring above one standard deviation from the mean also contains all three items in the *Science in the making* theme: E40 (inventions that have changed the world), E41 (recent inventions) and E42 (phenomena scientists cannot explain).

Further down the list, but still with a couple of items above the standard deviation, we find five out of six items from the *Technology* theme: C07 (computers), C03 (lasers in CD-players etc.), C04* (tapes, CD, DVD), C05* (radio and TV) and C06* (mobile phones). Item C02* (optical instruments) is the only item in this theme that is not found in the list.

Among the remaining items, item A25 (tornados and hurricanes) from *Geo, volcano and tornado* is the only items lying beyond one standard deviation from the mean.

The rest of the items are A47* (petrol and diesel engines), E28* (repair everyday electrical equipment), A27* (dangerous animals), A12* (cloning of animals) and A40* (exercise for fit body).

### 8.1.2 Less interesting

Table 8-2 lists the 30 bottom scoring items for the Selective Boy.

| Bottom 30 items for the Selective Boy | mean |
|---|---|
| E01. Symmetries and patterns in leaves and flowers | -1.25 |
| E25. Plants in my area | -1.05 |
| A39. The ability of lotions and creams to keep the skin young | -1.04 |
| A38. Eating disorders like anorexia or bulimia | -.97 |
| E26. Detergents, soaps and how they work | -.95 |
| A41. Plastic surgery and cosmetic surgery | -.86 |
| E19. Organic and ecological farming without use of pesticides and artificial fertilizers | -.83 |
| A42. How radiation from solariums and the sun might affect the skin | -.79 |
| C12. Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | -.79 |
| E33. Benefits and possible hazards of modern methods of farming | -.76 |
| A15. How plants grow and reproduce | -.76 |
| E34. Why religion and science sometimes are in conflict | -.74 |
| E02. How the sunset colours the sky | -.72 |
| E17. How to improve the harvest in gardens and farms | -.72 |
| E31. Biological and human aspects of abortion | -.69 |
| C01. How crude oil is converted to other materials, like plastics and textiles | -.68 |
| E36. Why scientists sometimes disagree | -.67 |
| E37. Famous scientists and their lives | -.64 |
| A11. How babies grow and mature | -.61 |
| E39. How scientific ideas sometimes challenge religion, authority and tradition | -.59 |
| E35. Risks and benefits of food additives | -.59 |
| E24* Animals in my area | -.58 |
| A05* Clouds, rain and the weather | -.58 |
| A21* How different musical instruments produce different sounds | -.52 |
| E04* The greenhouse effect and how it may be changed by humans | -.49 |
| A16* How people, animals, plants and the environment depend on each other | -.48 |
| E22* How different sorts of food are produced, conserved and stored | -.48 |
| A04* How mountains, rivers and oceans develop and change | -.44 |
| C17* Why we can see the rainbow | -.44 |
| A28* Poisonous plants in my area | -.42 |

Table 8-2. Bottom score ACE items for the Selective Boy. Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .58.

Plants and farming did not catch the interest of the Selective Boy. Item E01 (symmetries in leaves and flours), E25 (plants in my area), A15 (how plants grow), E19 (ecological farming), E33 (modern farming) and E17 (improve harvest) are all lying beyond one standard deviation from the mean. Within one standard deviation we find A28* (poisonous plants).

Very low interest scores are also noted in several items in the theme *Fit/sculptured body:* A39 (lotions for young skin), A38 (eating disorders), A41 (plastic surgery), A42

(radiation from solariums). Also item C12 (alternative therapies) and E26 (detergents and soaps) achieve low scores.

Four items in the *Science and scientists* theme appear in this list of less interesting items: E36 (why scientists disagree), E39 (scientific ideas challenging authority), E37 (life of famous scientists) and E34 (religion and science in conflict). Item E35 (risks of food additives) is in this list too. They all lie beyond one standard deviation from the mean. Here we also find two items from the theme *Human conception and maturing*: E31 (abortion) and A11 (babies).

Furthermore, this list has two items from the *Geo* theme: A05* (weather) and A04* (how mountains etc. develop), and two items from the *Geo, aesthetics* theme: C17* (rainbow) and E02 (sunset).

Among the remaining items in the list, C01 (crude oil) lies beyond one standard deviation from the mean, while the rest lies within: E24* (animals in my area), E04* (greenhouse effect), A21* (musical instruments), A16* (how "everything" depend on each other) and E22* (food production and conservation).

## 8.2 The Selective Girl

As mentioned in 6.2, k-means cluster analysis with six clusters indicated an additional interesting cluster. As the sixth cluster appeared like a sub-cluster of the Selective Girl (cluster 5), I preferred to keep only five clusters and to develop and study a sub-cluster of cluster 5 at a later stage. This is what I intend to do in this section.

### 8.2.1 Two sub-clusters: Selective W Girl and Selective B Girl

Two clusters, cluster 5a and cluster 5b, from k-means cluster analysis of the 321 respondents in the cluster 5 (data file sorted by questionnaire identification number) gave the distribution in Table 8-3.

| | 5a | 5b | 5 (tot) |
|---|---|---|---|
| **total** | 178 | 143 | 321 |
| **girls** | 166 | 136 | 302 |
| **boys** | 12 | 7 | 19 |

Table 8-3. Total number of respondents in cluster 5a, 5b and 5 (Selective Girl) and the number of girls and boys in each cluster.

The respondents in cluster 5 are relatively evenly distributed between the two sub-clusters (cluster 5a is somewhat larger than cluster 5b, though), also in terms of the proportions girls and boys. Mean responses to the 108 ACE items for the two sub-clusters are displayed in Figure 8-1. In most items, the two sub-profiles coincide, while in some particular places the lines break apart.

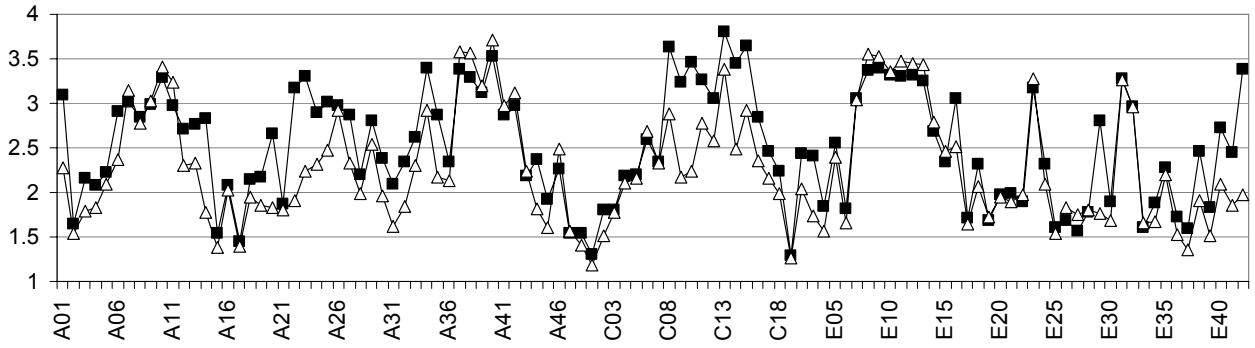



Figure 8-1. Profiles of scores for cluster 5a (filled squares) and cluster 5b (blank triangles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

The items producing the largest interest differences between the two sub-clusters (larger than .60) are reported in Table 8-4. In all these items, the distance goes in one direction, with cluster 5a more interested than cluster 5b. A few items have higher scores in cluster 5b than in 5a, but the largest difference value is no more than .28. This trait of general lower interest in cluster 5b than in cluster 5a can also be noticed from the grand ACE mean for the two sub-clusters. Here the value for cluster 5a is .25 higher than for cluster 5b.

Table 8-4 is sorted by descending mean scores in cluster 5a. This means that the items in the top of the table shows preferences of cluster 5a that are not in the same degree upheld by cluster 5b. The themes represented in the list are *Universe and enigmas, Mysteries, Science in the making,* mostly addressing philosophical topics connected with the universe, enigmas and mysteries. There is also one item from each of the themes *Animals* and *Environmental protection*.

| | 5 | 5a | 5b | diff |
|---|---|---|---|---|
| C15. Thought transference, mind-reading, sixth sense, intuition, etc. | .91 | 1.23 | .50 | .72 |
| C08. The possibility of life outside earth | .88 | 1.21 | .46 | .75 |
| C10. Unsolved mysteries in outer space | .50 | 1.04 | -.19 | 1.23 |
| C14. Ghosts and witches, and whether they may exist | .61 | 1.03 | .07 | .96 |
| E42. Phenomena that scientists still cannot explain | .34 | .96 | -.45 | 1.41 |
| A23. How meteors, comets or asteroids may cause disasters on earth | .41 | .88 | -.19 | 1.07 |
| C09. Astrology and horoscopes, and whether the planets can influence human beings | .34 | .82 | -.25 | 1.07 |
| A22. Black holes, supernovas and other spectacular objects in outer space | .19 | .75 | -.52 | 1.27 |
| A01. Stars, planets and the universe | .32 | .68 | -.14 | .81 |
| A35. How to find my way and navigate by the stars | .14 | .44 | -.24 | .69 |
| A14. Dinosaurs, how they lived and why they died out | -.05 | .41 | -.65 | 1.06 |
| E29. The first landing on the moon and the history of space exploration | -.08 | .38 | -.65 | 1.03 |
| E40. Inventions and discoveries that have changed the world | .03 | .31 | -.33 | .64 |
| A20. How animals use colours to hide, attract or scare | -.13 | .24 | -.60 | .83 |
| E03. The ozone layer and how it may be affected by humans | -.31 | -.02 | -.68 | .66 |

Table 8-4. Items with the largest mean score differences (differences above .60). Mean values for the Selective Girl (cluster 5), the two sub-clusters 5a and 5b as well as the differences between them. The table is sorted by descending scores of cluster 5a.

### 8.2.2 More interesting

Since the ACE interests of the two sub-clusters showed noteworthy and interesting differences, Top 30 lists will be developed for the two sub-clusters of the Selective Girl separately. The sub-clusters are small, and thereby sensitive to sample compositions. This means that if the Norwegian ROSE sample was drawn again, results of some analysis could come out differently. Therefore, I will only draw on the most salient features and ignore less robust differences between the clusters. (The two clusters will be reunited in later analysis.)

The residual data file applied so far was calculated from the grand ACE mean score of the whole Selective Girl cluster. In order to have the Top 30 lists of the two sub-clusters in the same metric as the other Top lists, I developed new residual scores for cluster 5a and 5b. This was developed with the same procedure as described in 7.3. The grand mean for cluster 5a is 2.53 (.11 above the grand mean for the total cluster), and for cluster 5b the value is 2.28 (.14 below the total cluster).

Table 8-5 and Table 8-6 are the Top 30 lists for cluster 5a and 5b respectively.

| **Top 30 items for cluster 5a (sub-cluster of Selective Girl)** | mean |
|---|---|
| C13. Why we dream while we are sleeping, and what the dreams may mean | 1.27 |
| C15. Thought transference, mind-reading, sixth sense, intuition, etc. | 1.12 |
| C08. The possibility of life outside earth | 1.10 |
| A40. How to exercise to keep the body fit and strong | 1.00 |
| C10. Unsolved mysteries in outer space | .93 |
| C14. Ghosts and witches, and whether they may exist | .92 |
| A34. How it feels to be weightless in space | .87 |
| E09. Sexually transmitted diseases and how to be protected against them | .86 |
| E42. Phenomena that scientists still cannot explain | .85 |
| A37. What to eat to keep healthy and fit | .85 |
| E08. Cancer, what we know and how we can treat it | .84 |
| E10. How to perform first-aid and use basic medical equipment | .79 |
| E12. How alcohol and tobacco might affect the body | .78 |
| E11. What we know about HIV/AIDS and how to control it | .77 |
| A23. How meteors, comets or asteroids may cause disasters on earth | .77 |
| A10. Birth control and contraception | .76 |
| A38. Eating disorders like anorexia or bulimia | .76 |
| E31. Biological and human aspects of abortion | .74 |
| C11. Life and death and the human soul | .74 |
| E13. How different narcotics might affect the body | .72 |
| C09. Astrology and horoscopes, and whether the planets can influence human beings | .71 |
| A22. Black holes, supernovas and other spectacular objects in outer space | .64 |
| E23. How my body grows and matures | .64 |
| A39* The ability of lotions and creams to keep the skin young | .59 |
| A01* Stars, planets and the universe | .57 |
| E07* How to control epidemics and diseases | .53 |

| Top 30 items for cluster 5a (sub-cluster of Selective Girl) | mean |
|---|---|
| E16* How to protect endangered species of animals | .53 |
| C12* Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | .52 |
| A25* Tornados, hurricanes and cyclones | .49 |
| A07* How the human body is built and functions | .48 |

Table 8-5. Top score ACE items for cluster 5a (sub-cluster of Selective Girl). Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .63.

In the Top 30 list for cluster 5a, all items from the *Mysteries* theme are represented: C13 (what our dreams may mean), C15 (thought transference), C14 (ghosts and witches), C11 (human soul), C09 (astrology and horoscopes) and C12* (alternative therapies). The last one is the only item lying within one standard deviation from the mean. One related item from the *Science in the making* theme is also represented here: item E42 (phenomena scientists cannot explain).

From the theme *Universe and enigmas* we recognise item C08 (life in space), C10 (unsolved mysteries in space), A34 (weightless in space), A23 (meteors causing disasters), A22 (black holes, supernovas) and A01* (stars, planets, universe). The only items related to the universe that are not represented here, are the three items addressing satellites and space travel (item A44, A45 and E29) and item A35 (find my way by stars).

Besides these items for mysteries and the universe, the Top 30 list contains a series of items related to the human body and health. From the theme *Human conception and maturing* we find item A10 (contraception), E31 (abortion), E23 (maturing body) and A07* (how the body functions); only the last one is within one standard deviation from the mean. Excepting item E32 (gene technology), all items from the *Health* theme are in the list: E09 (sexually transmitted diseases), E08 (cancer), E10 (first-aid), E11 (HIV/AIDS), E07* (epidemics and diseases). The interest in health topics includes also the two items in the *Youth health, drugs* theme: E12 (alcohol and tobacco) and E13 (narcotics). In addition, we find four out of the six items in the *Fit/sculptured body* theme: A40 (exercise for fit body), A37 (eat for fit body), A38 (eating disorders) and A39* (lotions for young skin).

The two remaining items in the list are E16* (protect endangered animals) and A25* (tornados and hurricanes), both within one standard deviation from the mean.

However, as we will se from the Top 30 list of cluster 5b below (Table 8-6), not *all* the Selective Girl students desire the mysteries and the secrets of the world...

| Top 30 items for cluster 5b (sub-cluster of Selective Girl) | mean |
|---|---|
| A40. How to exercise to keep the body fit and strong | 1.43 |
| A37. What to eat to keep healthy and fit | 1.30 |
| A38. Eating disorders like anorexia or bulimia | 1.29 |
| E08. Cancer, what we know and how we can treat it | 1.27 |
| E09. Sexually transmitted diseases and how to be protected against them | 1.24 |
| E11. What we know about HIV/AIDS and how to control it | 1.19 |
| E12. How alcohol and tobacco might affect the body | 1.17 |
| E13. How different narcotics might affect the body | 1.15 |
| A10. Birth control and contraception | 1.13 |
| C13. Why we dream while we are sleeping, and what the dreams may mean | 1.11 |
| E10. How to perform first-aid and use basic medical equipment | 1.07 |
| E23. How my body grows and matures | 1.00 |

| Top 30 items for cluster 5b (sub-cluster of Selective Girl) | mean |
|---|---|
| E31. Biological and human aspects of abortion | .99 |
| A11. How babies grow and mature | .95 |
| A39. The ability of lotions and creams to keep the skin young | .92 |
| A07. How the human body is built and functions | .87 |
| A42. How radiation from solariums and the sun might affect the skin | .83 |
| E07. How to control epidemics and diseases | .76 |
| A09. Sex and reproduction | .74 |
| A41. Plastic surgery and cosmetic surgery | .69 |
| E32. How gene technology can prevent diseases | .68 |
| A26* Epidemics and diseases causing large losses of life | .64 |
| C15* Thought transference, mind-reading, sixth sense, intuition, etc. | .64 |
| A34* How it feels to be weightless in space | .63 |
| C08* The possibility of life outside earth | .60 |
| E14* The possible radiation dangers of mobile phones and computers | .50 |
| C11* Life and death and the human soul | .50 |
| A08* Heredity, and how genes influence how we develop | .50 |
| C06* How mobile phones can send and receive messages | .40 |
| C12* Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | .30 |

Table 8-6. Top score ACE items for cluster 5b (sub-cluster of Selective Girl). Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .64.

In this list we find the entire item list from the themes *Health, Fit/sculptured body, Youth health, drugs* and *Human conception and maturing:* E08 (cancer), E07 (epidemics and diseases), E11 (HIV/AIDS), E10 (first-aid), E09 (sexually transmitted diseases), E32 (gene technology), A39 (lotions for young skin), A37 (eat for fit body), A40 (exercise for fit body), A42 (radiation from solariums), A41 (plastic surgery), A38 (eating disorders), E12 (alcohol and tobacco), E13 (narcotics), A09 (sex and reproduction), A10 (contraception), A11 (babies), E23 (maturing body), A07 (how the body functions), A08* (heredity) and E31 (abortion). Among these 21 items, the only one lying within one standard deviation from the mean is A08* (heredity). Also item E14* (radiation danger of mobiles) and A26* (epidemics causing large losses) are items from this list that may be perceived as related to human health (although not sorted under these themes in 7.4).

The list contains also some items from the *Mysteries* theme, but all except one lie within one standard deviation from the mean, and all are related to qualities of human beings: C13 (what our dreams may mean), C15* (thought transference), C11* (human soul) and C12* (alternative therapies).

The three remaining items in this Top 30 list are A34* (weightless in space), C08* (life in space) and the technology item C06* (mobile phones), all lying within one standard deviation from the mean.

It is more intelligible to refer to the two sub-clusters by labels than numbers. Therefore I will label cluster 5a and cluster 5b *Selective W Girl* and *Selective B Girl* respectively. The *W* refers to *Wonder* – the interests of cluster 5a for of the themes *Universe and enigmas* and *Mysteries*, while the *B* refers to the general and dominating interest of cluster 5b for the human *Body*.

### 8.2.3 Less interesting

When comparing the Bottom 30 lists of the two sub-clusters, I find that most of the items in these lists appear also in the lists of the total Selective Girl cluster. When expanding the sub-cluster lists to 33 items, all but three items from the total cluster are found in the both sub-cluster lists. (These three items were E20* (saving energy), E21* (new energy sources) and E22* (food production and conservation).) This means that the Bottom 30 list of the Selective W Girl is relatively similar to the Bottom 30 list of the Selective B Girl. As I am not interested in small and trivial differences between the clusters, I will rejoin the sub-clusters and discuss the Bottom 30 list of the total the Selective Girl cluster (Table 8-7).

| Bottom 30 items for the Selective Girl | mean |
|---|---|
| C01. How crude oil is converted to other materials, like plastics and textiles | -1.16 |
| E01. Symmetries and patterns in leaves and flowers | -1.14 |
| A17. Atoms and molecules | -.99 |
| A48. How a nuclear power plant functions | -.94 |
| A15. How plants grow and reproduce | -.94 |
| E37. Famous scientists and their lives | -.93 |
| A47. How petrol and diesel engines work | -.87 |
| E25. Plants in my area | -.84 |
| A02. Chemicals, their properties and how they react | -.82 |
| E33. Benefits and possible hazards of modern methods of farming | -.79 |
| E36. Why scientists sometimes disagree | -.78 |
| E27. Electricity, how it is produced and used in the home | -.77 |
| C02. Optical instruments and how they work (telescope, camera, microscope, etc.) | -.75 |
| E17. How to improve the harvest in gardens and farms | -.73 |
| E19. Organic and ecological farming without use of pesticides and artificial fertilizers | -.72 |
| E39. How scientific ideas sometimes challenge religion, authority and tradition | -.72 |
| E04. The greenhouse effect and how it may be changed by humans | -.70 |
| E26. Detergents, soaps and how they work | -.67 |
| E06. How technology helps us to handle waste, garbage and sewage | -.67 |
| C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.) | -.63 |
| E34. Why religion and science sometimes are in conflict | -.63 |
| E28. How to use and repair everyday electrical and mechanical equipment | -.63 |
| A45. The use of satellites for communication and other purposes | -.63 |
| E30. How electricity has affected the development of our society | -.62 |
| A21* How different musical instruments produce different sounds | -.57 |
| A31* Explosive chemicals | -.53 |
| E22* How different sorts of food are produced, conserved and stored | -.48 |
| E21* New sources of energy from the sun, wind, tides, waves, etc. | -.47 |
| E20* How energy can be saved or used in a more effective way | -.46 |
| A04* How mountains, rivers and oceans develop and change | -.44 |

Table 8-7. Bottom score ACE items for the Selective Girl. Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .61.

The Bottom 30 list contains items regarding plants and farming: E01 (symmetries in leaves and flours), A15 (how plants grow), E25 (plants in my area), E33 (modern farming), E17 (improve harvest) and E19 (ecological farming). We also find items from the *Science and scientists* theme: E36 (why scientists disagree), E39 (scientific ideas challenging authority), E37 (life of famous scientists) and E34 (religion and science in conflict).

The Bottom list contains also the two items A17 (atoms and molecules) and A02 (chemicals and how they react).

From the *Environmental protection* theme, we have E04 (greenhouse effect) and E06 (handling waste), and from the *Farming and advancing nature* theme we find E20* (saving energy) and E21* (new energy sources).

Neither is the Selective Girl interested in learning about A48 (nuclear power plant), A47 (petrol and diesel engines), C02 (optical instruments), C03 (lasers in CD-players etc.), E28 (repair everyday electrical equipment), A45 (satellites), E27 (electricity in homes) or E30 (electricity in society).

Most of these items lie beyond one standard deviation from the mean, and so do item C01 (crude oil) and E26 (detergents and soaps). Item A21* (musical instruments), A31* (explosive chemicals), E22* (food production and conservation) and A04* (how mountains etc. develop) lie within one standard deviation from the mean.

## 8.3 The Reluctant, the Undecided and the Enthusiast

As remarked in 6.6, Figure 6-2 indicates that the profiles of the Reluctant, the Undecided and the Enthusiast oscillate up and down in phase. As accounted for in 1.3, I aim at robust results. This means that small differences in the Top or Bottom lists of the Reluctant, the Undecided and the Enthusiast are not worthy of note. Besides, as the clusters are relatively small, the results are sensitive to sample composition. If the Norwegian sample was drawn again, we could have found that small sample changes lead to somewhat different results. Consequently, if I find that the three clusters show relatively similar ACE profiles, I will not be interested in pursuing the small differences between them.

### 8.3.1 In phase?

In this paragraph, I will scrutinise cross-cluster similarities of the Reluctant, the Undecided and the Enthusiast, by employing three methods: First, by visually comparing the three profiles in a diagram for the residual data, second by running hierarchical cluster analysis on the five student types, and finally by comparing the Top and the Bottom lists of the separate clusters and for the combined Unselective cluster.

The residual data facilitates comparisons of the three lines in Figure 6-2, as in this data the lines are rearranged to lie at the same level. Figure 8-2 is a reproduction of Figure 6-2, but here with the residual data. The figure shows that the three lines follow each other in a relatively consistent manner.

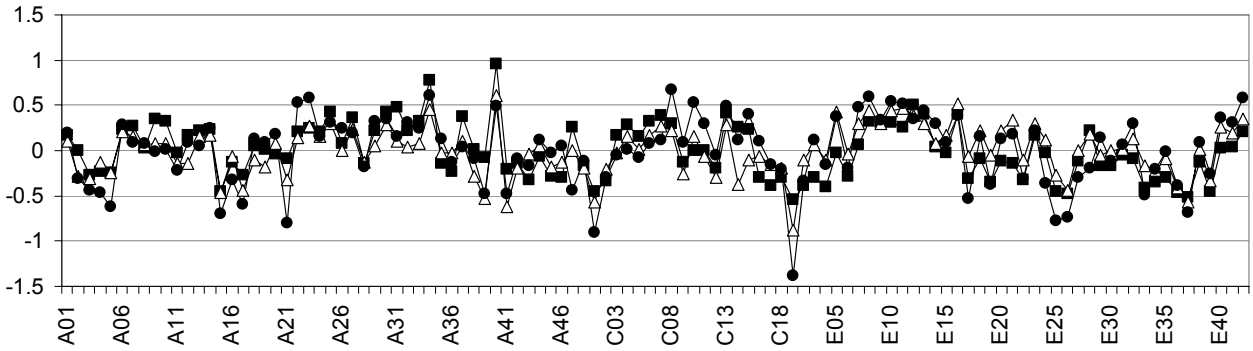



Figure 8-2. Profiles of residual scores (see text) for the Reluctant (filled squares), the Undecided (blank triangles) and the Enthusiast (filled circles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

The variances for the 108 ACE items are .09, .07 and .14 in the Reluctant, the Undecided and the Enthusiast respectively (Table 6-2), and the ranges in the mean scores within the clusters are 1.50, 1.49 and 2.05. Also from Figure 8-2 it is apparent that the Enthusiast has more differentiated mean values than the two other student types. We see that in many items the Enthusiast constitutes the extreme high or low values. This means that this student type gives the most significant contributions to gaps between the lines[73] and that the Top and Bottom lists for the combined Unselective cluster will largely be affected by the Enthusiast.

Figure 8-3 shows a dendrogram from hierarchical cluster analysis of the ACE residual mean scores for the student types. Here, the clustering method is between-groups linkage and squared Euclidean distance metric (see section 5.5). Reading the dendrogram from left to right, we see that the Reluctant and the Undecided join right away, and the Enthusiast immediately after, while the distances to the Selective Girl and the Selective Boy are considerably larger. This dendrogram suggest that the mean residual scores of the Reluctant, the Undecided and the Enthusiast are relatively similar to each other, and that the Selective Girl and the Selective Boy show somewhat different profiles.

However, this pretty picture is a little unstable. For example, Pearson correlation as similarity measure on standardised z-score values by case[74] (see section 5.5) indicates that the Undecided and the Enthusiast are more similar to each other, and that the Reluctant is somewhat different from these two (Figure 8-4). However, the Selective Girl and the Selective Boy still appear as noticeable different from any of the other clusters.

[73] The largest distances are found in the following items (gaps above .5; values in brackets):
E01. Symmetries and patterns in leaves and flowers (.84)
A21. How different musical instruments produce different sounds (.71)
A47. How petrol and diesel engines work (.71)
C14. Ghosts and witches, and whether they may exist (.63)
C10. Unsolved mysteries in outer space (.53)
E25. Plants in my area (.50)

[74] Scaling differences may affect the hierarchical cluster analysis. The scaling is the same for the five student types, and all have a grand ACE mean of zero, but since the standard deviations of the Selective student types are larger than for the Unselective, I tried the algorithm with z-scores (which imply that the standard deviations are 1 for all student types).

After several hierarchical cluster analyses with a variety of clustering methods and proximity metrics, I still infer that the residual interest scores of the Reluctant, the Undecided and the Enthusiast seem relatively similar to each other.

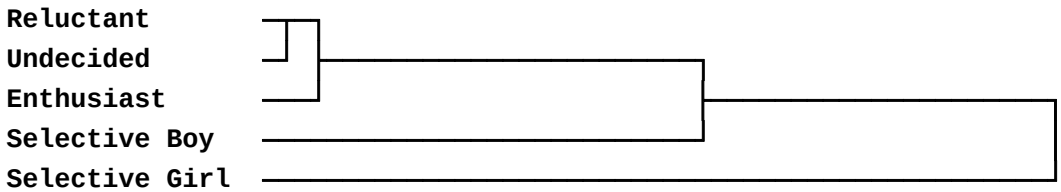



Figure 8-3. Hierarchical cluster analysis of residual mean scores for the five clusters. Proximity measure: squared Euclidean distance.

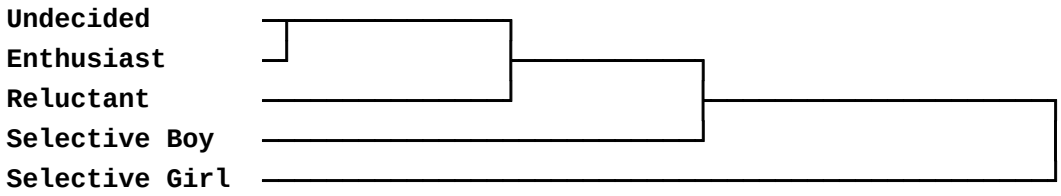



Figure 8-4. Hierarchical cluster analysis of residual mean scores for the five clusters. Proximity measure: Pearson correlation on standardised (by case) Z-score values.

Also comparisons of the Top/Bottom lists for the three single clusters with the Top/Bottom list for the merged Unselective clusters, give some support for assuming that the three cluster profiles have relatively similar mean residual scores profiles. With only three exceptions, all items beyond one standard deviation from the mean in the lists of the Unselective appear in the list lists for the single clusters. (The exceptions are item E42 (phenomena scientists cannot explain) which is not in the Top 30 list of the Reluctant, and item A21 (musical instruments) and A39 (lotions for young skin) which is not in the Bottom 30 list of the Reluctant.)

Altogether, I conclude that I find support for perceiving the three profiles of mean ACE residual scores as relatively similar. Although the *levels* of interest are very different in the three clusters, the *relative* interests in the various topics are much in phase. Consequently, the merged scores of the three Unselective student types will present the Top/Bottom lists for the Reluctant, the Undecided and the Enthusiast jointly.

### 8.3.2 More interesting

Table 8-8 reports the Top 30 items from the mean score ranking list for the Unselective student types.

| Top 30 items for the Unselective student types | mean |
|---|---|
| A40. How to exercise to keep the body fit and strong | .67 |
| A34. How it feels to be weightless in space | .60 |
| E08. Cancer, what we know and how we can treat it | .46 |
| E16. How to protect endangered species of animals | .44 |
| E10. How to perform first-aid and use basic medical equipment | .44 |
| E11. What we know about HIV/AIDS and how to control it | .42 |
| E12. How alcohol and tobacco might affect the body | .41 |
| C08. The possibility of life outside earth | .41 |

| Top 30 items for the Unselective student types | mean |
|---|---|
| C13. Why we dream while we are sleeping, and what the dreams may mean | .39 |
| E42. Phenomena that scientists still cannot explain | .39 |
| E13. How different narcotics might affect the body | .38 |
| A23. How meteors, comets or asteroids may cause disasters on earth | .38 |
| A30. How the atom bomb functions | .35 |
| A25. Tornados, hurricanes and cyclones | .34 |
| E09* Sexually transmitted diseases and how to be protected against them | .32 |
| A22* Black holes, supernovas and other spectacular objects in outer space | .30 |
| E07* How to control epidemics and diseases | .29 |
| E05* What can be done to ensure clean air and safe drinking water | .27 |
| C07* How computers work | .25 |
| A27* Brutal, dangerous and threatening animals | .25 |
| C10* Unsolved mysteries in outer space | .24 |
| A06* The origin and evolution of life on earth | .24 |
| A31* Explosive chemicals | .24 |
| E23* How my body grows and matures | .23 |
| E40* Inventions and discoveries that have changed the world | .23 |
| A14* Dinosaurs, how they lived and why they died out | .22 |
| A33* The effect of strong electric shocks and lightning on the human body | .21 |
| A29* Deadly poisons and what they do to the human body | .21 |
| E41* Very recent inventions and discoveries in science and technology | .19 |
| A32* Biological and chemical weapons and what they do to the human body | .19 |

Table 8-8. Top score ACE items for the Unselective student types. Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation in the combined Unselective cluster is .32.

The mean scores of item A40 (exercise for fit body) and A34 (weightless in space) are superior to the scores of the other items in this list. These two items are also the two highest scoring items in the total sample and occurring in all three Top 30 lists in this chapter. Besides A40, there are no other items from the *Fit/sculptured body* theme.

From the theme *Universe and enigmas* we recognise item A22* (black holes, supernovas), A23 (meteors causing disasters), A34 (weightless in space), C08 (life in space), C10* (unsolved mysteries in space), A06* (origin of life) and A14* (dinosaurs). Items from this theme that are *not* included in the list are those related to satellites and space travel (A44, A45 and E29), the general item A01 (stars, planets, universe) as well as A35 (find my way by stars).

All items but E32 (gene technology) from the *Health* theme occurs in this top-score list: item E07* (epidemics and diseases), E08 (cancer), E09* (sexually transmitted diseases), E10 (first-aid) and E11 (HIV/AIDS); and so do both items from the *Youth health, drugs* theme: E12 (alcohol and tobacco) and E13 (narcotics).

The two items E16 (protect endangered animals) and A27* (dangerous animals) are from the *Animals* theme, while the *Mysteries* theme is represented by only item C13 (what our dreams may mean).

All three items from the *Science in the making* theme are in the list: E40* (inventions that have changed the world), E41* (recent inventions) and E42 (phenomena scientists cannot explain).

In the lower part of the list (only one of them beyond one standard deviation from the mean) we find some items of a more dramatic character: A30 (atom bomb), A31*

(explosive chemicals), A32* (chemical weapons) and A33* (strong electric shocks) from the *Explosives and shocks* theme, as well as A25 (tornados and hurricanes) from *Geo, volcano and tornado* and A29* (deadly poisons) from *Health threats*.

Below one standard deviation from the mean we also find one item from each of the three themes *Environmental protection*, *Technology* and *Human conception and maturing*: item E05* (clean air, safe drinking water), C07* (computers) and E23* (maturing body).

### 8.3.3 Less interesting

Table 8-9 shows the items with the lowest interest scores among the Unselective student types.

| Bottom 30 items for the Unselective student types | mean |
|---|---|
| E01. Symmetries and patterns in leaves and flowers | -.96 |
| C01. How crude oil is converted to other materials, like plastics and textiles | -.66 |
| E37. Famous scientists and their lives | -.60 |
| E26. Detergents, soaps and how they work | -.56 |
| A15. How plants grow and reproduce | -.55 |
| E25. Plants in my area | -.51 |
| A17. Atoms and molecules | -.45 |
| A41. Plastic surgery and cosmetic surgery | -.45 |
| A21. How different musical instruments produce different sounds | -.43 |
| E36. Why scientists sometimes disagree | -.42 |
| A05. Clouds, rain and the weather | -.38 |
| A39. The ability of lotions and creams to keep the skin young | -.38 |
| E33. Benefits and possible hazards of modern methods of farming | -.35 |
| E39. How scientific ideas sometimes challenge religion, authority and tradition | -.34 |
| A03. The inside of the earth | -.34 |
| E17* How to improve the harvest in gardens and farms | -.30 |
| C02* Optical instruments and how they work (telescope, camera, microscope, etc.) | -.28 |
| A04* How mountains, rivers and oceans develop and change | -.28 |
| E02* How the sunset colours the sky | -.27 |
| E34* Why religion and science sometimes are in conflict | -.25 |
| E19* Organic and ecological farming without use of pesticides and artificial fertilizers | -.25 |
| E22* How different sorts of food are produced, conserved and stored | -.24 |
| C18* Properties of gems and crystals and how these are used for beauty | -.23 |
| C17* Why we can see the rainbow | -.22 |
| E04* The greenhouse effect and how it may be changed by humans | -.21 |
| A02* Chemicals, their properties and how they react | -.21 |
| A16* How people, animals, plants and the environment depend on each other | -.18 |
| C12* Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | -.18 |
| E06* How technology helps us to handle waste, garbage and sewage | -.17 |
| A43* How the ear can hear different sounds | -.17 |

Table 8-9. Bottom score ACE items for the Unselective student types. Items within one standard deviation from the grand ACE mean are asterisked. The standard deviation is .32.

E01 (symmetries in leaves and flours) is the lowest scoring item in the whole ACE question and lies at or near the peak in all three Bottom 30 lists. There are other items on the subject of plants in this list: A15 (how plants grow) and E25 (plants in my area).

Furthermore, we find the three items on farming: E33 (modern farming), E17* (improve harvest) and E19* (ecological farming), and two items from the *Environmental protection* theme: E04* (greenhouse effect) and E06* (handling waste); both within one standard deviation from the mean.

Four items in the *Science and scientists* theme appear in this Bottom 30 list: item E36 (why scientists disagree), E39 (scientific ideas challenging authority), E37 (life of famous scientists) and E34* (religion and science in conflict).

The whole *Geo* theme is represented in this list. Besides A15 (how plants grow, mentioned above), we find item A04* (how mountains etc. develop), A05 (weather) and A03 (inside of earth). The only item from the *Geo, aesthetics* theme that is not in the Bottom 30 list, is item C16 (why the stars twinkle). The other items in this theme, within one standard deviation from the mean, though, are: C17* (rainbow), C18* (gems and crystals) and E02* (sunset).

In spite of the high health interest apparent from the Top 30 list, the more mysterious and unconventional health item C12* (alternative therapies) appears in this Bottom 30 list. Two more items related to the human body from the theme *Fit/sculptured body* are found in this list: A39 (lotions for young skin) and A41 (plastic surgery).

The Bottom 30 list also contains the two items A17 (atoms and molecules) and A02* (chemicals and how they react). Item C02* (optical instruments) is the only item in this list representing the *Technology* theme. The remaining six items in this Bottom list are item C01 (crude oil), A21 (musical instruments), E22* (food production and conservation), A16* (how "everything" depends on "everything else"), E26 (detergents and soaps) and A43* (how ear can hear).

### 8.3.4 Two sub-clusters: Unselective Boy and Unselective Girl

It is obvious that the most salient feature of the Reluctant student type is the general and steady poor interest in any of the ACE topics. Correspondingly, the distinguishing characteristic of the Undecided and the Enthusiast is their expressions of respectively medium and very high interests in learning about nearly all the topics. The three clusters appear with consistent and unselective interests profiles (Figure 6-2), which is supported by the low variance in each cluster (Table 6-2) and the relatively few items having mean scores beyond one standard deviation from the grand ACE cluster mean in the Top 30 and Bottom 30 lists (Table 8-8 and Table 8-9).

Therefore, the previous paragraph about the top and bottom interests of the Unselective student types may seem somewhat uninteresting and elaborated, as the score differences between the items are small and trivial. The Top and Bottom list of the combined Unselective cluster are also uninteresting in the sense that they appear as conglomerates of the Top/Bottom lists of the Selective Girl and the Selective Boy. The Top 30 and the Bottom 30 lists for the Unselective student types have only three unique items (E16, E05*, A29* in the Top list and A03, A43*, C18* in the Bottom list). The rest of the items occur in the corresponding lists of the two Selective student types.

This latter point made me question whether the specific level of interest in the clusters hides two interest profiles similar to the two profiles of the Selective Girl and the Selective Boy. Can the Unselective student types be divided into two groups of

respondents that reflect the profiles of the Selective Girl and the Selective Boy, although in a flatter and more unselective manner?

I ran k-means cluster analysis with residual scores for the respondents in the Unselective student types. As remarked elsewhere (in section 7.3), it may still be a shared factor in the residual data standardised at the level of clusters, in terms of a general level of interest. Therefore, in order to omit any such shared factor, the cluster analysis was processed on a residual data file standardised at the level of individuals rather than clusters. The data file was sorted by ascending questionnaire identification number, and two clusters were requested.

The sizes of the two clusters coming out of this analysis are of the same magnitude, with 313 and 267 students. Table 8-10 shows the distribution of girls and boys between the two clusters. Like in the clusters of the Selective Boy and the Selective Girl, although not that distinguished, these two new clusters are unevenly divided with respect to sex, with 83 percent girls in one cluster and 89 percent boys in the other. Consequently, the labels of these two clusters are the Unselective Girl and the Unselective Boy.

| | Unselective Boy | | Unselective Girl | | tot |
|---|---|---|---|---|---|
| **total** | 313 | *100* | 267 | *100* | 580 |
| **girls** | 33 | *11* | 221 | *83* | 254 |
| **boys** | 279 | *89* | 46 | *17* | 325 |

Table 8-10 Percentages (italicised) and number of respondents, girls and boys in each cluster. (Due to one missing response in the sex-variable in the Unselective Boy, the number of girls and boys do not add up to the total number of respondents.)

| | Reluctant | | | | Undecided | | | | Enthusiast | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Girl | | Boy | | Girl | | Boy | | Girl | | Boy | | tot |
| **total** | 68 | *100* | 104 | *100* | 88 | *100* | 110 | *100* | 111 | *100* | 98 | *100* | 579 |
| **girls** | 58 | *85* | 6 | *6* | 65 | *74* | 14 | *13* | 98 | *88* | 13 | *13* | 254 |
| **boys** | 10 | *15* | 98 | *94* | 23 | *26* | 96 | *87* | 13 | *12* | 85 | *87* | 325 |

Table 8-11 Percentages (italicised) and number of respondents, girls and boys in each cluster. (Due to one missing response in the sex-variable, the number of girls and boys do not add up to the total number of respondents.)

The Unselective Girl and the Unselective Boy should be seen as respondent *clusters* rather than student types. Each of the two Unselective clusters contains three student types, namely the Reluctant, the Undecided and the Enthusiast. Each of these may be divided into a girl's and a boy's type. This gives the Reluctant Girl and the Reluctant Boy, the Undecided Girl and the Undecided Boy, and the Enthusiast Girl and the Enthusiast Boy. Table 8-11 shows how girls and boys are distributed between the student types.

The mean score profiles for the Unselective Girl and the Unselective Boy through all ACE items are shown in Figure 8-5. Below the figure, there is a copy of Figure 6-3 with the corresponding profile for the Selective Girl and the Selective Boy. We see that there are striking similarities between the two diagrams: the Unselective Boy and the Selective Boy are largely in phase, and so are the Unselective Girl and the Selective Girl.

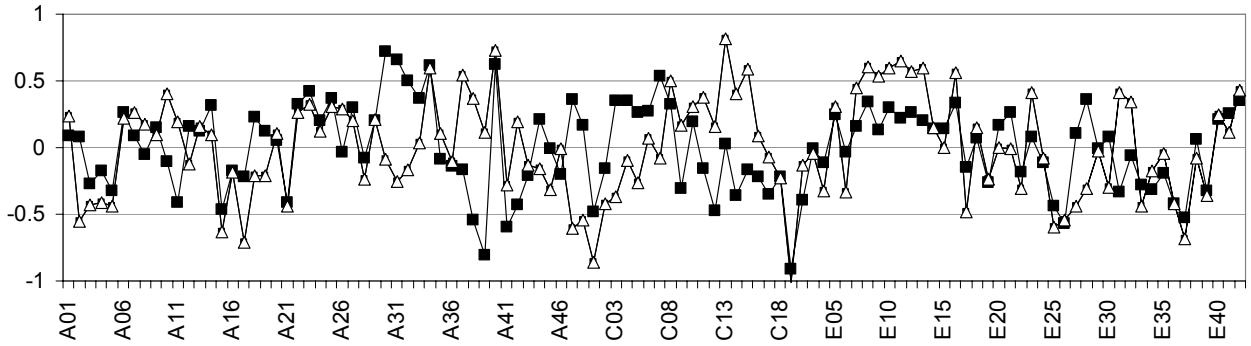



Figure 8-5. Profiles of mean residual scores for the Unselective Boy (filled squares) and the Unselective Girl (blank triangles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

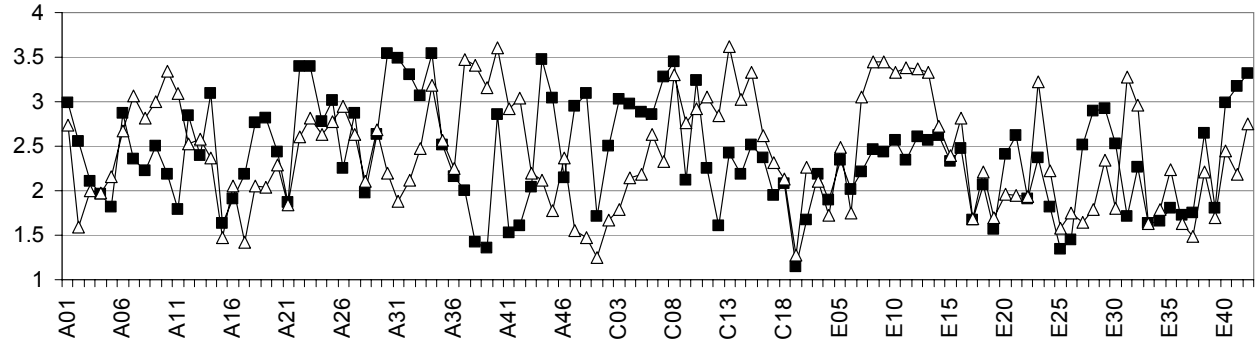



Figure 6-3 (copy). Profiles of mean raw data scores for the Selective Boy (filled squares) and the Selective Girl (blank triangles) through the 108 ACE items (A01-A48, C01-C18 and E01-E42).

However, the scales in the diagrams have very different extensions; with a range of 2 in the first figure and 3 in the other. (The profiles in Figure 8-5 fluctuate around the zero line because the diagram is based on residual data. This means that, when compared to Figure 6-3, the profiles are parallelly displaced downwards on the scale, but the unit sizes are identical in both scales.) The Unselective Girl and the Unselective Boy differ markedly from the Selective Girl and the Selective Boy in the overall level of differentiation. While the Selective Girl and the Selective Boy show mean scores at virtually all levels of the scale, the Unselective Girl and the Unselective Boy fluctuate with much smaller span between the extreme values. This is also confirmed by the small variance in these clusters compared to the Selective Girl and the Selective Boy (Table 8-12).

| | Selective Boy | Unselective Boy | Selective Girl | Unselective Girl |
|---|---|---|---|---|
| **variance** | .34 | .10 | .37 | .14 |

Table 8-12. Grand ACE standard deviation for each of the four sex clusters.

The proportion of the other sex in each cluster is larger than what is the case for Selective Boy and Selective Girl (Table 6-1). This may partly be due to the flatter profiles making many of the individual profiles less distinct, and thereby more interchangeable between the clusters. Besides, I would surmise that the student profiles in the two clusters represent a continuum, rather than two distinct clusters. The clusters probably blend relatively seamlessly into each other, making the line of demarcation between the two clusters unclear.

The analysis in this section indicates that the Norwegian sample may be divided into four sex-specific clusters, two clusters for each sex. In addition to the Selective Girl and the Selective Boy, we may also construct clusters for the Unselective Girl and the Unselective Boy.

When investigating the Top 30 and Bottom 30 lists for the four (more or less) sex-specific clusters, I find that most items in the Top and Bottom lists are common to the two student types of the same sex. In other words, the Selective Boy and the Unselective Boy have more or less the same interests, and the same accounts for the Selective Girl and the Unselective Girl. Yet, there are some differences. For example, there are three items that lie more than one standard deviation from the mean in the Top 30 list of Unselective Boy, but which are not in the Top 30 list of the Selective Boy. These are item E08 (cancer), E16 (protect endangered animals) and E10 (first-aid). There are also two items lying more than one standard deviation from the mean in the Top 30 list for the Unselective Girl, which are not in the corresponding list for the Selective Girl: E16 (protect endangered animals) and E42 (phenomena scientists cannot explain).

I do not wish to pursue these differences any further, and there are several reasons for this. First, the main focus of this study is the student types and identities. I assume that the identities of the respondents in the three Unselective clusters are better described by the identity of the Reluctant, the Undecided and the Enthusiast than by the small sex-specific interest fluctuations within the three clusters. Second, my research approach allows me to pursue only robust results. Loosely, I would say that the interest profiles of the two girls-clusters are similar to each other, and that the small deviations between them are not very interesting. The same applies for the profiles of the two boys-clusters. Third, the reporting would become long and laborious if I were to give accounts for the Top and Bottom lists of these clusters too. Last, but not least, the composition and the scores of these two Unselective clusters are fabricated, and distant to the real groups of students. Results will therefore be removed from the raw data, and consequently hard to assign a meaningful interpretation for. Natural follow-up questions, for results revealing differences between the clusters, would be: Which of the student types among the Reluctant, the Undecided and the Enthusiast gave the strongest contribution to the difference? For example: The Top lists for both of the Unselective clusters differ from the Top lists of the Selective clusters, by containing E16 (protect endangered animals). Is this concern about endangered animals a characteristic of the Reluctant, the Undecided *and* the Enthusiast, or is it largely one of them that enhances the mean values? May it even be that the difference is caused by different clusters for the two sexes, e.g. by the Undecided Boy and the Enthusiast Girl?

Although I will not pursue these clusters any further, the appearance of the two clusters leads me to close this section by highlighting an interesting (and for me surprising) result:

My approach to the data grew out of the belief (accounted for in the introduction to chapter 6) that if you want to describe students' interests in science, you need to ask what type of students they are, rather than what sex they have (expression inspired by Brickhouse & al., 2000). But my analysis seems to contradict this assumption. In chapter 6, five clusters from exploratory cluster analysis resulted in one girl's cluster, one boy's

cluster and three mixed clusters. For the three mixed clusters, the main characteristic was their different general levels of interest. When these three clusters were standardised in relation to each other, and the cluster analysis was run again with two clusters, I once again got one boy's and one girl's cluster. The interest profiles of these two clusters are remarkably similar to the corresponding boy's and girl's cluster profiles developed in the first stage.

This indicates that sex is a more important proxy for student interests than I had assumed. Still, sex cannot explain all interest variances. Naturally, none of the clusters were pure single-sexed. All four sex clusters contained a low percentage of students of the opposite sex. Furthermore, when one of the girl's clusters was divided into two sub-clusters, two rather different interest profiles appeared. Clearly, I could continue and continue to divide clusters into sub-clusters, and I would then continue and continue to find interesting differences – until there was only one respondent left in each cluster. However, sticking to the aim of my study – to describe and compare typical student types – it is evident from the analysis that sex is a powerful variable for explaining different interest profiles.

The Unselective Girl and the Unselective Boy clusters have appeared after normalising the data of the Unselective Reluctant, Undecided and Enthusiast. This means that what I saw as the main identity trait of these three student types is wiped out. Since the data representing the Unselective Girl and the Unselective Boy are distant from the real responses of the students, I will not regard the Unselective Girl and the Unselective Boy as *student types*. The student types within the combined Unselective cluster are more closely linked to the identities of the Reluctant, the Undecided and the Enthusiast. The emergence of the Unselective Girl and the Unselective Boy clusters may nevertheless be understood against the theoretical perspectives in 2.4.1, saying that youth identities are tightly linked to sex.

## 8.4 Index scores

We see from the Top/Bottom lists that groups of items appearing in one theme may be divided between the Top and the Bottom lists. Even items appearing in the same index, checked for internal consistency, are split between Top and Bottom lists. Examples of this are the theme *Fit/sculptured body* in the Selective Boy. Item A40 (exercise for fit body) is in the Top 30 lists, while item A39 (lotions for young skin), A41 (plastic surgery), A38 (eating disorders) and A42 (radiation from solariums) appear in the Bottom list. Another example is the *Animals* index, with A27 (dangerous animals) in the Top 30 list of the Selective Boy and E24 (animals in my area) in the Bottom 30 list of the same cluster. One last example may be the Top list of cluster 5b containing the technology item C06 (mobile phones), while the Bottom list holds item C03 (lasers in CD-players etc.); also in the *Technology* theme.

How could it happen that items grouped in the same themes through the factor analysis in 7.4 and showing acceptable internal consistency in 7.5.1, at the same time could be divided between the Top and Bottom lists in this chapter? Does the fact that items

within one theme or index sometimes are split between the Top and Bottom lists imply that there is no such thing as different overall interest orientations?

One obvious cause for the split indexes is connected with how alpha and the factors are calculated. Both analyses are influenced by the correlations between the variables, but the mean values are not directly involved in the alpha and factor calculations. This means that as long as the items are correlated, items with disparate mean values may group in the same factor and show some degree of internal consistency.

Another explanation refers to the issue described in the first sections of chapter 7: The factor solution and indexes are developed from the total sample, but they would probably have come out somewhat differently if they were developed within the sample of each student type. This would give different indexes for each student type, because the items may bring different connotations among different groups of students. This means that the themes, indexes and interest orientations from 7.4 and 7.5 must be seen as common denominators for all clusters. If such intra-cluster factor structures could be compared with the Top and Bottom lists, the index items could possibly appear more jointly in one Top/Bottom lists.

For example, considering the Selective Boy, the correlation coefficient (r) for item A27 (dangerous animals) and E24 (animals in my area) is .18 ($p < .01$). This is lower than the correlation of item A27 with item A25 (tornados and hurricanes) ($r = .31$, $p < .01$), which is categorised in another theme. Furthermore, this correlation is lower than the correlation of E24 with E25 (plants in my area) ($r = .52$, $p < .01$). This means that, although the two items A27 and E24 are in the same *Animals* index for the total sample, a factor analysis of the ACE items with only the data for the Selective Boy might place the animal items differently in the factor structure. For the Selective Boy, the interest in dangerous animals may be more related to his curiosity about other spectacular phenomena in nature, such as tornados and hurricanes, while his interest in animals where he lives may be more related to his lack of interest in everyday matters in his everyday surroundings.

Although the criteria for unidimensionality and internal consistency may not be met in all indexes in all clusters, I will now compare the index scores of the student types. The purpose is to study whether they show some general and overall interest patterns through the different interest orientations.

Because the two sub-clusters of the Selective Girl showed some interesting differences, these will be reported separately. Furthermore, up to here, the Reluctant, the Undecided and the Enthusiast clusters have been unjustly treated by being merged in the one way or the other – not allowed to speak for themselves. In this section, I will compare the mean index scores for each student type separately. (This may also inform the discussion in 8.3.1, about whether the three clusters are in phase through the ACE question.) From the previous section, we know that there is a relationship between sex and the ACE interest of the students. It is therefore important to note that although the three clusters are mixed, the number of girls and boys are not evenly distributed in the three clusters. The Reluctant has 37 percent girls, the Undecided 40 percent and the Enthusiast 53 percent (Table 6-1). This means that, if the scores of the Reluctant and the Undecided tend to lie in the direction of the Selective Boy, this may be due to the uneven gender distribution in these two clusters.

The data file applied here has residual scores standardised at the level of clusters, so the grand ACE mean value for each of the six clusters is zero. Consequently, the focus will be on the *relative* interest rather than the absolute. The reason for not analysing the raw data is that I find it hard to make any inferences of raw data comparisons, other than that the Enthusiast scores above the Undecided, which again scores above the Reluctant. The grand ACE mean for these three clusters are 3.1, 2.5 and 1.7 respectively. For the Selective Boy, the Selective W Girl and the Selective B Girl the grand mean is 2.4, 2.5 and 2.3 respectively. This means that these lie more or less at the same level. From the diagrams below, one can envisage the raw score of the student types, by displacing the score rightwards a distance equal to the grand mean of the cluster.

The following results are reported in error bar diagrams. Such diagrams facilitate examination of the statistical significance of differences between the student type mean scores. If the confidence limit of two clusters not overlap, one can interpret that the differences probably have not occurred in the sample by chance (see 5.1.2).

The following presentation of cluster index scores is structured according to the interest orientations developed in 7.5.

### 8.4.1 The *Body* interest orientation

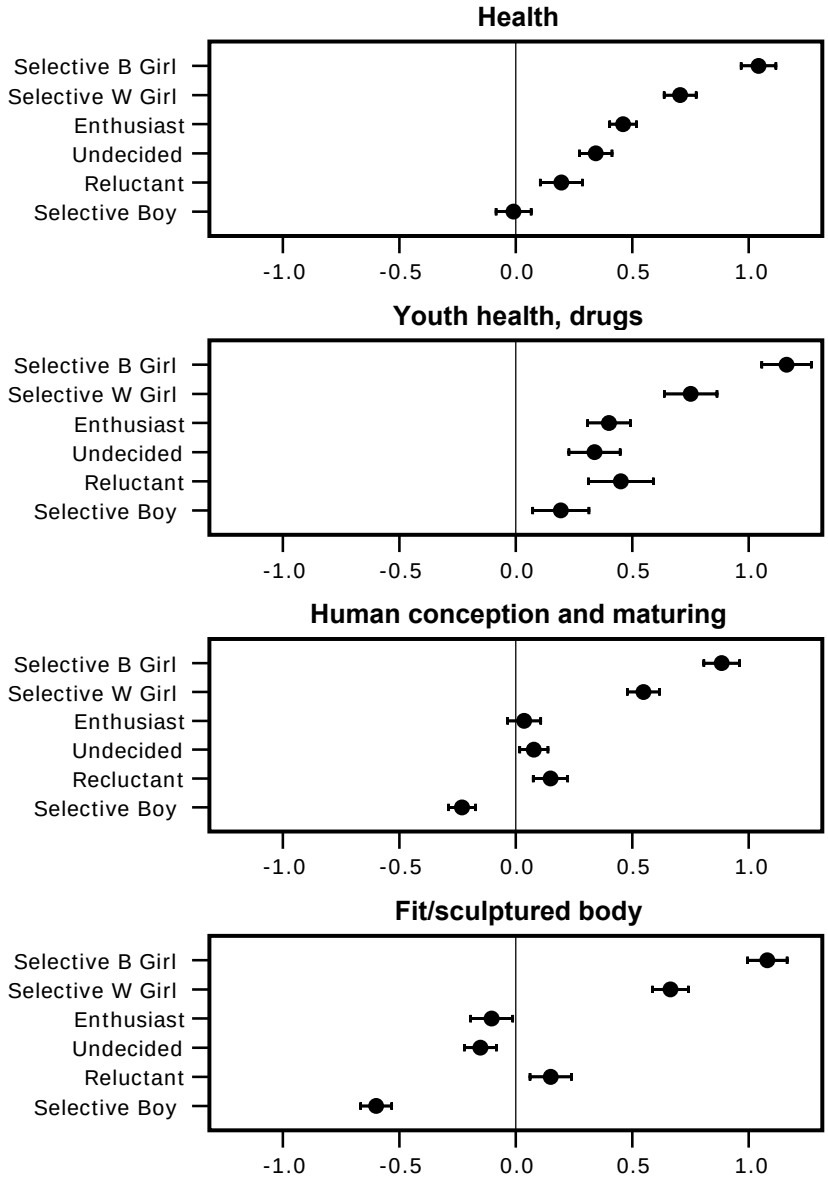



Figure 8-6. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Body* interest orientation.

The most salient pattern of this interest orientation is the high interest scores of the two Selective Girl student types, especially the Selective B Girl. In index *Fit/sculptured body* and *Human conception and maturing*, the scores of the Selective Boy are particularly low. This is consistent with the impression we got from the Top and Bottom lists of these clusters. However, item A40 (exercise for fit body) indeed was in the Top 30 list of the Selective Boy (within one standard deviation from the mean, though). This may indicate that there is some general interest, also among boys, for shaping a fit body, and, furthermore, that the items in this index are biased towards ways of sculpturing the body that are considered to be specific to girls. More items related to boy's activities (for example use of anabolic steroids) might have given a different index score for the Selective Boy.

In all indexes, the differences between the Reluctant, the Undecided and the Enthusiast are relatively small, but one interesting pattern appears: In the *Health* index, the differences between the Reluctant, the Undecided and the Enthusiast can partly be explained by the proportion of girls and boys in the clusters, but for the *Fit/sculptured body* index, the differences cannot be explained by the uneven gender distributions. In this index, the scores go *against* the gender pattern, with highest scores for the Reluctant. Although the differences between these three clusters are small, there is a tendency, except in the *Health* index, for the Reluctant cluster to show more interest in this interest orientation, especially if we correct for the large proportion of boys in this cluster.

### 8.4.2 The *Concern* interest orientation

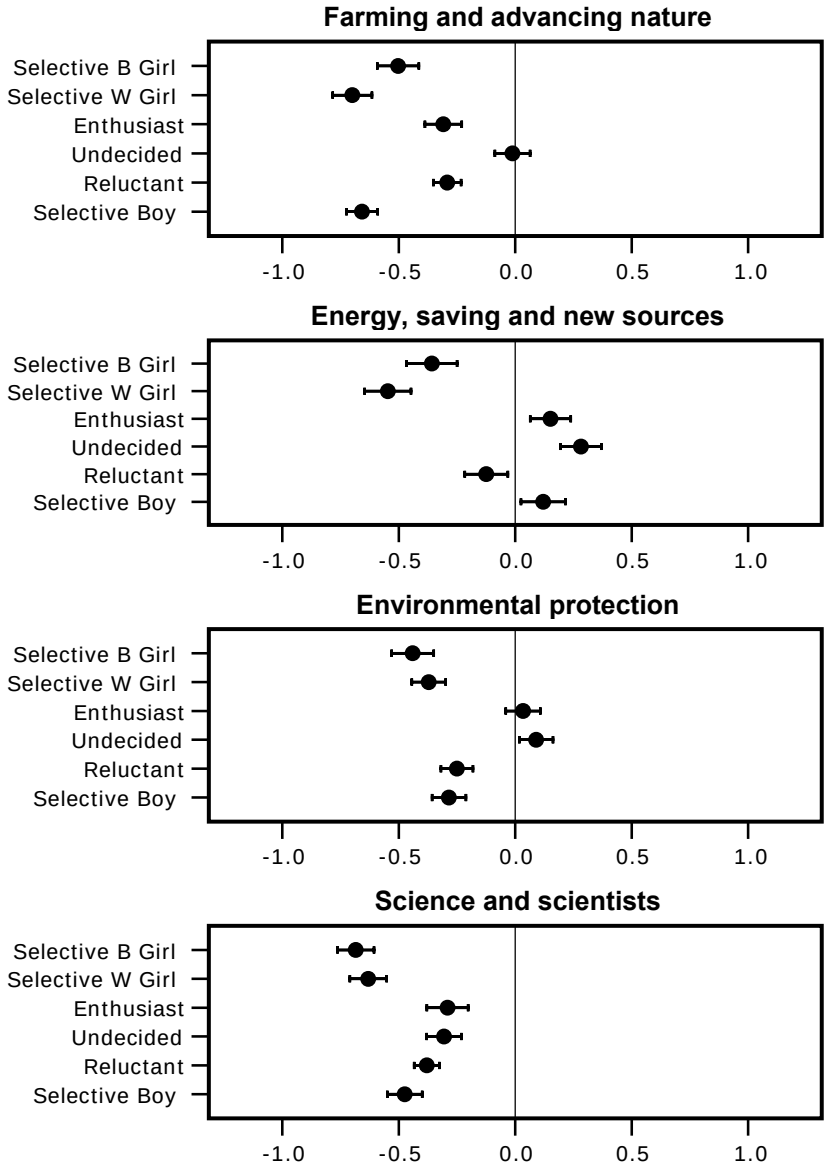



Figure 8-7. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Concern* interest orientation.

In general, the scores in these indexes are low. Except from in the *Energy, saving and new resources* index, both the Selective Girl and the Selective Boy express low interest. This means that for this interest orientation we find no clear sex-specific tendencies.

In the index *Energy, saving and new sources* the interest of the Selective Boy is somewhat higher than in the other indexes. This may be explained by the component of the *Science in the making* index (see in Appendix E that these items are loading on the same factor), and the component of the *Techno* interest orientation (see Table 7-28 that this index is loading on the *Techno* orientation). As we will see in the following paragraphs, the *Science in the making* index and the *Techno* interest orientation achieve high scores from the Selective Boy.

There is a tendency for higher interest among the Undecided than among the other student types in this interest orientation. In the *Environmental protection* index, the Enthusiast also lies above the others. However, even for the relative interested Undecided and Enthusiast, the scores are still just above the average (zero) line.

### 8.4.3 The *Puzzles* interest orientation

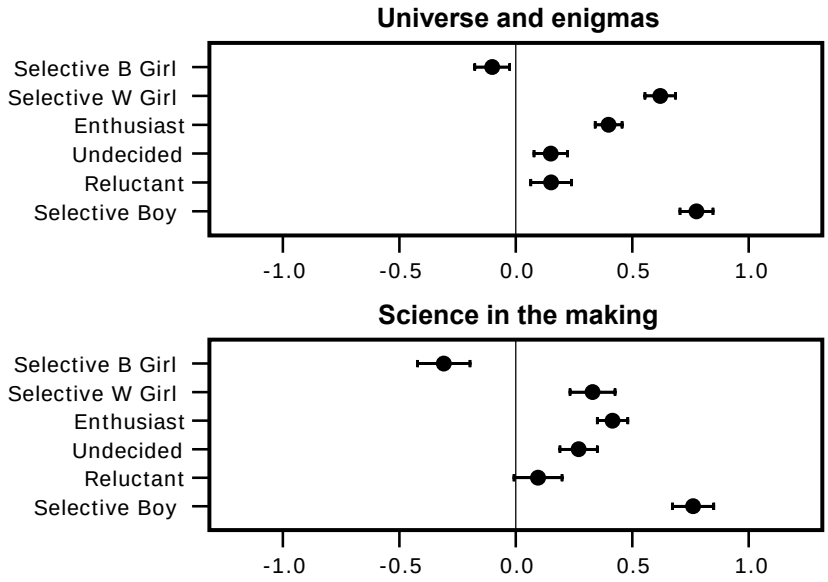



Figure 8-8. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Puzzles* interest orientation.

In this interest orientation there are remarkable differences between the two Selective Girl clusters; the Selective W Girl shows much higher interests than the Selective B Girl. In fact, all student types except the Selective B Girl have scores lying above the zero line in this interest orientation. This means that among the 108 items in the ACE question, the Selective B Girl is the only student type finding these topics *less* than averagely interesting. (Although both item A34. *How it feels to be weightless in space* and item C08. *The possibility of life outside earth* appeared in this student type's Top 30 list, but within one standard deviation from the mean, though.)

Especially the Selective Boy gives very high scores in this interest orientation, but also the Selective W Girl express much interest in the *Universe and enigmas* index.

### 8.4.4 The *Techno* interest orientation

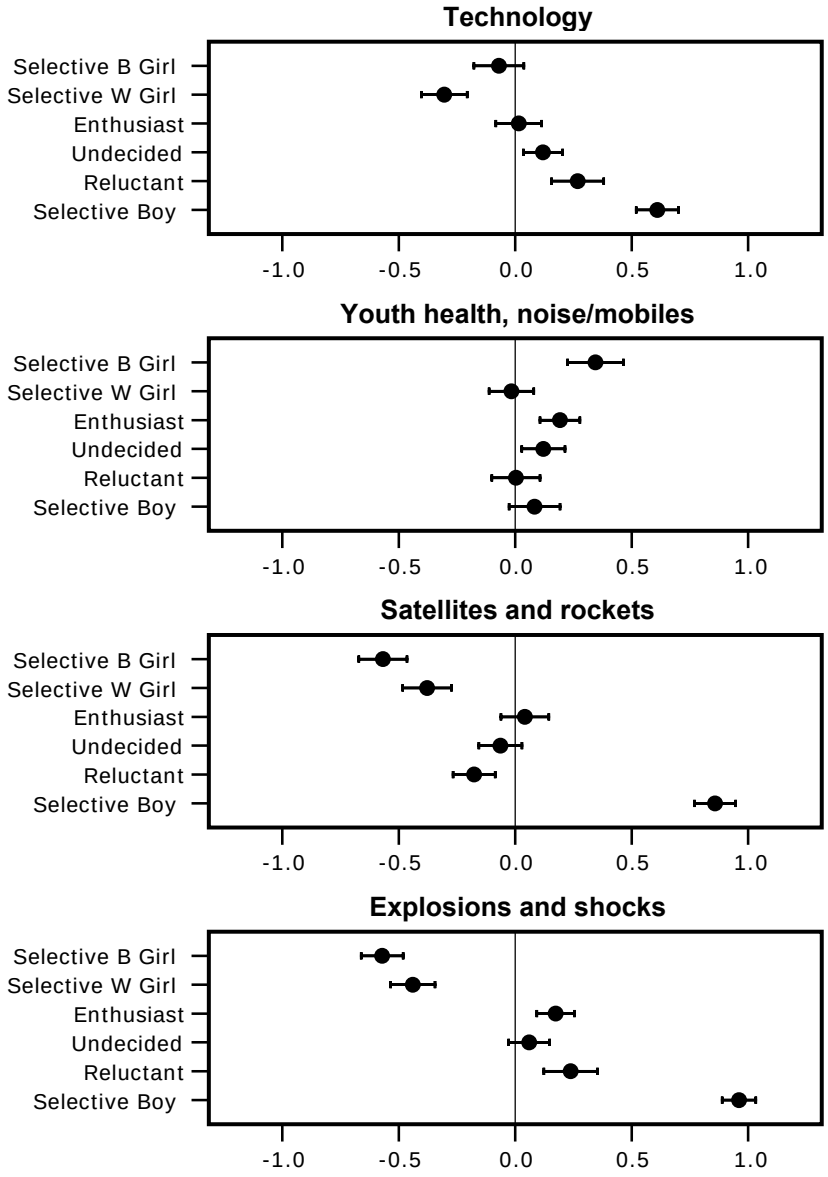



Figure 8-9. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Techno* interest orientation.

Apart from index *Youth health, noise/mobiles,* the scores in these indexes show a considerable range in mean values, with very high values for the Selective Boy and many low values for the two Selective Girl student types.

There are some remarkable differences in the scores of these two Selective Girl student types: We know from section 8.2.2 that the Selective W Girl is interested in, among other topics, mysteries, wonders, the universe and enigmas, while the Selective B Girl generally is more interested in the many aspects of the human body. The diagrams above show that for the index related to the universe, *Satellites and rockets*, the Selective W Girl gives the highest scores, while for the index related to the human body, *Youth health, noise/mobiles*, the Selective B Girl is more interested. This means that although the differences are small, the interest patterns are consistently appearing also in this *Techno* interest orientation.

A supplementary explanation for the relatively high interest of the Selective B Girl in the *Youth health, noise/mobile* index may be their interest in mobile phones. Item C06. *How mobile phones can send and receive messages* appeared in the Top 30 list of this student type (within one standard deviation from the mean). This means that her interest in the *Youth health, noise/mobile* index also can be connected to her interest in mobiles (see footnote 66 about mobile phones and identity).

The index *Youth health, noise/mobiles* is almost equally divided between this interest orientation and the *Body* interest orientation (see 7.5.6). This may explain the differing response pattern in this index compared to the three other indexes. The responses in this *Youth health, noise/mobiles* index appear as a mix between the general score pattern for this *Techno* orientation and the pattern in the *Body* orientation. Compared to the other indexes in this orientation, the two Selective Girl types score high and the Selective Boy scores low, while compared to the indexes in the *Body* orientation, the Selective Boy scores high and the two Selective Girl types score low. Furthermore, we see that the Selective B Girl scores higher than the Selective W Girl. The only other indexes in which the Selective B Girl scores above the Selective W Girl is in the *Body* interest orientation.

The scores of the Reluctant, the Undecided and the Enthusiast lie close to each other and show no distinctive pattern.

### 8.4.5 The *Ponder* interest orientation

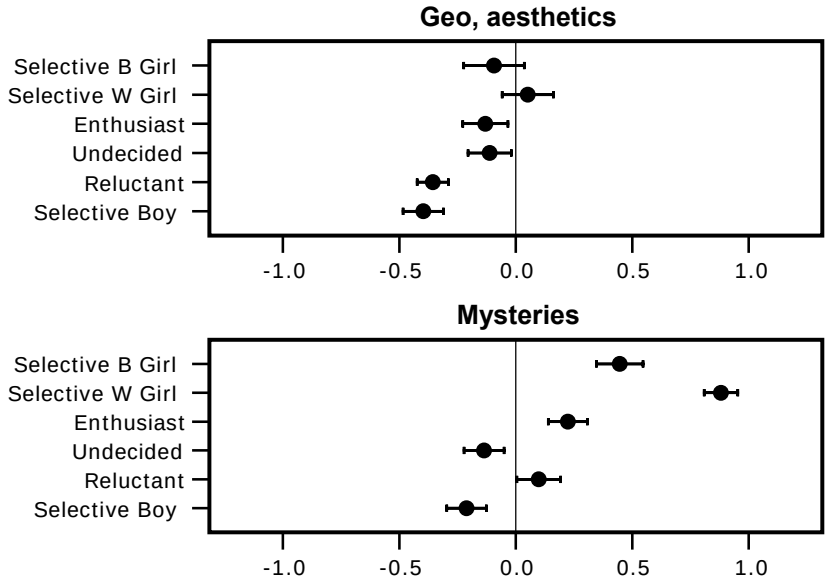



Figure 8-10. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Ponder* interest orientation.

We saw, from the Top 30 lists of the two sub-clusters of the Selective Girl, that a significant proportion of the Selective Girl students did *not* express much interest in mysteries. The same is shown in this *Mysteries* index: the Selective W Girl express far more interest than the Selective B Girl (although also the Selective B Girl expresses relatively high interest).

The *Geo, aesthetics* index does not discriminate the clusters noteworthy. The Selective Boy and the Reluctant show less interest than the others do, but also the other student types are only moderately interested in the topics brought up in this index.

### 8.4.6 The *Nature* interest orientation

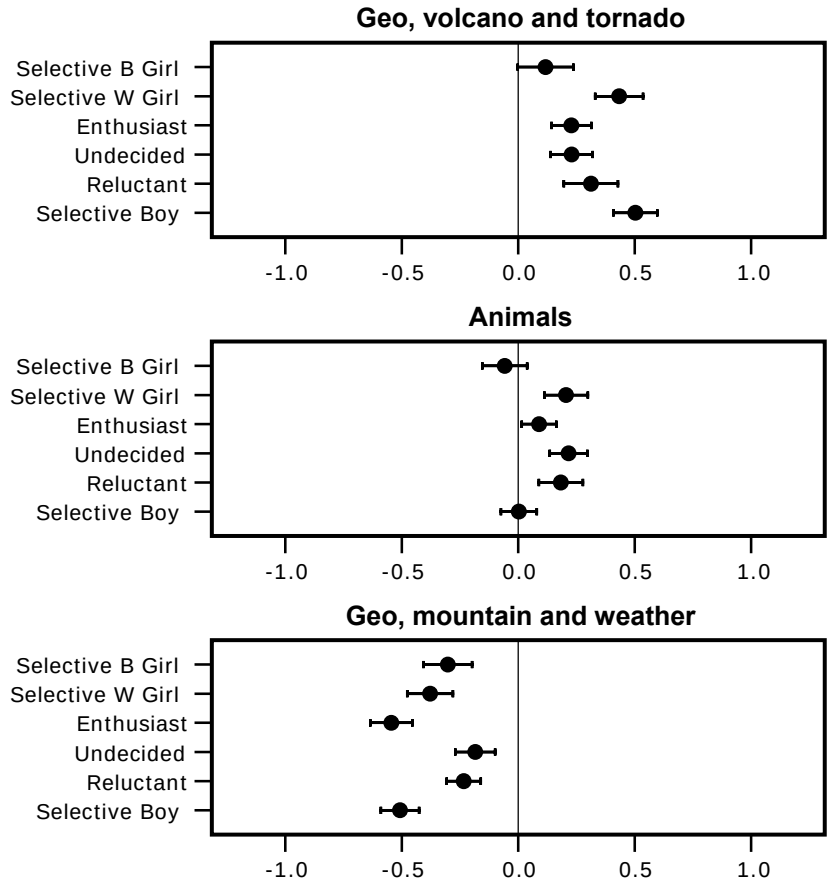



Figure 8-11. Cluster means and 95 percent confidence intervals for the indexes with main loadings in the *Nature* interest orientation.

Like in the *Geo, aesthetics* index above, also these indexes do not display clear characteristics of cluster differences.

More noteworthy is the inequality of the general score levels for the indexes; with the *Geo, volcano and tornado* index scoring higher than the *Geo, mountain and weather* index. This may be understood from the component of the *Puzzles* interest orientation in the *Geo, volcano and tornado* index. The Selective Boy and the Selective W Girl express high interest in the *Puzzles* interest orientation. Except from the Selective B Girl, all student types are more than averagely interested in *Puzzles*. The same pattern appears in the *Geo, volcano and tornado* index.

## 8.5 Discussion

In this section, I will extract and discuss some general issues related to the ACE question and the response patterns of the student types. The summary of student types characteristics are postponed to the conclusion in chapter 11.

I have divided the students into five clusters, numbered them from 1 to 5 and labelled them respectively Selective Boy, Unselective Reluctant, Unselective Undecided, Unselective Enthusiast and Selective Girl. The Selective Girl was divided into two sub-clusters: Selective B Girl (expressing most interest in the human body) and Selective W Girl (who in addition to the human body also was interested in wondering about mysteries, the universe, etc.). The algorithm for developing the clusters did not take the sex-variable into account. Nevertheless, two of the clusters were virtually single sexed. These two clusters, Selective Boy and Selective Girl, can be seen as indicators for some archetypal girls' and boys' interests. In the three other clusters, the Reluctant, the Undecided and the Enthusiast, the gender patterns were more indistinct. The most noticeable characteristic of these three student types was rather their stable and distinctive level of interest.

In most of the ACE items, the Reluctant, the Undecided and the Enthusiast are recognised by responses that are heavily weighted in three different parts of the response scale. Figure 8-12, Figure 8-13 and Figure 8-14 show "typical" response patterns for the three clusters: The Reluctant have most responses in the leftmost categories (no or low interest), the Undecided in the two medium categories, while the Enthusiast have highest response frequencies in the two rightmost categories (medium or high interest).

The two other clusters, Selective Boy and Selective Girl, have a more variable response pattern. The mean scores of these clusters are fluctuating, from lower than the Reluctant in some items to higher than the Enthusiast in others (Figure 8-12, Figure 8-13 and Figure 8-14).

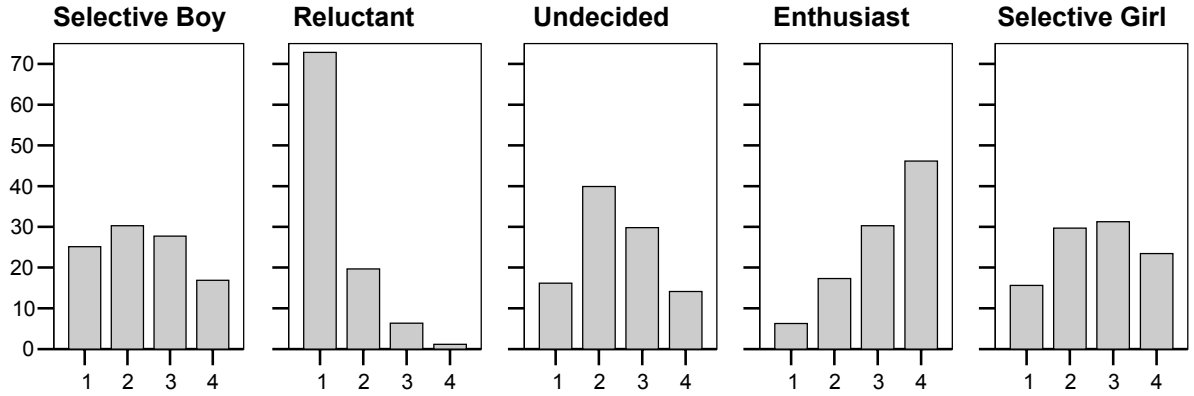



Figure 8-12. Percentage of responses in the response categories 1 (not interested) to 4 (very interested) for item C16 "Why the stars twinkle and the sky is blue".

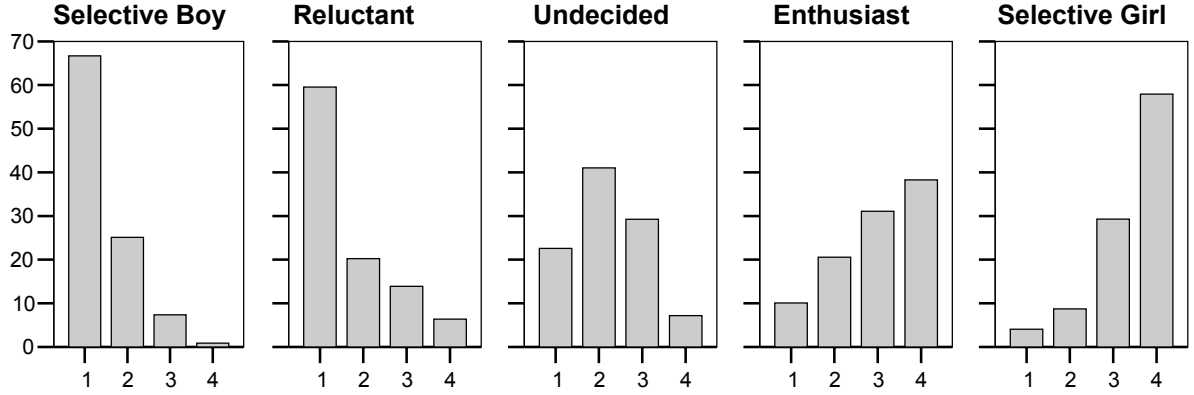



Figure 8-13. Percentage of responses in the response categories 1 (not interested) to 4 (very interested) for item A38 "Eating disorders like anorexia or bulimia".

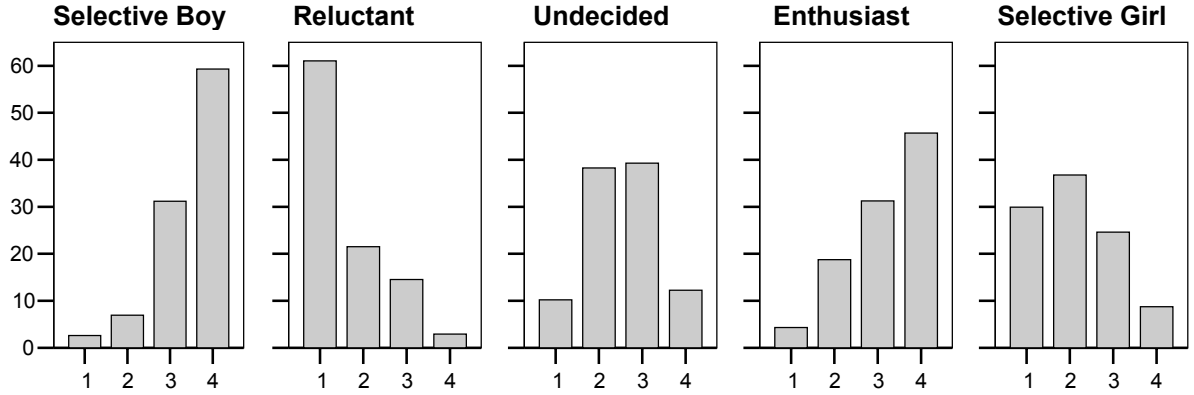



Figure 8-14. Percentage of responses in the response categories 1 (not interested) to 4 (very interested) for item A44 "Rockets, satellites and space travel".

At this point, my conclusion could be that in order to understand students' interests in science, we need to know *other* characteristics than their sex. We need to know what kind students they are (expression inspired by Brickhouse & al., 2000).

Because the interest profiles of the three Unselective student types, the Reluctant, the Undecided and the Enthusiast appeared as a conglomerate of the interest profiles of the Selective Boy and the Selective Girl, I experimented with the three clusters: The ACE scores of the Reluctant, the Undecided and the Enthusiast clusters were standardised to the same interest level, merged into one group of students and subsequently divided into two clusters. The two new clusters were relatively sex-specific. These clusters were labelled

Unselective Boy and Unselective Girl. The ACE mean scores of these two clusters showed patterns that were strikingly similar to the corresponding gender profile for the two Selective student types, although with a more stable and regular pattern. I see the clusters and their interest profiles as evidence for that interests in ACE topics are strongly related to sex.

This means that I have to adjust the tentative conclusion above: In order to understand students' interests in science, we need to know *more* than their sex. We need to know what kind of boys or girls they are.

### 8.5.1 Common Bottom and Top items

As described above, the same response pattern for the Reluctant, the Undecided and the Enthusiast student types reappear in almost all items. But there are some exceptions. Figure 8-15 shows an example of an item provoking low interest among all student types. Even though the Undecided and the Enthusiast do not reach the same one-sided profile as the Reluctant, the response cargoes in the two clusters have shifted somewhat leftwards. Also the Selective Boy and Selective Girl have high response frequencies in the two leftmost categories. This is a low-scoring item in all five clusters; appearing in all three Bottom 30 lists.

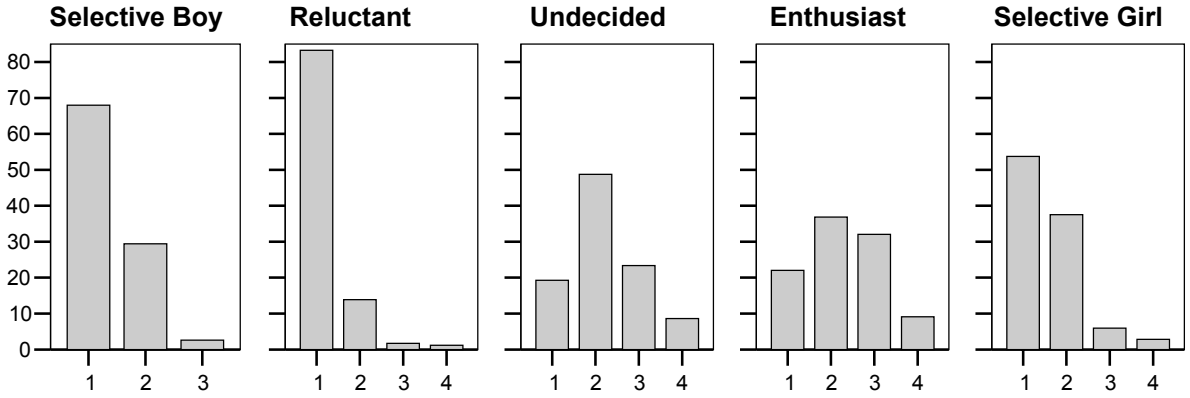



Figure 8-15. Percentage of responses in the response categories 1 (not interested) to 4 (very interested) for item E25. "Plants in my area". The Selective Boy diagram has only three bars due to no responses in category 4.

One Bottom list contains 30 items, and more than half of these appear in all three Bottom lists (asterisked items appeared within one standard deviation from the mean in one or more of the Bottom 30 list):

A04* How mountains, rivers and oceans develop and change
A15. How plants grow and reproduce
A21* How different musical instruments produce different sounds
C01. How crude oil is converted to other materials, like plastics and textiles
E01. Symmetries and patterns in leaves and flowers
E04* The greenhouse effect and how it may be changed by humans
E17* How to improve the harvest in gardens and farms
E19* Organic and ecological farming without use of pesticides and artificial fertilizers
E22* How different sorts of food are produced, conserved and stored
E25. Plants in my area
E26. Detergents, soaps and how they work
E33. Benefits and possible hazards of modern methods of farming
E34* Why religion and science sometimes are in conflict

E36. Why scientists sometimes disagree
E37. Famous scientists and their lives
E39. How scientific ideas sometimes challenge religion, authority and tradition

Two themes from the factor structure in 7.4 are strongly represented here, namely the *Farming and advancing nature* theme (item E17, E19, E33) and the *Science and scientists* theme (item E34, E36, E37, E39). Among the remaining items, we have E04 regarding the greenhouse effect and three items regarding plants (A15, E01 and E25).

The items in this list are among the ACE variables with the lowest variances, ranging from .41 in item E01 to .98 in item A21. (The maximum variance among the items in question ACE is 1.52. Standard deviations are reported in Appendix C.) Low variance in the total sample means that the respondents are relatively unison in their expression about an item. Variances in the separate clusters are often even smaller, for example dropping to .15 in the Reluctant for item E37.

A corresponding shift of the weight of the responses is found for some high-scoring items, for example for item A40 (Figure 8-16). Here, the responses in the Reluctant and Undecided are displaced rightwards. Although they do not reach an "Enthusiast" profile, the responses are different from the "typical" Reluctant and Undecided response patterns. The item in the figure appears in all four Top 30 lists (within one standard deviation from the mean for the Selective Boy, though).

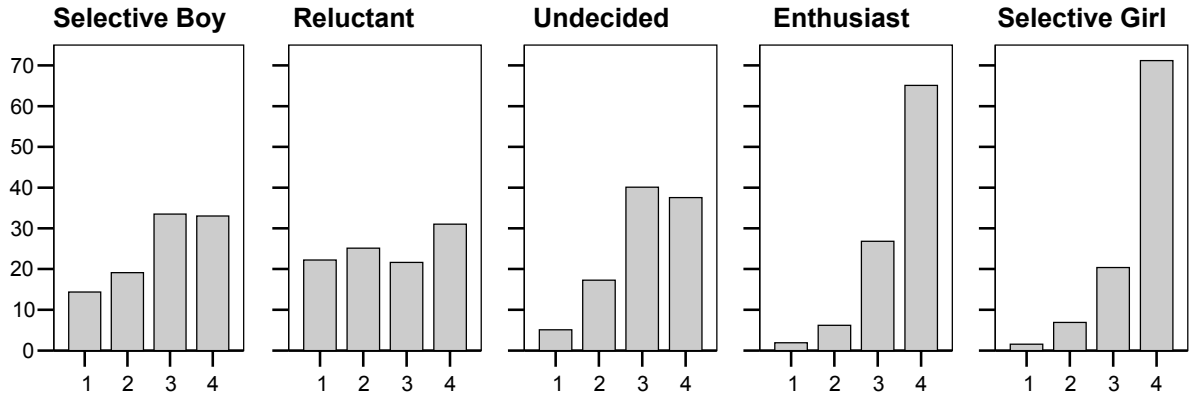



Figure 8-16. Percentage of responses in the response categories 1 (not interested) to 4 (very interested) for item A40. "How to exercise to keep the body fit and strong".

Compared to the Bottom lists, there is only a limited number of shared items in the Top 30 lists (asterisked items appeared within one standard deviation from the mean in one or more of the Top 30 lists):

A34* How it feels to be weightless in space
A40* How to exercise to keep the body fit and strong
C08* The possibility of life outside earth

Due to separate lists for the two sub-clusters of the Selective Girl, there are totally four Top 30 lists versus three Bottom 30 lists. This can partly explain why the list of shared items is relatively short. Therefore, with the purpose of comparing the Top 30 lists on equal terms with the Bottom 30 lists, I will exclude the Top 30 list of the Selective B Girl

from the cross-reading of the tables.[75] In addition to the three items above, the list of common items in the Top 30 lists of the Unselective, the Selective Boy and the Selective W Girl is expanded with the following items:

A22* Black holes, supernovas and other spectacular objects in outer space
A23. How meteors, comets or asteroids may cause disasters on earth
A25* Tornados, hurricanes and cyclones
C10* Unsolved mysteries in outer space
E42. Phenomena that scientists still cannot explain

Among these altogether eight items we find unexplained phenomena (E42), hurricanes and tornados (A25) and exercising for fit body (A40) and five items in the *Universe and enigmas* theme (C08, C10, A22, A23, A34). Still, the number of common items in the three Top lists is considerably lower than in the Bottom lists.

The number of common items in the Bottom lists is double the number of common items in the Top lists. One interpretation of this may be that the Top lists have more capacity to discriminate and describe student types than the Bottom lists. Furthermore, one could argue that statements about *interests* are more powerful tools for identity expressions than statements about *lack of interest*.

Issues related to the questionnaire design can of course counter this argument: Assuming that none of the items in the list of common Bottom items were retained after the process of developing the questionnaire – would the common items in the adjusted Bottom lists then still outnumber the Top lists? The answer to this question lies in the data, but I will not pursue this issue any further here.

### 8.5.2 Interests and identity

Interest scores in subject matters raised by the ACE question can be understood through other fields of theory than youth research and identity construction. Youth's interest in science can be explained, for example, by theories in biology, or cognitive or social psychology. As accounted for in chapter 1, I wish to see the responses in the ACE question through lenses of the modern project of identity construction. As the ROSE instrument is not developed with the goal of tapping into this particular field, my theoretical framework may be perceived as somewhat strained. I will see responses as identity expressions, although I pragmatically realise that some items will function for this research aim, while others will not. Not all ACE items have the capacity to tap into issues of youth identity. A person may perceive topics as interesting or uninteresting *per se*[76]. In such cases, interpretations about identities or student types would be to misuse the data and to push the concept of interests too far.

[75] As the Top 30 list of the Selective B Girls virtually contains only items regarding the human body and health (see 8.2.2), this cluster appears with the narrowest interest variety. Especially the Selective Boy and the Selective B Girl display different interests: apart from the three items in the list above, the Top 30 lists of these two clusters only share item C06 (mobile phones).

[76] Here, I am discussing responses on the level of individuals. Naturally, no topic is *de facto* interesting or uninteresting. Cross-cultural analysis of the responses in the ACE items shows that low-scoring items in one culture may achieve high values in others. Even within the Norwegian context, there are differences of opinion.

For example, for some students the low-scoring items E26 (detergents and soaps) and E25 (plants in my area) may simply be a couple of very boring subjects; beyond any identity linkage. The same can be said about high-scoring items, for example item A34 (weightless in space). The topic may simply be an inspiring supposition, regardless of their identity. This line of thought could of course be followed through the whole ACE question; to topics of mobile phones, explosive chemicals, the human body, animals, nature, etc. However, my assumption is that some interest expressions can also be read as identity expressions. For example, when the Selective W Girl expresses high interests for item C11 (human soul) and E16 (protect endangered animals), this may arise from her desire to define and express who she is. On the other hand, her high interest in item A34 (weightless in space) may simply have its origin in the nature of the topic; the item may provoke her interest without any particular connection to her identity. This means that a high interest score in some cases may mean a nod (*ok, this seems interesting...*), while in others it represents an identity expression (*yes! I am very concerned about exactly this issue!*).

In section 1.5, I discussed whether negative interests exist: Does the quantity of interests lie on a scale from zero and upwards, or on a scale from negative to positive? I assume that in the head of the students, both scales act interchangeably. In some items, for example in item E26 (detergents and soaps), the Selective Boy may check the leftmost category simply because the topic seems boring, or *zero interesting*. In other items, for example in item C12 (alternative therapies) the Selective Boy may check the same leftmost box; but now because he wishes to express rejection of an identity, or a *negative interest* (or a negative attitude). In the former case, the low interest represents only a shrug (*nope, this seems boring...*), while in the latter it is a declaration of incongruous identities (*no! this kind of stuff is just not me!*).

These interpretations of student responses mix up the two concept *interest* (going from zero and upwards) and *attitudes* (going from negative to positive) (see 1.5). The questionnaire requested the *interest* of the students by asking *How interested are you in learning about the following?* Consequently, I have referred to responses in this question as students' *interests*.

As seen from chapter 2, identity expressions involves not only an indication of who one *is*, but also an indication of who one is *not*. Lack of interest in a subject can therefore be seen as a person turning one's back on the matter and as a rejection or a discard of the identity connected to persons who are interested in the subject. By stating lack of interest, a student may put a distance between her/himself and incongruous identities. Furthermore, expressions of high interest may be seen as signs of the identity one has, or wants to have. Based on the perspectives of interests and identity described here, I will interpret some of the responses in the ACE items as identity expressions and identity rejections.

The meaning students inject into their responses may not only change from one item to another, but also from one student to another. I cannot see how it would be possible to demarcate the *per se* boring/interesting items from items that are more connected to youth identity, or differentiate between students declaring their interests and students proclaiming parts of their essential selves. Thus, the common items in 8.5.1 will

undoubtedly function more as constants than as variables for characterising the student types. Or, stated differently: the more unique and the more pronounced the interest orientations and interest rejections are, the larger potential they have for portraying distinctive student types and identities.

The next step in this discussion would be to connect the interest of the five clusters to descriptions of student types and youth identities. However, before addressing this issue, I will investigate responses of the five student types in other parts of the questionnaire. The purpose of the coming chapter is to achieve a broader description and a better understanding of the student types, and to learn more about their relation to science and science education.

# 9 MORE CHARACTERISTICS OF THE STUDENT TYPES

This chapter refers to research objective

*III Describe the student types' relations to some other aspects of science and science education*

In the previous chapter, I applied the ACE question for portraying five types of Norwegian students. In this chapter, I will continue the descriptions of the student types by using other parts of the ROSE questionnaire as descriptive tools. Here I will touch upon these student types' more general view of science in society, their perceptions of their science classes, issues of societal priorities, environmental protection and wishes for their future job.

The approach to the data in this chapter is somewhat different from that in the previous. This chapter is more superficial, descriptive and incoherent. In the previous chapters, I started with all the 108 items in the ACE question, and filtered items out through the process of item validation. Here, I have a more pragmatic approach. I will pick and choose items that I find interesting and that show good statistical properties, but I will not describe and justify reasons for excluding items from the analysis. There may be several reasons for leaving items out. For example, the responses may not be interesting in terms of describing cluster *differences*, I may question what meaning the students have made of the items, or I may find it hard to connect the items to discussions about late modern student types. Item G16. *Scientific theories develop and change all the time* is one example of an item that was excluded due to the latter argument. This item taps into students' understanding of the nature of science, and has a right and a wrong answer. Although one might find that there is a relationship between students' cognitive understanding and their identities, my focus is directed towards questionnaire items that are closer related to *interest* and *attitudes*. One last reason for leaving items (and whole questions) out from this chapter is related to the volume of this thesis. The ROSE questionnaire addresses many interesting issues, but discussing them all would outsize the thesis.

In chapter 6, the clusters were formed on the basis of different response patterns in the ACE question. This means that in chapter 8 (with descriptions of the student types' interests) one would *expect* to find that scores in most ACE items differed from one student type to another. However, one cannot take for granted that corresponding student type differences will appear in other parts of the questionnaire. Some items discriminate the student types better than others, and therefore have a larger capacity for describing typical traits of the student types. In this sense, some items are more suitable for characterising the student types than others. When the student types scores in an item are similar to one another, the item functions, in the context of my research aims, as a constant rather than as a variable. Some places in this chapter, I will touch upon common views held by the student types, but in general, I will pay more attention to variables that are suitable for telling the clusters apart.

In the following analysis, I will return to the raw data. Furthermore, I will study the Enthusiast, the Undecided and the Reluctant clusters separately. The two Selective Girl sub-clusters do not show substantially and pedagogically interesting differences in most of the questions. Consequently, they are reunited.

In question D, F and G, the students gave responses to various statements in a four-point scale ranging from *Disagree* (coded 1) to *Agree* (coded 4). This means that 2.5 is the middle of the scale. I will interpret cluster mean values close to 2.5 as students in the cluster averagely neither agreeing nor disagreeing with the statement; i.e. the student type remains neutral. The response scale does not have any category for the neutral middle. This means that response *frequencies* (instead of mean values) lack neutral values. When reporting frequencies, I will interpret responses in the categories coded 1 and 2 as signifying *strong* or *part* disagreement, and responses in categories coded 3 and 4 similarly as *part* or *strong* agreement. I will refer to the sum of the frequencies in the two categories on each side of the neutral middle as *disagree* and *agree*.

In most instances, I will present the data through error bar diagrams, indicating mean scores and 95 percent confidence intervals. Also in this chapter, I have developed indexes (see 5.6 about advantages and challenges connected to use of composite variables). In section 7.1, I concluded that the framework that was used during the development of question ACE was a useful tool for developing the items, but not an interesting point of departure for the data analysis. Corresponding frameworks were used for developing the items in question B and D (see 4.5.3 and 4.5.4). Neither these frameworks will be used in the forthcoming analysis. Like in chapter 7, the items constituting one composite variable will emerge from exploratory factor analysis, accompanied by tests for unidimensionality and internal consistency (according to the procedure and the criteria described in 5.6). Alpha for the index is reported in the caption for the index error bar diagrams. Mean values and standard deviations for the items that will be discussed in this chapter are reported in Appendix D.

The statistical significance of the differences in item or index scores can be examined through the error bar diagrams. If the confidence intervals of two student types do not overlap, one can interpret that the differences probably have not occurred in the sample by chance (see 5.1.2).

## 9.1 Science in society

Ulrich Beck sees nuclear, chemical, genetic and ecological risks as direct or indirect side-effects of scientific and technological development (see 2.3.3). In attempts to understand the falling recruitment to studies in science and technology, one hypothesis is related to the damaging and hurtful implications of scientific and technological developments (see 3.1). Science and technology are perceived as cold and inhuman, the cause of the pain on Earth, the root of mega-wars, the cause of environmental problems and the ruthless exploitation of natural resources, etc. If young people perceive science as the cause of modern catastrophes and hazards, it should not surprise us that they prefer involving themselves in other and maybe more meaningful subjects. Studies of students' drawings of

scientists at work give some support to this view. The SAS study found that only students in Western countries drew the cruel, gruesome and crazy scientist (Sjøberg, 2002b).

Question G probes different aspects of how students perceive the role and function of science and technology in society. We do not know what understanding the students have of the concept *science and technology* (see 4.3.7), but I assume that the different student types all put the same meaning in the concept, so that cluster comparisons are valid.

Figure 9-1 shows responses in an index labelled *Science benefits society,* which is developed from items connected to the discussion outlined above (se item list in the caption).

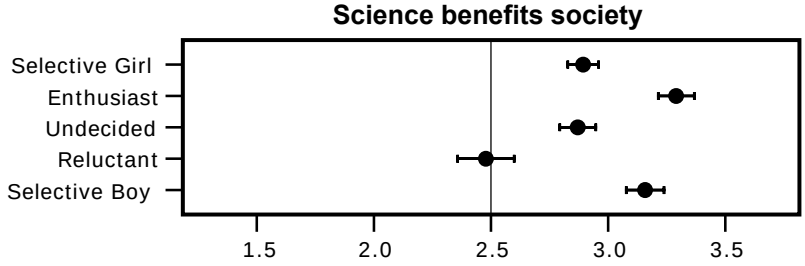



Figure 9-1. Cluster means and 95 percent confidence intervals for the index calculated from the following items (alpha .81):
G01. Science and technology are important for society
G02. Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.
G03. Thanks to science and technology, there will be greater opportunities for future generations
G04. Science and technology make our lives healthier, easier and more comfortable
G05. New technologies will make work more interesting
G06. The benefits of science are greater than the harmful effects it could have

The Reluctant student type is far less positive towards the benefit of science in society than the other student types are. The mean score of the Reluctant lies around the neutral 2.5 line. The Undecided and the Selective Girl are modestly positive, while the Enthusiast and the Selective Boy are more positive.

Responses at item-level show that as much as 66 percent of the students in the Reluctant cluster agree that *Science and technology are important for society* (G01), while 92 percent of the Enthusiast students agree to the same statement. In short, the vast majority of the students in all clusters agree to this statement.

The picture is, however, not that unambiguous and simple for all items in the index. Only 55 percent of the students in the Selective Girl cluster and 40 percent of the Reluctant say that they partly or strongly agree that *The benefits of science are greater than the harmful effects it could have* (G06).

In the company of these items, item G02. *Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.* appears as the most acceptable statement. Especially in the Selective Girl cluster, there is a jump in the proportion of students agreeing with the statement, with 87 percent agreeing. In the previous chapter, this student type appeared as the one with the highest interest in the human body and health. Here the Selective Girl appears as the student type with the strongest belief in science and technology as means for finding cures to diseases.

## 9.2 Goals for society

When asking students about the importance, benefits and hazards related to science and technology in society, a natural follow-up question can be: What are important goals for a society?

One question in the Norwegian version of the ROSE instrument is an inventory of goals for a society. The students were asked to indicate how important they found each goal. In a universe of thinkable tasks and ambitions for a society, the item sample in this question is naturally small and unrepresentative. I will, nevertheless, take a closer look at responses in these items.

Nearly all items in this question achieve high scores. The grand mean in the total sample is 2.93, which means that the students find most of the issues is this question important for our society. Like in the ACE question, the Reluctant is in general more aloof, with a grand L mean at 2.60, while the Enthusiast has the highest mean at 3.17. The Selective Girl, the Selective Boy and the Undecided lie close to the total sample mean.

| | mean |
|---|---|
| L16. Provide a society free from drugs | 3.38 |
| L14. Enhanced emphasis on education and better schools | 3.34 |
| L12. Lower taxes and duties | 3.25 |
| L03. More emphasis on medical research (e.g. on cancer and HIV/AIDS) | 3.23 |
| L11. Eradicate all forms of poverty and distress in Norway | 3.18 |
| L05. Give the elderly safe and decent conditions | 3.11 |
| L04. Protect the environment against pollution | 3.08 |
| L06. Preserve law and order | 3.05 |
| L15. Give economic support to poor countries | 2.87 |
| L02. Protect untouched Norwegian nature | 2.85 |
| L09. Provide protection of our big predators | 2.82 |
| L01. Achieve high economic growth | 2.80 |
| L07. More emphasis on research on new technology | 2.76 |
| L13. Use sex quotas to have more women in senior appointments | 2.76 |
| L08. Bring in prohibition of smoking | 2.53 |
| L10. Prepare Norway for welcoming more refugees and immigrants | 1.87 |

Table 9-1. Total sample means for question L. *Important goals for society*. The items are sorted according to descending mean values.

Table 9-1 shows the 16 societal goals ranked in order to total sample mean score. The highest priority seems to be given to items that address national issues related to youth's own life and future. Issues as preventing drugs, emphasis on education, lower taxes, medical research and national welfare and security may have in common a relationship to individual life risks.

The item rank for the five student types separately are in many respects similar to the total sample rank in Table 9-1, but with some exceptions. From before (8.1.1 and 8.4.4), we know the Selective Boy as very interested in technology. This engagement shines through also in this question. Item L07 (research on new technology) ranks as number four for the Selective Boy, while all the other student types place this item closer to the bottom of their priority lists. The Selective Boy's top-priority is item L12 (lower taxes), and next L16 (society free from drugs) and then L14 (emphasis on education). These

three items are identically ranked by the Reluctant. The Undecided places the same three items at the top, although item L12 (lower taxes) ranks below the two others. Other studies (e.g. Hellevik, 1996) find that boys are more infected by the affluence race than girls are.

At the top of the Selective Girl's list, we find item L03 (medical research). In previous sections (8.2.2, 8.4.1 and 9.1), we have seen this student type as the one with most interest in human health and with strongest belief in research for meeting health problems. The top priority to medical research in this question may be seen as another sign of this student type's general health concern. The second and third ranks in her list are, as for the Selective boy, to provide a society free from drugs (L16) and to put more emphasis on education (L14). Similarly, the Enthusiast places these three items at the top, although item L14 (emphasis on education) is ranked above the other two items.

Both for the Selective Girl and the Selective Boy, item L04 (protect the environment) is positioned lower than its rank in the list for the total sample (Table 9-1), while the Undecided and the Enthusiast give higher priority to this item. These were also the student types giving the highest interest scores to the *Environmental protection* index in the *Concern* interest orientation in 8.4.2. The Selective Boy prioritises for example economic growth (L01) before environmental protection (L04).

The Selective Girl prioritises item L13 (sex quotas) higher than the other student types. As this cluster consists of almost only girls, the high priority of this item falls into line with the other top-ranked items related to personal future risks. In spite of the larger proportion of girls in the Enthusiast cluster than in the Reluctant and the Undecided clusters, item L13 (sex quotas) is not ranked higher for the Enthusiast than for the two others.

For the Enthusiast, item L12 (lower taxes) is ranked far down in the list of important goals for our society, while, as described above, this item is in the top of the lists of the Undecided, the Reluctant and the Selective Boy. The Selective Girl places this item somewhat lower, but not as low as the Enthusiast.

For all student types, the scores on the item for giving economic support to poor countries (L15) are much higher than for welcoming more refugees and immigrants to Norway (L10). Above, I have argued that youth's top priorities in this question may be related to their need and wish for safeguarding their personal future. This perspective may be extended to the responses in these two items. Welcoming more refugees is more likely to threaten youth's personal success and happiness in life. Immigrants will be candidates in the same labour, love and housing market. The cause of the low scores in item L10 is probably very complex, but one part of it may be that they perceive immigration as a threat for their personal life.

## 9.3 Science classes

Question F provides information about different aspects of the students' perception of their science classes. As mentioned earlier, many items in the questionnaire do not have the ability to tell the clusters apart. But in this question, there is a considerable range in cluster mean scores in all items. This means that there is a relationship between the interest

profiles in question ACE and the scores in question F about their science classes. Through all items, the Enthusiast is the most positive and the Reluctant the most negative.

36 percent of the students in the Reluctant cluster answer that they agree that everybody should learn science at school (F06). The corresponding number for the Enthusiast cluster is 86. Furthermore, 90 percent of the students in the Enthusiast cluster agree that *School science is interesting* (F02), while 44 percent of the Reluctant students agree. Mean cluster scores for this latter item are shown in Figure 9-2.

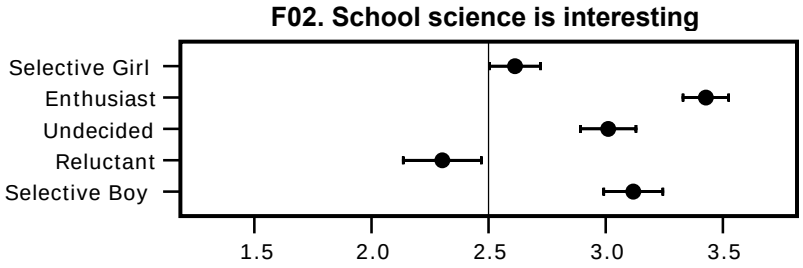



Figure 9-2. Cluster means and 95 percent confidence intervals for item F02.

I see this figure as giving a rather positive and hopeful contribution to the discussion in the science education community about students' disenchantment with school science. The Reluctant and the Selective Girl express the most negative views, but still the scores of the Selective Girl is on the right side of the neutral line. The mean score of the Reluctant is on the other side, but relatively close to the neutral line. Although the Reluctant is far from expressing enthusiasm about the subject, s/he does not express clear dissatisfaction either. From chapter 6 and 8, we have seen that through the entire ACE question, the Reluctant express very low interest in science-related topics. In spite of this, more than every third student in this cluster have ticked one of the two response categories indicating agreement with *I think everybody should learn science at school* (F06). And not far off half of the students in the Reluctant cluster answered that they strongly or partly agree that *School science is interesting* (F02).

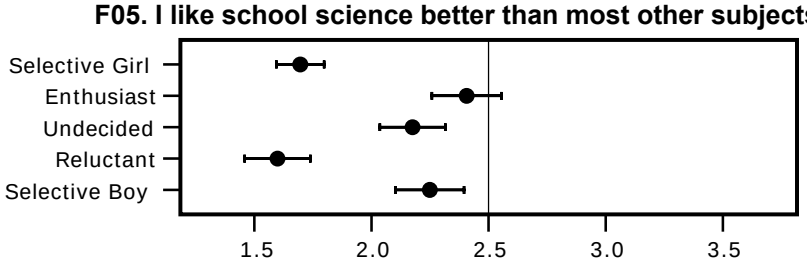



Figure 9-3. Cluster means and 95 percent confidence intervals for item F05.

However, when compared to other school subjects, it seems like science cannot compete. The majority of the students do not like school science better than most other subjects (F05, Figure 9-3). Among the Reluctant and the Selective Girl students, only 19 and 21 percent, respectively, agree with this statement. The percentages among the Selective Boy and the Undecided are 40 and 38. The low enthusiasm among the Reluctant students was perhaps to be expected. After all, these students have given a very dull testimonial about science so far. On the other hand, one might expect the Enthusiast students to be aspiring scientist – they have consistently shown very positive attitudes to science and technology:

They are interested in learning about most of the ACE topics, they assent to positive statements about the role of science in society, and they find their science classes very interesting. Nevertheless, only 47 percent of these students agree that they like science better than most other subjects. Most of these students are probably very positive to other school subjects as well.

Some of the items in the F question are statements about various qualities that the students may have developed (in part) from their science classes. The intention of these statements was to provide empirical data on what kind of Bildung students report that school science facilitates or provides. However, it seems like some items tap into (at least) two different aspects. One is naturally connected with the science classes, and maybe consistent with the intention of the items. The other is more related to aspects of interests and identity. Students who perceive themselves as possessing a particular quality tend to express and show this attribute through agreement with statement addressing the same quality. I will return presently to this issue, with some examples.

| | Selec-tive Boy | Reluc-tant | Unde-cided | Enthu-siast | Selective | |
|---|---|---|---|---|---|---|
| | | | | | W Girl | B Girl |
| F07. The things that I learn in science at school will be helpful in my everyday life | 66 | 32 | 70 | 84 | 60 | 51 |
| F10. School science has increased my curiosity about things we cannot yet explain | 64 | 25 | 59 | 86 | 69 | 44 |
| F11. School science has increased my appreciation of nature | 32 | 16 | 53 | 75 | 36 | 29 |
| F12. School science has shown me the importance of science for our way of living | 42 | 13 | 53 | 79 | 35 | 30 |
| F13. School science has taught me how to take better care of my health | 36 | 28 | 65 | 71 | 53 | 63 |

Table 9-2. Percentages of students in each cluster strongly or partly agreeing with the statements.

Figure 9-4 shows mean scores for the five clusters on an index calculated from the items in Table 9-2. The index covers far from all possible aspects of what the index label *Useful science classes* indicates, so the label must rather be seen as a common denominator for the few items in the index. The index scores show that the Enthusiast agrees, while the Reluctant disagrees. The other three student types are closer to the neutral line.

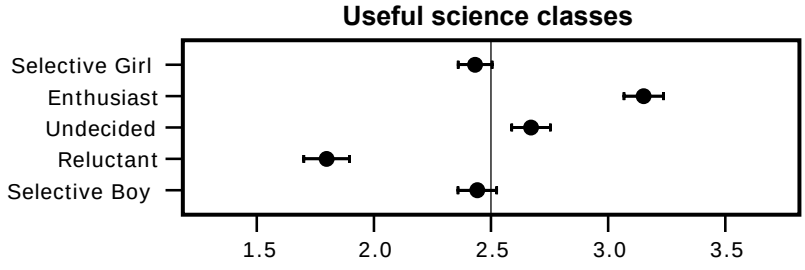



Figure 9-4. Cluster means and 95 percent confidence intervals for the index calculated from the items in Table 9-2 (alpha .79).

Responses at item-level (Table 9-2) indicate that the responses are influenced by the interests and the identity of the students. I will exemplify this with some response differences between the two sub-clusters of the Selective Girl. In contrast to most of the other items dealt with in this chapter, the responses from these two sub-clusters do show some interesting differences in these items.

The mean score differences for the Selective W Girl and the Selective B Girl in item F10 (*School science has increased my curiosity about things we cannot yet explain*) are statistically significant at the .01 level. In the Selective W Girl cluster, 69 percent agree that school science has increased their curiosity about unexplained phenomena, while the percentage among the Selective B Girl is 44. From chapter 8 we know that the Selective W Girl possesses a particular curiosity about things we cannot yet explain.

One interpretation of these responses, which I doubt is the most valid one, is that their curiosity is developed and stimulated by school science. An alternative interpretation is that the item taps into youth identities, and that the students partly respond according to qualities they believe that they posses. Item F10 (*School science has increased my curiosity about things we cannot yet explain*) is the item in Table 9-2 with the highest agreement rate among the students in the Selective W Girl cluster. The Selective W Girl perceives herself as curious about mysteries and unexplained phenomena. Her interest has probably some of its origin in conditions outside the science classroom, and her agreement with the statement may be understood as the following: In addition to school science stimulating her interest, she wishes to express that this curiosity is a part of her identity. A third interpretation may be that the science classes are perceived as useful only when the teaching addresses subjects she finds interesting.

Along the columns in Table 9-2, we see indications of the same mechanism for the Selective Boy. In chapter 8, he expresses interest about the enigmas and the universe, and he shows a relatively high agreement rate in item F10.

Responses in item F13 show a corresponding example. Although both the Selective W Girl and the Selective B Girl are interested in the human body and health, this interest is more pronounced by the Selective B Girl (see 8.2.2). Some of the health knowledge held by the Selective B Girl can, naturally, be ascribed to her science classes. However, I perceive it as likely that this young girl in our modern information society has developed significant knowledge about her chosen issue also outside school. 63 percent of the students in Selective B Girl cluster agree that *School science has taught me how to take better care of my health* (F13). This is the item with the highest agreement rate among the students in the Selective B Girl cluster. The percentage for the Selective W Girl is 53.

A similar chain of thoughts may partly account for the responses in F11. *School science has increased my appreciation of nature*. None of the student types showed high interests in the ACE indexes sorted under the *Nature* interest orientation in chapter 8. The low agreement rates in item F11 can be perceived as consistent with the low interest.[77]

Regrettably, the F question lacks more items related to the specific interests of the Selective Boy, for example items addressing whether science at school has developed their knowledge about advanced technology. Such items could have further expanded our understanding of these items; for instance, we might then have seen that this student type expressed relatively strong agreement with statements about the usefulness of school science for developing their technological knowledge and skills.

[77] Naturally, this touches on the hen-and-egg discussion, about whether it was the science classes that did not succeed in developing the students' interests in nature, or it is modern youth that have little curiosity about nature and therefore cannot see that their science classes has increased their appreciation of nature...

In the *Useful science classes* index, the Selective Girl and Selective Boy show the same level of agreement (Figure 9-4). However, since this index lacks items more closely related to the interests of the Selective Boy, the scores cannot be generalised to express the extent to which the two clusters perceive their science classes as useful. The responses from the Reluctant, the Undecided and the Enthusiast are perhaps more generalisable. In contrast to the Selective Girl and the Selective Boy, these student types do not have fluctuation interests: Their responses follow the same pattern through all the five items in this index.

Item F01 (*School science is a difficult subject*) and F03 (*School science is rather easy for me to learn*) address the difficulty level of the subject. In the index *School science is easy* (Figure 9-5) item F01 is inverted due to negative wording.

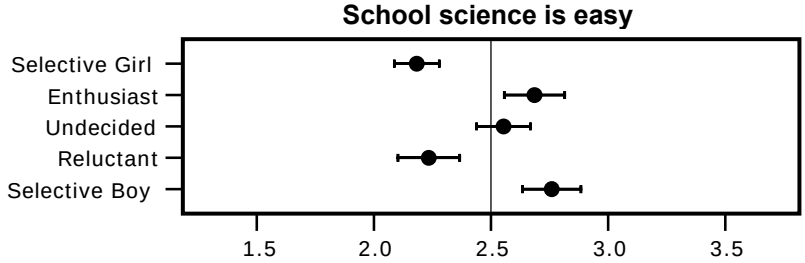



Figure 9-5. Cluster means and 95 percent confidence intervals for the index calculated from the following items (alpha .77):
F01_inv. School science is [not] a difficult subject
F03. School science is rather easy for me to learn

The Selective Girl and the Reluctant give the lowest scores in this index, implying that these students find school science most difficult.[78] However, all cluster means lie relatively close to the neutral line, indicating that the student types do not have strong expressions about the difficulty level of the subject.

## 9.4 Personal involvement in environmental protection

As described in 4.5.4, some items in the D question were initially developed with the intention of measuring some specific aspects of students' attitudes towards environmental protection. In order to prevent response biases and thereby strengthen the reliability of the measures (Horan, DiStefano & Motl, 2003), we used the strategy of addressing the same issue with some items positively, and some items negatively worded. However, exploratory factor analysis did not confirm the existence of the intended underlying variables. Factor analysis sorted the items in two separate factors: positively worded statements in one factor and negatively worded items in another. This is a well known effect of wording (see e.g. Horan & al., 2003; Marsh, 1996). However, the interpretation of the result is still undecided. Is the wording effects a systematic irrelevant methodological artefact? Or are there substantive conceptual differences between negatively and positively

[78] The TIMSS study has found that, although differences in Norwegian girls' and boys' *performance* in science are very small, Norway is among the countries in the study with the largest gender differences in students' *self-perception* (Grønmo & al., 2004; Lie & al., 1997).

worded items? Or may it be that this division of negatively and positively worded statements stems from response styles and personality traits of the respondents?

I will not go far into this discussion here, as I do not see it as crucial for my research. Through conceptual analysis of the items in the two factors, I perceive the two factors as substantially meaningful. Item D01, D03, D08, D09 and D13[79] had their main loadings in the same factor, and seem to have in common a *lack of concern* for the environmental issue. The items express that the environmental problems are exaggerated, and that people overstate these problems. Students agreeing with these items put a distance between themselves and the environmental issue: If at all necessary, it is the task of somebody else to solve the problems.

The positively worded items are describing a *personal involvement* in the issue. These items express willingness to act, that it is still possible to overcome the problems, and that every individual can make an important difference (the items are listed in the caption of Figure 9-6).

Alpha is .71 for the personal involvement items, while for the items expressing a lack of concern alpha is below the cut-off point for constructing an index (see 5.6.2). Cluster scores for the *Personal involvement* index show that the students in general express concern about the environmental issue (Figure 9-6). All mean scores are on the agreement side of the neutral line. The issue is, however, of greater significance to the Enthusiast than to the Reluctant. The scores of the three other clusters lie between these.

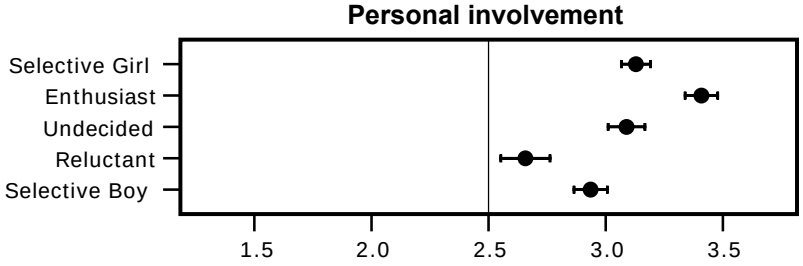



Figure 9-6. Cluster means and 95 percent confidence intervals for the index calculated from the following positive worded items (alpha .71):
D05. I am willing to have environmental problems solved even if this means sacrificing many goods
D06. I can personally influence what happens with the environment
D07. We can still find solutions to our environmental problems
D10. People should care more about protection of the environment
D12. I think each of us can make a significant contribution to environmental protection

Again, we see that the Reluctant exhibits the extreme low mean value, the Enthusiast the extreme high, while the Undecided lie in the middle. Since this pattern is consistently repeated through virtually all the questions studied so far in this chapter, one may question whether the pattern is a matter of systematic response bias. Can it be that the student types steadily tick items in one part of the scale and are relatively unresponsive to the substantial meaning of the items?

[79] D01. *Threats to the environment are not my business*, D03. *Environmental problems are exaggerated*, D08. *People worry too much about environmental problems*, D09. *Environmental problems can be solved without big changes in our way of living* and D13. *Environmental problems should be left to the experts*

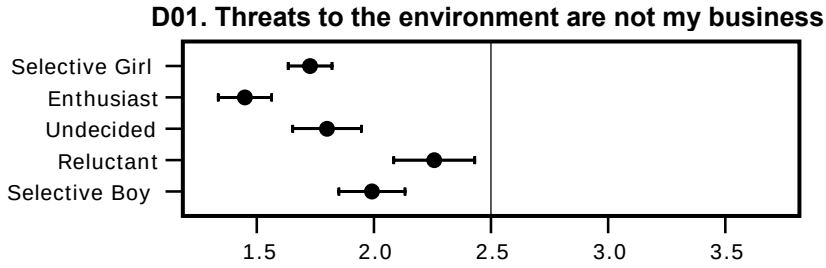


Figure 9-7. Cluster means and 95 percent confidence intervals for item D01.

From Figure 9-7 it is evident that this is not the case[80]. Item D01. *Threats to the environment are not my business* is addressing a similar issue as the *Personal involvement* index, but negatively worded. Figure 9-7 is nearly a mirror image of Figure 9-6, with the responses reversed across the neutral 2.5 line. The correlation coefficient in the total sample for this item and the index is -.40. A similar response pattern, with the Reluctant disagreeing less than the other student types, appears also in the negatively worded items D03. *Environmental problems are exaggerated*, D08. *People worry too much about environmental problems*, D13. *Environmental problems should be left to the experts*.

Consequently, the repeated and uniform responses of the Reluctant, the Undecided and the Enthusiast cannot be explained by a response bias appearing because the students are not applying the whole response scale.

## 9.5 Future occupation

Question B and some items in question F tap into aspects of the students' future choice of education and job, and some criteria for their choice. In this section, I will refer to responses in these questions.

### 9.5.1 Importance for future job

Question B asks the students about their job priorities, and Table 9-4 shows how the students in the total sample prioritise different factors related to their future job. In order to shorten the list of items, simplify the discussion and achieve more reliable scores, some items are transformed into composite variables, or indexes. See Table 9-3 for items, alpha coefficients and index names for the composite variables.

[80] Figure 9-5 also supports this. I inverted item F01 due to negative wording, but I could just as well have inverted item F03. That would have mirrored the diagram, and the Reluctant cluster would have *agreed* that school science is difficult.

| | |
|---|---|
| Bi1. Work with and help people (alpha .80) | B02. Helping other people<br>B01. Working with people rather than things |
| Bi2. Using hands and tools (alpha .85) | B06. Building or repairing objects using my hands<br>B07. Working with machines or tools |
| Bi3. Invent, design, new ideas (alpha .75) | B10. Making, designing or inventing something<br>B11. Coming up with new ideas |
| Bi4. Realise and develop oneself (alpha .71) | B09. Using my talents and abilities<br>B13. Making my own decisions<br>B15. Working with something I find important and meaningful<br>B16. Working with something that fits my attitudes and values<br>B25. Developing or improving my knowledge and abilities |
| Bi5. Reach power and glory (alpha .80) | B24. Becoming "the boss" at my job<br>B21. Controlling other people<br>B22. Becoming famous |
| Bi6. Leisure matters (alpha .64[81]) | B12. Having lots of time for my friends<br>B17. Having lots of time for my family<br>B23. Having lots of time for my interests, hobbies and activities |

Table 9-3. Items forming the composite variables in question B. The letter *i* in the index name denotes that the variable is an index.

| | mean |
|---|---|
| Bi4. Realise and develop oneself | 3.37 |
| B20. Earning lots of money | 3.33 |
| Bi6. Leisure matters | 3.26 |
| B19. Working at a place where something new and exciting happens frequently | 3.14 |
| B26. Working as part of a team with many people around me | 2.96 |
| Bi3. Invent, design, new ideas | 2.79 |
| B18. Working with something that involves a lot of travelling | 2.69 |
| Bi1. Work with and help people | 2.66 |
| B14. Working independently of other people | 2.66 |
| B08. Working artistically and creatively in art | 2.28 |
| Bi5. Reach power and glory | 2.21 |
| Bi2. Using hands and tools | 2.19 |
| B03. Working with animals | 2.06 |
| B05. Working with something easy and simple | 1.99 |
| B04. Working in the area of environmental protection | 1.77 |

Table 9-4. Total sample means for question B. *My future job*. The items are sorted according to descending mean values.

The grand mean for the total sample is 2.62 and, again, the Enthusiast and the Reluctant lie on opposite sides of the total sample mean. The grand B mean for the Enthusiast and the Reluctant is 2.82 and 2.36 respectively.

[81] This index does not satisfy my requirement for internal consistency, as alpha is below the cut-off value .70. This means that this index should maybe not be employed in further statistical analysis. However, for the particular purpose in this section, I found the index useful. In the ranking of the B items, these three items lie in adjacent positions for all the student types. In order to shorten Table 9-4 and the discussion, I have merged the three items into one index.

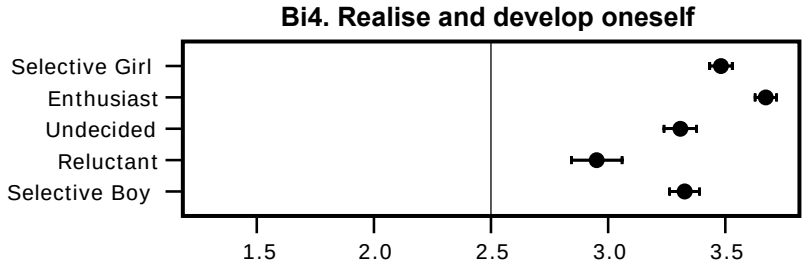



Figure 9-8. Cluster means and 95 percent confidence intervals for the Bi4 index.

Figure 9-8 shows student type scores in the index Bi4. *Realise and develop oneself*. As one can see from Table 9-3, these items carry dimensions that are highlighted and idolised by late modernity, namely the idea of using one's abilities, developing and fulfilling one's potentials in agreement with one's identity. The index achieves high priority from all student types. The Enthusiast, the Undecided and the Selective Girl give top priority to this index, while it is ranked next to the top by the Selective Boy and two places below the top by the Reluctant. (Score differences between the Undecided, the Enthusiast and the Selective Girl may consequently indicate differences in response styles.) The Selective Boy and the Reluctant give highest priority to B20 (earn lots of money).

The top four items in the ranking list in Table 9-4 appear also in the top of the lists for all the student types separately. All of them wish to develop and realise themselves (Ai4) at a place where something new and exciting happens frequently (B19), to earn lots of money (B20) and to have leisure time for their family, friends, interests and hobbies. Furthermore, all of them give high priority to working with many people around them (B26), and all except the Reluctant are eager to invent and design things and to come up with new ideas (Bi3).

Although the five student types in many instances express quite similar priorities for their future job, index Bi2. *Using hands and tools* is an index example that is ranked very differently from one student type to another. For the Selective Boy and the Reluctant, this index ranks just below the six top-scoring items mentioned above, while it is placed at or near the bottom by the Selective Girl and the Enthusiast. On the other hand, the Selective Girl and the Enthusiast give much higher priority to index Bi1. *Work with and help people* than the other student types do. The two following diagrams illustrate their scores in the two indexes.

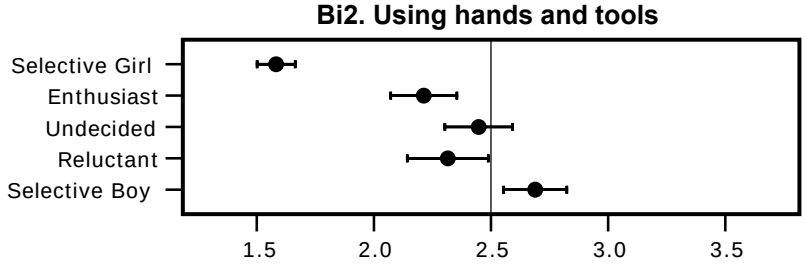



Figure 9-9. Cluster means and 95 percent confidence intervals for the Bi2 index.

In Figure 9-9 the responses of the Reluctant, the Undecided and the Enthusiast break the repeatedly appearing pattern of the Enthusiast scoring higher than the Reluctant, and the Undecided lying between. In this diagram, the Selective Boy gives the highest scores and the Selective Girl gives the very lowest, while the Reluctant, the Undecided and the

Enthusiast give more or less the same score. (Again, we find differences in response styles, as in the ranking lists, the Enthusiast positions this index much lower than the Reluctant.)

This index, *Using hands and tools*, is probably more closely related to boys' than to girls' interest area. Consequently, the cluster response pattern might to some degree have been caused by the unequal proportions of girls and boys in the clusters.

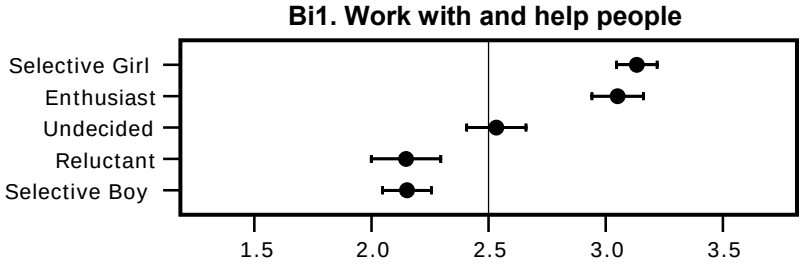



Figure 9-10. Cluster means and 95 percent confidence intervals for the Bi1 index.

The same sex bias may be the case in Figure 9-10, but now towards the girls' area. Here, the scores of the two Selective student types are reversed; the Selective Girl finds it much more important than the Selective Boy to work with people and to help other people. The Selective Girl and the Enthusiast give high scores to this index, while the Selective Boy and the Reluctant lie on the other side of the 2.5 middle line. The Undecided cluster lies between. From other analysis of the ROSE material (Schreiner & Sjøberg, 2005b, 2006a) and from other studies (Angell & al., 2003; Fauske & Øia, 2003; Sjödin, 2001), we know that girls give noteworthy higher priority than boys to working with and helping other people. This might explain the low score of the Selective Boy and the high score of the Selective Girl. The low scores of the Reluctant and the high scores of the Enthusiast can not be explained by the composition of girls and boys in the clusters, because these sex-mixed clusters have roughly the same scores as the two sex-specific Selective student types.

The response pattern emerging from this diagram corresponds well with how this index is positioned in the ranking lists; i.e. in the middle of the Undecided's list, higher in the Enthusiast's and the Selective Girl's list and lower in the Reluctant's and the Selective Boy's list.

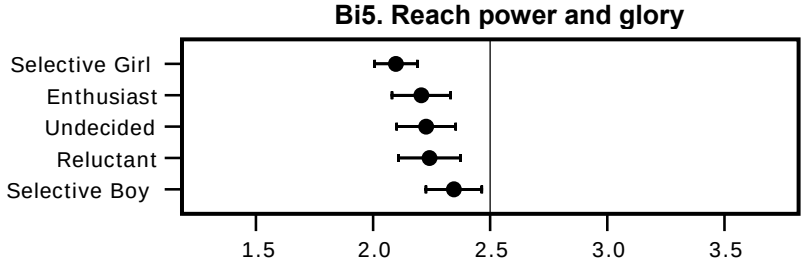



Figure 9-11. Cluster means and 95 percent confidence intervals for the Bi5 index.

Index Bi5 (power and glory) in Figure 9-11 shows average scores at about the same level for all five student types, while the ranking lists give a somewhat different picture. The index is ranked just below the middle in the Reluctant's list, while it appears next to the bottom in the Enthusiast's list. So again, we probably observe different response styles among the student types or different ways of expressing themselves and their concerns.

For the Selective Boy, the Reluctant and the Undecided, the three items B03 (work with animals), B05 (work with something easy) and B04 (work with environmental protection) are among the four items at the bottom of their ranking lists. While the Enthusiast gives lowest priority to Bi2 (use hands and tools), Bi5 (power and glory) and B05 (working with something easy), while B03 (work with animals) and B04 (working with environmental protection) is ranked just above these three. The same five items are at the bottom of the Selective Girl's list.

### 9.5.2 Studying and working with S&T

Two items in the F question explicitly ask whether the students would like to work with science and technology:

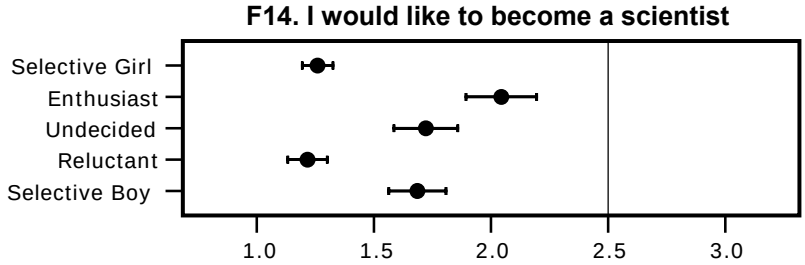



Figure 9-12. Cluster means and 95 percent confidence intervals for item F14. Note that compared to the other error bar diagrams in this section, the scale in this diagram is shifted 0.5 towards the left.

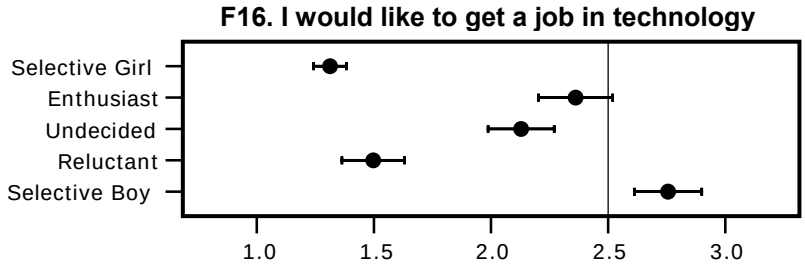



Figure 9-13. Cluster means and 95 percent confidence intervals for item F16. Note that compared to the other error bar diagrams in this section, the scale in this diagram is shifted 0.5 towards the left.

The Selective Girl is clearly stating that these two suggestions are not part of her plans. Only seven percent of the students in this cluster agree that they would like to be a scientist, and eight percent agree that they would like to get a job in technology. Neither are these jobs in the plans of the Reluctant: 15 and five percent are positive about a job in technology and science respectively. The Selective Boy is more positive about a job in technology (63 percent agreeing with F16), but he hardly wants to be a scientist (18 percent agreeing in F14). The Undecided and the Enthusiast are more positive about working with technology than with science, but their scores are low for both items. Respectively 21 and 34 percent of the students in the Undecided and the Enthusiast clusters agree that they would like to become a scientist, while the corresponding figures for a job in technology are 38 and 46.

The more positive attitude of the Selective Boy towards a job in technology is probably connected with this student type's high interest in technology. The *Technology* index in Figure 8-9 indicates that boys in general are interested in technology. This association between boys and technology is not followed up in Figure 9-13: The Reluctant

student type is somewhat interested in technology-related topics, but not in getting a job in technology.

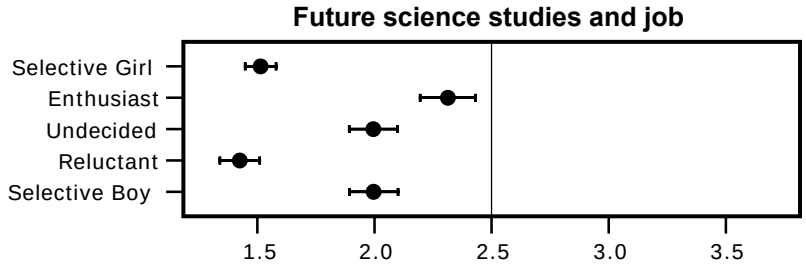



Figure 9-14. Cluster means and 95 percent confidence intervals for the index calculated from the following items (alpha .83):
F04. School science has opened my eyes to new and exciting jobs
F05. I like school science better than most other subjects
F14. I would like to become a scientist
F15. I would like to have as much science as possible at school

Factor analysis of the variables in question F gives that the items in the caption to Figure 9-14 have their main loading in the same factor. (Two of these items are discussed above: item F05 (school science better than other subjects) and F14 (become scientist).) In addition, item F16 (job in technology) load on the same factor, but this item weakened alpha, and is therefore not included in the index.[82]

In chapter 2, I referred to literature highlighting the role of youth's *aspirations* and *desires* in their educational choices (see 2.3.6). Young people's educational choices are first and foremost based on their interests – they choose *the* most interesting subject. This means that although students may find school science interesting (Figure 9-2), they will not pursue the subject unless they place science on the top of their interest.

During the questionnaire development, I expected item F05. *I like school science better than most other subjects* to load on the same factor as item F02. *School science is interesting*. However, item F05 loaded, as we have seen, on the same factor as items that are more connected to science-related jobs (F04 and F14) and education (F15). These items may have in common the idea of pursuing science in studies and occupation. Item F05 loading on this factor may be read as support for the hypothesis referred in 2.5.1, stating

[82] The fact that item F16 (job in technology) weakens alpha indicates that a job in technology is perceived as substantially different from becoming a scientist, although (at last in the science education community) science and technology are often perceived as related fields.

As described in 4.3.7, the translation of the term *scientist* into Norwegian is somewhat complicated. The Norwegian version of item F14 is *Jeg kan tenke meg å bli forsker i naturvitenskap*, which literally translates as *I would like to become a researcher in the natural sciences*. The phrase *a researcher in the natural sciences* does undoubtedly bring associations that are very different from *a job in technology*. Working with technology may for example be to become an ICT operator, while becoming a researcher is probably seen as a more ambitious job goal. Furthermore, we have seen that the student types give distinctive score patterns to ACE items related to technology. Based on this, we may understand why item F16 (job in technology) did not show sufficient internal consistency with the other items to be merged into the same composite variable.

Still, we do not know much about what occupations the students associate with *become a scientist* and *job in technology*. Does for example a ship's operator work with technology? And is a doctor working with science? This thesis will not give any answers to such questions.

that when young people choose their educational way ahead, their personal interest has major influence on their decision.

All mean cluster values for this index are very low. Even the Enthusiast, repetitively expressing a very positive attitude to science and science education, scores below the middle 2.5 line. Still, the Enthusiast is not as negative to science studies and jobs as the Selective Girl and the Reluctant.

## 9.6 Summary and discussion

The purpose of this chapter is to understand the student types better by examining how they "behave" in other parts of the questionnaire. The approach to the data has been sketchier than the analysis in the previous chapters was. For example, from the error bar diagrams, we know the variability of population means, but I have not reported how the scores are distributed around the mean. (The standard deviations are, however, reported in Appendix D.)

From the fact that the student types were developed on the basis of their responses to question ACE, it follows logically that the student types showed different response profiles through the ACE items in the previous chapter. In this chapter, I have examined responses to questions that were *not* involved in the student type development in chapter 6. In spite of that, the student types still expressed different orientations towards the various issues raised by these questions.

### 9.6.1 Explaining and understanding the results

It appears that, for interpreting and explaining the scores of the three Unselective student types, at least three mechanisms must be taken into consideration. First, we can assume that the student types actually have different opinions and views related to the issues raised in this chapter. This means that some of the differences between the student types will show up as "true" differences between them. For example, it may be that the Enthusiast actually is more involved in the environmental issue than the Reluctant is, and that the Reluctant actually does find the science classes less interesting than the Enthusiast does.

However, we have seen examples where the Reluctant and the Enthusiast show the same scores, while in a ranking list, they position items differently – or conversely, that they rank items equally, but give them different scores; even with statistical significance. This means that there is a second possible explanation for their scores; connected with communication styles. The Enthusiast might, more than the Reluctant, be inclined to express her/himself with superlatives; or the Enthusiast might, more than the Reluctant, wish to make an impression on her/his science teacher and the ROSE researcher.

Finally, for understanding different responses among the three Unselective student types, one can draw on sex differences. The two Selective clusters are virtually single-sexed, the Reluctant and the Undecided clusters have more boys than girls, while the Enthusiast cluster is almost evenly divided. Due to uneven proportions of girls and boys, score differences between student types may partly be explained by sex. In questions that appeal more to one sex than to the other, student type differences may represent sex

differences, rather than true differences in opinion among the student types. Answers concerning to what extent the sex variable can explain variance can be extracted from the data, but I will not pursue this matter here. In general one can say that if the scores of the Reluctant and the Undecided tend to lie in the direction of the Selective Boy, this may be due to the uneven gender distribution in these two clusters. For such variables, the gender effect should be taken into account in the interpretations of the results.

In most cases, there will be a *combined* effect, with response styles and sex differences simultaneously influencing the "true" differences. For example, we know from other studies that girls more often than boys wish to work with people. Here, this matter is represented by the *Work with and help people* index (Figure 9-10). The scores as well as the ranking of this index, show that the Enthusiast is in line with the Selective Girl, and that the Reluctant corresponds to the Selective Boy. Probably, if elaborating more on the two Unselective clusters, we would find that the Enthusiast Girl prioritises this matter higher than the Enthusiast Boy, and correspondingly for the Reluctant Girl and Boy. This means that, relative to the Selective student types, the keenness of the Enthusiast Girl and the aloof attitude of the Reluctant Boy are moderated by the fact that the clusters are sex-mixed. The same effect is probably found in, for example, the expressions about their science classes (section 9.3), whether they would like to work with tools and use their hands (9.5.1), and whether they want to become a scientist or get a job in technology (9.5.2).

In some cases, it complicates the discussions of the results that we do not know which score level that can be perceived as "high" and which level should count as "low". We have seen that "high" and "low" vary from one question to another. For example, in question L, the items generally achieved higher scores than the ACE items. Question D has statements that are positively and negatively worded, and the response scale goes from negative to positive. Therefore, the grand mean will not help us in interpreting response tendencies in the question. (There are alternative ways of examining the student type's deviations from the mid-point in the scale, but I have not pursued this matter.) The *Personal involvement* index (in environmental protection, Figure 9-6) may serve as an example of the complexity connected to interpreting the response level. For this index, the scores of the five student types lie from just above 2.5 and up to 3.5. Naturally, the results can be discussed in relative terms, i.e. how low or high the student type scores are relative to each other. But we cannot judge whether, for example, a personal involvement of 3.0 in a scale ranging from 1 to 4 represents "little" or "much" involvement. Another example would be item F14 and F16: What average values for the statements *I would like to become a scientist* and *I would like to get a job in technology* would imply recruitment of "enough" scientist and engineers for tomorrow's society?

Therefore, I perceive some items in this chapter as being more suitable for characterising and comparing the student types than for discussing the various matters raised by the questions. (This is, in any case, the purpose of the chapter.) The following is a summary of some results. The student type characteristics will be followed up in chapter 11.

### 9.6.2 Student stereotypes

The most salient feature from this chapter is perhaps the stereotypic responses of the three Unselective student types: The Reluctant gives the most discouraging and disapproving expression, while the Enthusiast appears as the sympathetic student type holding the most progressive views, and the Undecided lies between these two. This pattern reappears in the vast majority of the variables. There are, however, some exceptions. For example, in the index *Using hands and tools* in Figure 9-9, this pattern is broken. Here, the three Unselective student types lie at the same level.

The scores of the two Selective student types often lie within the range spanned by the Reluctant and the Enthusiast, but we have also seen several examples of the Selective Girl and the Selective Boy constituting the extreme values, with the responses of the three Unselective student types lying between. In such cases, if the scores of the Reluctant and the Undecided lie closer to the Selective Boy, there might be a gender effect in the responses. Again, the *Using hands and tools* index exemplifies an exception. Here, the Selective student types makes the extremes, while the three Unselective lie between with more or less the same score.

### 9.6.3 Summary

The two Selective student types have, in general, a relatively positive view of the role of science and technology in society. The Selective Boy is somewhat more positive than the Selective Girl, but the differences are not very pronounced. The Unselective student types show the usual stereotype response pattern: Relative to each other, the Enthusiast is positive, the Reluctant is negative and the Undecided lies between these two.

#### Science classes

When it comes to the student types' view of their science classes, the Selective Girl can scarcely agree that school science is interesting, while the Selective Boy is more positive. Compared with other school subjects, the Selective Girl strongly disagrees that she likes school science better. The Selective Boy disagrees as well, but not that strongly.

When the Selective student types are asked whether, or in what way, their science classes have been useful to them, they seem to respond in accordance with their interests. The two student types developed from the two sub-clusters of the Selective Girl served as an example on this. In the foregoing chapter, the Selective B Girl appeared as very interested in issues related to the human body. In this chapter, she expressed that her science classes in particular have taught her how to take better care of her health. Furthermore, the Selective W Girl is found to be particularly curious about unexplained mysteries and wonders, and she expresses that her science classes in particular have increased her curiosity about things we cannot explain. One interpretation of these responses may be that *science is perceived as useful when the teaching addresses issues related to the students' personal interests*. By reading interests as signs of identities, this can be rephrased to: *The science lessons are experienced as useful mainly when the teaching directs and involves the students' identities and their essential selves*.

Also in questions related to the science classes, the Unselective student types show the same stereotype response pattern. However, even the positive and cheering Enthusiast does not agree that science is more interesting than other school subjects are. Concerning this question, s/he is not more positive than the Undecided and the Selective Boy. When it comes to the subjects' level of difficulty, the Reluctant and the Selective Girl find it more difficult than the other student types do.

**Goals for society**

In chapter 2, I referred to perspectives on cultural liberation, individualisation and the notion of personal risks. According to such perspectives, young people have the impression that if they do not succeed in life, they alone are responsible for handling the consequences. When youth are asked about their private life future fears, failure in study and work, unemployment, illness and their own or relatives' death are their main future worries (Head, 2002). When youth are asked what they perceive as important goals for our society, their hopes, fears and expectations for the future will naturally influence their responses. Issues like drugs, education, labour market, health and personal economic prosperity are probably factors that are seen as closely connected with their success in life. Consequently, the students express that such issues should be prioritised tasks for our society. Among the five student types, the Enthusiast may be seen as holding the most post-materialistic values (see 2.5.4), e.g. by ranking personal economy far below environmental protection.

**Future job**

The Enthusiast is more positive than any other student type about becoming a scientist, but even s/he does not plan to study or pursue science[83]. Furthermore, all student types except the Selective Boy express a general lack of interest in working with technology. (Like in all other parts of the questionnaire, the Selective Boy is more positive than the others towards issues related to technology.)

In chapter 2, I referred to perspectives conveying that when today's Western youth choose an education, their decision is based on more than family traditions and a need for ensuring a safe job with a stable income. Their interests and identity construction have a major influence on their educational choices. Their education and their jobs have to be interesting, meaningful and important, to harmonise with their identity and to open up for self-realisation and self-development.

Also from the analysis in this chapter, such viewpoints are promoted. Youth hope to get a job in which they can do something they find important and meaningful. The job should offer opportunities for using and developing their talents and abilities, and for making their own decisions. They also want to earn lots of money, and to have lots of time

[83] Here, we see a limitation of describing the *typical* through making student types of the clusters. By describing the students as diverse and unalike individuals in one cluster, we have seen that, after all, 34 percent of the Enthusiast students agree that they would like to become a scientist. However, when describing the cluster as one stereotypical student type, the average value indicates that the cluster disagrees.

for their hobbies, interests, friends and family. The Selective Girl and the Enthusiast want to work with and help other people, while the Selective Boy and the Reluctant give a higher rank to working with hands and tools.

One interpretation of the low interest in S&T studies may be that students believe that these aspects, which they apparently value so high, will not be found in S&T subjects and careers. For example, science is perceived as difficult, and maybe as a subject demanding persistent, concentrated and determined hard work. This means little leisure time for their hobbies, interests, friends and family. Another interpretation may be that young people do not want to have the *identity* that seems to be associated with being a researcher in the natural sciences or, except from the Selective Boy, with working with technology.

**Environmental protection**

When it comes to environmental protection, the Selective Girl and the Selective Boy give medium-range responses compared to the other student types. The selective Girl seems somewhat more concerned than the Selective Boy, but the differences are relatively small. Again, the three Unselective student types appear with the usual pattern; i.e. the Enthusiast expressing more concern than the Undecided, who again expresses more concern than the Reluctant. However, even the Reluctant, who usually does not hesitate to clash with the "socially accepted" and "politically correct" attitudes and conventions, shows some concern and engagement related to the environmental issue.

Diversity in people's 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). Also in Western societies, there are groups taking quasi-religious approaches to the environment. Furthermore, there are traits of eco-centric as well as anthropocentric worldviews and motives for people's environmental concern (Strumse, 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). In Western societies, however, the predominant factor motivating for environmental protection is the perception of personal risks, and to a smaller extent the value of nature per se (Skjåk & Bøyum, 1993).

Also, the responses in the ACE question indicate that environmental protection achieves more concern when the concrete issues are connected with personal risks. For example, in chapter 8, item E05 (clean air, safe drinking water) may be perceived to be the item in the *Environmental protection* theme that is closest connected to the life and the health of the individual. This item did also load on the *Health* factor (see 7.4.2). Among the items in the *Environmental protection* theme, this item (E05, clean air, safe drinking water) achieved the highest interest score; while item E04 (greenhouse effect) got the lowest. (This did in fact surprise me, as clean air and safe drinking water are not of general public concern in a Norwegian context. Our national identity is partly based on an idea of "untouched nature" including clean air and safe drinking water.) This may be understood

as the notion of *individual* risk attracting more concern than issues with more bearing for the society and the globe as such.

Through this line of thought, I suggest that the results from this chapter indicate that in general, youth do not perceive the environmental problems as a great threat to their personal lives. They rank many other goals for our society higher. But still, in the question that specifically addresses the environmental issue, even the most indifferent and unconcerned student type agrees to some extent that this is an important issue.

# 10 INTERNATIONAL COMPARISONS

This chapter refers to research objective

*IV Study Norwegian youth's interests against a background of students from less modernised countries*

In chapter 2, I referred to literature describing how modernisation processes of societies influence peoples' way of understanding and thinking about oneself, one's surroundings and the world. Inevitably, modernity will also have an effect on students' interests related to science. I assume that signs of late modern perceptions can be identified in the ROSE material, but so far in my analysis, I have only studied the Norwegian students.

At the outset of my analysis, I was hesitant to divide students into categories of sex. I thought that there might be other and more appropriate ways of categorising students for describing their identities and their interests. Although I do maintain this line of reasoning for youth *identities*, I withdraw it for student *interest*: My analysis points towards sex as an important factor for understanding students' interests in the ACE topics. The distinctive responses of the Unselective Reluctant, Unselective Undecided and Unselective Enthusiast hide gendered response patterns. The Selective Girl and Selective Boy express interests that are similar to boys and girls in the three Unselective clusters, although clearly accentuated and amplified. This means that dividing students into categories of boys and girls actually is a fruitful approach for describing youth's interests.

In this chapter, I will step back from the five Norwegian student types and rather explore the Norwegian gender pattern against a background of girls and boys in other countries at other levels of modernisation. For this analysis, I will include the respondents that were excluded in section 6.3 and thereby use data from all 1204 respondents. The purpose is to examine whether empirical support can be found for my assumption that interests in science are related to modernisation of societies. More precisely, I ask: Is there a relationship between responses in the ACE items and the degree of modernisation?

## 10.1 Justifications and reservations

This chapter will only present a snapshot of the international ACE material. The analysis should be seen as a preliminary approach to the international data – it needs to be followed up by a more in-depth analysis. Rather than drawing firm and absolute conclusions, the objective is to outline some rough response patterns. This may inform my discussion (in

chapter 11) about modernity's effect on interests in science[84], and generate some new hypotheses.

The following paragraphs account for some justifications and reservations that I perceive as necessary before I proceed with the analysis:

### 10.1.1 National vs. cultural differences

There are several ways of defining the concept *culture*. Aikenhead uses the definition "the norms, values, beliefs, expectations, and conventional actions of a group" (Aikenhead 1996, p. 8, adopted from Phelan & al., 1991). Ember and Ember (2001) suggest that the definition of culture should be related to the concept *society*: "a culture is the set of customary beliefs and practices characteristic of a society" (ibid, p. 77) and refer to collections of the world's described cultures that can be used as sampling frames for research[85].

Regardless of what definition one chooses, one country (or nation) is not necessarily equivalent to one culture, as one country may contain more than one culture (Ember & Ember, 2001). The international ROSE sample is composed of sub-samples drawn from nations. This means that *nations* are my unit of analysis, whereas I do not know what possible cultures that may be involved in the national samples. I will therefore use the term *cross-national* or *international* rather than *cross-cultural*.

### 10.1.2 Modernisation vs. human development

In section 4.8, I gave some justifications for my decision to use a country's HDI value as an indicator of a country's degree of modernisation. Naturally, there are examples of countries in which the degree of modernisation is not fruitfully described by the degree of human development. Japan may be one such example. Japan is highly industrialised and developed and has consequently a high HDI. On the other hand, Japan is less influenced by processes related to modernity, like detraditionalisation, individualisation and market-driven economy (Lash, 1994). Table 4-3 shows that in Japan, the proportion of the population living in cities is smaller than in many other high-HDI countries, and that Japan has somewhat fewer female employees in services and more in industry than many other countries in the top of the table. Consequently, the HDI may be too high in terms of describing the country's degree of modernisation.

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[84] The reason for these severe restrictions is that my main research interest is related to student types, and that this part of my study was completed in chapter 9. A corresponding thorough analysis for the international data, including validation of the ACE items and descriptions of all participating countries (school systems, science curricula sampling procedure, how the study was organised in each country, etc.) would go beyond the scope of my thesis. On the other hand, I do not wish to leave the international perspective completely out. With the diversity of the countries represented in the ROSE material, I actually have a chance to see the Norwegian students against a background of youth from countries with different levels of development. I will not forego the hints that this material can give about the relationship between the ROSE data and the level of modernisation.

[85] The Human Relations Area Files (HRAF) produces a major collection of cultures for research purposes; the HRAF Collection of Ethnography. See www.yale.edu/hraf/index.html (accessed 2005-08-06)

Trinidad and Tobago (T&T) is another country that may be improperly categorised in terms of development vs. modernity and high or low HDI. T&T has a medium HDI rank, for example far below Japan. Moreover, due to the geographical closeness to the US and an accordingly Western influence on the T&T culture, the mentality among T&T youth may be more modern than among youth in other countries at the same level of human development (George, 2004).

Still, although the compatibility between the HDI rank and the degree of modernisation in a country may be weak, I will use *level of human development* (as defined by the HDI) synonymously with *degree of modernisation*.

### 10.1.3 National HDI vs. ROSE target population

In some countries the ROSE target population is defined as the students in one *region* of the country (Karelia in Russia, Gujarat in India and the Central region in Ghana), whereas the HDI values applied here are based on indicators for the whole nation[86]. This means that the HDI for a country may be too low or too high for the province, and thereby not representative for the region in focus.

In other instances, we may have that the target population of a country is defined as a particular group of students. For example, in Bangladesh data are collected from top achieving science-streamed students.

I have not corrected for this, but one should have it in mind when interpreting the results.

### 10.1.4 Modernity rather than development

In spite of the fact that developing countries are often referred to as *non-modern,* and thereby perceived as the "opposite" of modern societies or as exhibiting an absence of modernity, theories about modernity cannot help us understand characteristics of developing countries (Beck, 1999). The results from students in non-modern countries need to be looked at in the light of other perspectives than those outlined in chapter 2 about late modernity. This means that, although some of the responses from students in the developing countries show interesting patterns worthy of our attention, the focus of my discussions will be directed towards the developed countries in general and Norway in particular. In this analysis, the less modernised countries serve as a backdrop for studying relationships between students' interest scores and degree of national development. Because one can better see the particular in the light of diversities, the developing countries will also serve as a background for comparisons.

### 10.1.5 Modernity rather than culture

This chapter will show some interesting similarities between countries that are commonly compared with each other (for example the Nordic countries, countries of the British Isles, the Baltic states, and African countries). I will, however, pay little attention also to these

[86] From http://hdr.undp.org/ (accessed 2005-08-06), there are also national reports with regional HDI values, but I have not gone into these in order to search for regional indexes.

results. The reason for this is analogous to the reason for omitting discussions regarding the developing countries: My research interest is related to modernisation of societies, and my results will be interpreted against the perspectives on late modernity outlined in chapter 2. For understanding similarities between countries like those indicated here, one needs to draw on theories about similarities due to geographical closeness and correspondences in the countries' history, culture, language, politics, type of government, school system, science curricula, etc., rather than on theories of modernity.

### 10.1.6 Modernity rather than national details

In several diagrams, some countries show very particular responses compared to other nations. Again, I am looking for traces of a relationship between social development and students' interests in science, whereas particular national characteristics (others than the Norwegian) are of minor interest for my purpose. Therefore, I will not discuss whether such particularities are caused by errors in the measurement, the translation, the coding, etc. or whether it can be explained by distinct cultural, social, geographical, natural or educational conditions.

### 10.1.7 Item face value rather than indexes

In chapter 7, I divided the ACE items into themes and developed ACE indexes. The purpose was, among other things, to validate the items. The justification of the index formations was based on the substantial meaning of the item texts, along with testing of unidimensionality and internal consistency (see 7.5). In an international context, the items will inevitably have different connotations in different cultures, so the requirements of unidimensionality and internal consistency cannot be met for one group of items in all countries. Therefore, I will not use the indexes, but rather understand the items by their face value, i.e. from the superficial appearance of the items.

Through chapter 7, I tried to validate the ACE items and ended up with excluding 30 items. One option for the analysis in this chapter would be to use only the 78 items that to some extent are validated in a Norwegian context. However, this will not bring me any further in understanding what meaning students in other countries make of the items. Although some items seem to function well in *Norway*, I still do not know how they function in other cultures. Therefore, all 108 ACE items will be the subject of my analysis in this chapter.

I will focus on items that I perceive as having a straightforward face value and a plausible cross-cultural relevance and meaning[87], i.e. the students' understanding of the questions should not be much influenced by the cultural background of the students. Some items may be particularly related to Western public discourse. For example, items in the *Fit/sculptured body, Universe and enigmas* and *Mysteries* themes, are issues that are attracting massive media attention. Conversely, due to the larger proportion of the population in the developing countries employed in agriculture, items in the *Farming and*

[87] ...although I am aware that I, as every researcher, belong to a culture which can limit my capacity to perceive and understand.

*advancing nature* theme may be less relevant in a modern context. As one may question the consistency in how students in different countries interpret such items, I will not single out and draw particular attention to these.

### 10.1.8 Sample and data quality

In several national samples, there are some weaknesses in the data quality. All participating countries were requested to use a probabilistic (random) sampling routine, but for some reason, this was not complied with in several countries. (In most cases, the national reports have not given any account for the choice of alternative sampling methods.) In some other countries, the response rate was relatively low. As a result, not all countries have data that without reservation can be regarded as representative and generalisable to the target population. Consequently, any conclusions should be tentative.

We will, however, note that in spite of non-random sampling procedures, countries that are commonly put side by side (for example African, Baltic or Scandinavian countries) in most instances show similar or related response patterns in the ROSE material. Such results can be understood as strengthening the reliability of the data.

The results in this chapter need to be looked at in the light of these reservations. Again, only robust results will be pursued and discussed. Nevertheless, the analysis can give an idea about some cross-national patterns relating to my research questions.

## 10.2 International residual data

There turns out to be a strong relationship between the HDI for a country and the national grand ACE mean (Figure 10-1). The correlation coefficient between these two is -.85 ($p < .01$), which means an inverse relationship: The higher level of human development, or the more modernised a country is, the lower interest is expressed by the students in the ACE items.

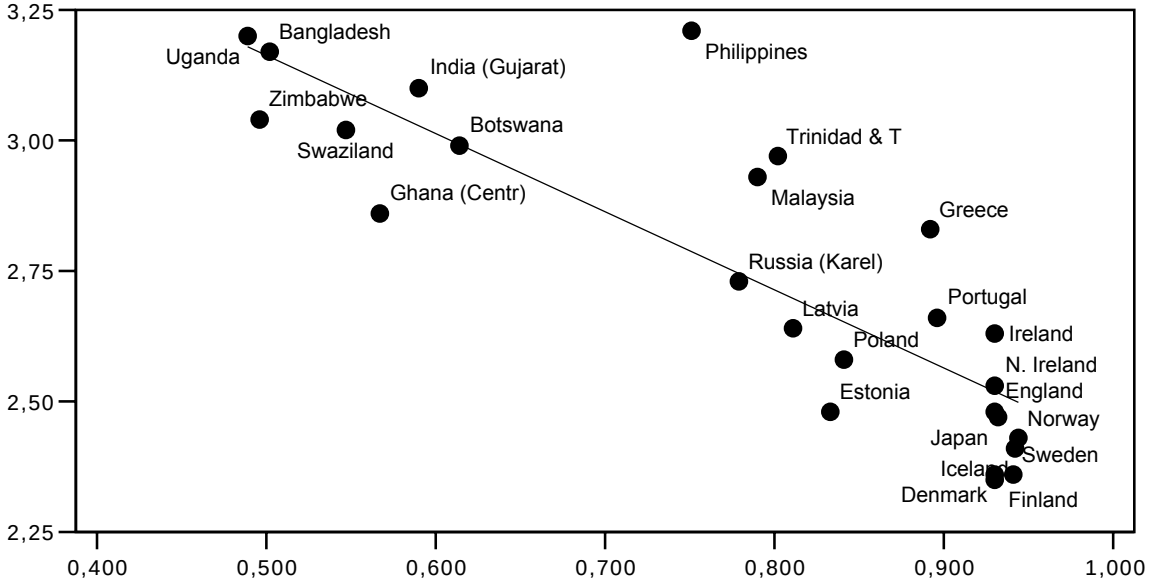



Figure 10-1. Scatter-plot with regression line: HDI values (horizontal axis) and grand ACE mean values (vertical axis) for all countries.

Figure 10-1 shows that the grand ACE mean for some of the countries in the extreme low end of the HDI scale lies one unit (in a scale with a span of three units) above many countries in the extreme high end of the HDI scale. In most of the 108 ACE items, students in countries like Uganda and Bangladesh express much more interest in learning about the topics than students in more developed countries like Norway, Iceland, Finland and Japan.

This issue was raised at a ROSE workshop in Oslo in October 2004 with representatives from 20 countries present. *Hunger of information* and *lack of access to education* were the dominant explanations from the participants representing the developing countries (the Philippines, India and all the African countries). Cultural differences in students' self-reports in Likert-measured variables, and alternative causes and explanations, are described in literature (Fischer, 2004; Lee & al., 2002; Lie & Turmo, 2005). One essential discussion, connected to this response bias, is whether the cross-cultural differences reflect "true" interest differences between countries or response style differences.

I touched on this issue in 6.6.2 and 9.6.1, where I discussed possible causes of the distinctive response patterns of the five student types. I do not wish to pursue this discussion any further, as I do not regard it as a central concern for my study. But the differences have methodical implications, as the distinctive response patterns complicates the task of making sense of raw score comparisons. Furthermore, the data has a shared factor corresponding to the one described in 7.1. The shared factor is students' general degree of interest in learning about anything: Students in some countries, especially in the less developed countries, tend to express that they are interested in "everything". This effect leads to a negative correlation coefficient between HDI and national mean scores for almost all ACE items. Thus, the inescapable follow-up question is how to deal with this shared factor.

There are several ways of standardising the data (Fischer, 2004). In order not to complicate the interpretation and the communication of the results, I wish to keep the data as close as possible to the raw data. Therefore the data are transformed into residual data simply by subtracting the grand national ACE mean (the average value across all ACE items and across all respondents in a country) from the national mean score of each ACE item. In other words: Each national mean profile through all ACE items is parallelly displaced downwards on the scale. The size of the displacement is equal to the grand ACE mean for the country. (This transformation of raw scores into residual scores is similar to the way the data were standardised in 7.3.) In addition to standardising the data for the total national samples, the data are also transformed for girls and boys separately. This means that when reporting mean residual scores for girls and boys, the values are relative to the national grand ACE means for the respective sex.

The grand ACE mean in the residual data is zero for both sexes in all countries, so that in the transformed data material, the average item scores will fluctuate around zero. If the average item score for students in one country equals zero, the students (girls or boys) found this topic averagely interesting (compared to the other ACE items). A negative residual score means that the students are less than averagely interested, and a positive value means that the item achieves higher than grand ACE mean scores.

In the rest of this chapter, I will only report results from the analysis of the residual data. This means that when I describe students in different countries as "more" or "less" interested, these are relative terms.

## 10.3 Cross-national similarities in interests

In this section, I will explore some similarities between countries in the ACE items. For this purpose, hierarchal cluster analysis (see section 5.5) is a useful explorative tool. The aim of the analysis is to investigate whether I can find support for my hypothesis that the level of modernisation of societies affects students' interests.

### 10.3.1 Clustering the countries

Figure 10-2 shows a dendrogram describing a hierarchical cluster analysis of all ACE residual mean scores for the international sample. The clustering method is between-groups linkage and squared Euclidean distance metric (see section 5.5). The dendrogram illustrates the entire process of going from single countries (left in the diagram) to one large meta-cluster of countries (to the right).

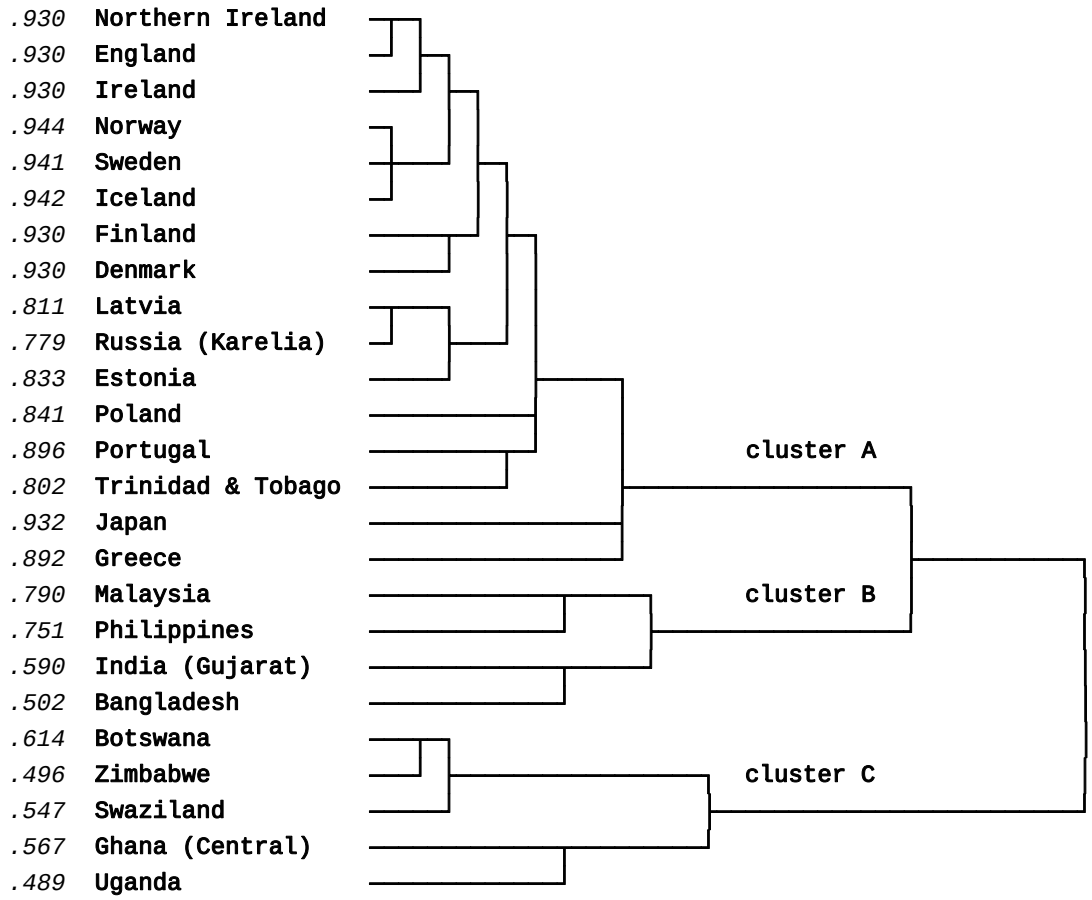



Figure 10-2. Hierarchical cluster analysis of residual ACE mean scores for all countries. Proximity measure: squared Euclidean distance. Clustering method: between-groups linkage. To the left, I have inserted a column showing the national HDI values.

The distance along the horizontal axis from the point at which the clusters come into existence to the point at which they aggregate into a larger cluster represents the

distinctness of the clusters. The distinctness tells us how different one cluster is from its closest neighbour. The more compact a cluster is, i.e. the further to the left the branches merge, the more similar to each other the countries are, and the more stable the cluster structure is.

By reading the dendrogram from the right towards the left, we see that the meta-cluster contains three main clusters: (A) High HDI countries including all the European countries plus Japan and T&T, (B) Medium HDI Oriental countries and (C) Low HDI African countries. As the length of the branch for all these three clusters are relatively long, they can be perceived as three distinctive clusters of countries. Cluster B is more similar to cluster A than cluster C is.

By reading the part of the dendrogram with cluster A from the left to the right, we see that Norway, Sweden and Iceland form a sub-cluster immediately, and that so do the three countries of the British Isles. Next, these two sub-clusters combine, and at the same stage Finland and Denmark merge and almost immediately group with the other North West European countries. Then, a sub-cluster formed by the two Baltic countries and Russia (Karelia) merge. Finally, Poland, Portugal, T&T, Japan and Greece merge and complete the formation of cluster A.

The three countries in southern Africa (Botswana, Zimbabwe and Swaziland) have responses that are relatively similar to each other and merge at an early stage, whereas the other African countries merge later. Cluster B is the least compact cluster. This means that these countries show a lesser degree of similarity.

SPSS arranges the countries downwards by two criteria: First, dendrogram lines are not to cross, and second, countries merging at an early stage are placed above those merging further out in the dendrogram. The HDI value was not an input variable for the statistical analysis, and is consequently ineffectual on the result. Nevertheless, by reading the dendrogram from the top and downwards, we see a general pattern of decreasing HDI values; i.e. that the order in which the countries and sub-clusters of countries merge largely follows the level of human development. The most modernised countries lie in the top of the diagram, while the more traditional countries lie in the bottom. This indicates that the more developed a country is, the more similar it is to the group of more modern countries above. One exception is the Baltic cluster (with Karelia). This cluster merges at an earlier stage than the countries below, although those below have higher HDI values. This can possibly be explained with the geographical and cultural relationship between the Nordic and the Baltic countries.

Cluster A contains the most developed countries. Cluster B joins before cluster C, signifying that cluster B is more similar to cluster A than cluster C is. In general the HDI values are higher for the countries in cluster B than in cluster C. Japan joins the more developed European countries in cluster A, and then cluster B joins cluster A before cluster C. These results, combined with the general pattern of increasing HDI values downwards in the diagram, may support my hypothesis about similarities between the more developed countries with respect to youth's interests.

Due to weaknesses in the data (see 10.1.8), and doubts concerning the appropriateness of the HDI as a measure of degree of modernisation (see 4.8 and 10.1.2), one should focus on the overall patterns and regard the details as insignificant. For

example, among the Nordic countries (Norway, Sweden, Denmark, Iceland and Finland) it is more common to compare Norway and Sweden with Denmark than with Iceland. However, the Scandinavian countries did not immediately form one cluster. I do not find it fruitful to speculate on whether it is the culture, the level of HDI [88] or possible weaknesses in the data[89] that may have caused the clustering of Denmark and Finland.

One noticeable result from this analysis is that similarities between countries in the ACE question seem to be determined by two properties: geographical closeness and level of modernisation. The general pattern is that first, the countries merge with neighbouring countries, and next, the group of neighbouring countries merge with groups of countries having a comparable level of development. But the unifying effect of geographical closeness only works within a certain limit of diversity in development. For example, Japan is geographically closer to the Philippines and Malaysia than to Europe, but the Japanese students seem to have more interests in common with European students. This is possibly due to the relatively high level of development and industrialisation in Japan.

### 10.3.2 Cluster stability

Cluster analysis is sensitive to changes in the data, to changes in the variable input to SPSS, and to changes in clustering methods and proximity measures. The data applied in this analysis are mean scores calculated from a relatively large number of students (see Table 4-2). This means that the data can be perceived as stable with respect to changes at the level of individual student responses. On the other hand, there are some weaknesses in the sample and the data (see in 4.8 and 10.1.8), and we do not know in what direction the results would have been altered with a higher data quality.

The stability of the cluster solution above is tested by running the cluster analysis again, with another set of variables and with different clustering methods and proximity measures. As mentioned in 10.1.7, some ACE items, e.g. those in the *Fit/sculptured body, Universe and enigmas, Mysteries* and *Farming and advancing nature* themes, probably are more and less relevant in countries with different development level. Therefore, the stability of the dendrogram above was tested by running the cluster analysis again, but without the 24 items in these four themes. The result was virtually identical to the dendrogram above, which means that the solution is very robust in terms of variable input. This is maybe not surprising, since the larger number of variables that are applied in the algorithm, the more stable the solution will be. The large number of items in the ACE question makes the cluster solution so stable that it is almost unresponsive to a reduction of the number of items from 108 to 84. Neither a change of clustering method to *centroid* clustering, nor a change of proximity measure to *Pearson correlation* (see section 5.5),

[88] The clustering supports my hypothesis of a relationship between interests and HDI, as Norway, Iceland and Sweden have higher values than Denmark and Finland, but I doubt that this explains the cluster formation.

[89] Denmark is one of the countries in the ROSE sample that achieved a very low response rate from the schools. Furthermore, data was collected through a web-based survey rather than with the standard printed questionnaire. Consequently, the sample may give a biased representation of the Danish students.

resulted in noteworthy differences in the dendrogram (only a few single countries switched position). Yet, the *within-groups* clustering method gave a somewhat different result, wherein particularly two differences may be worthy of note (Figure 10-3):

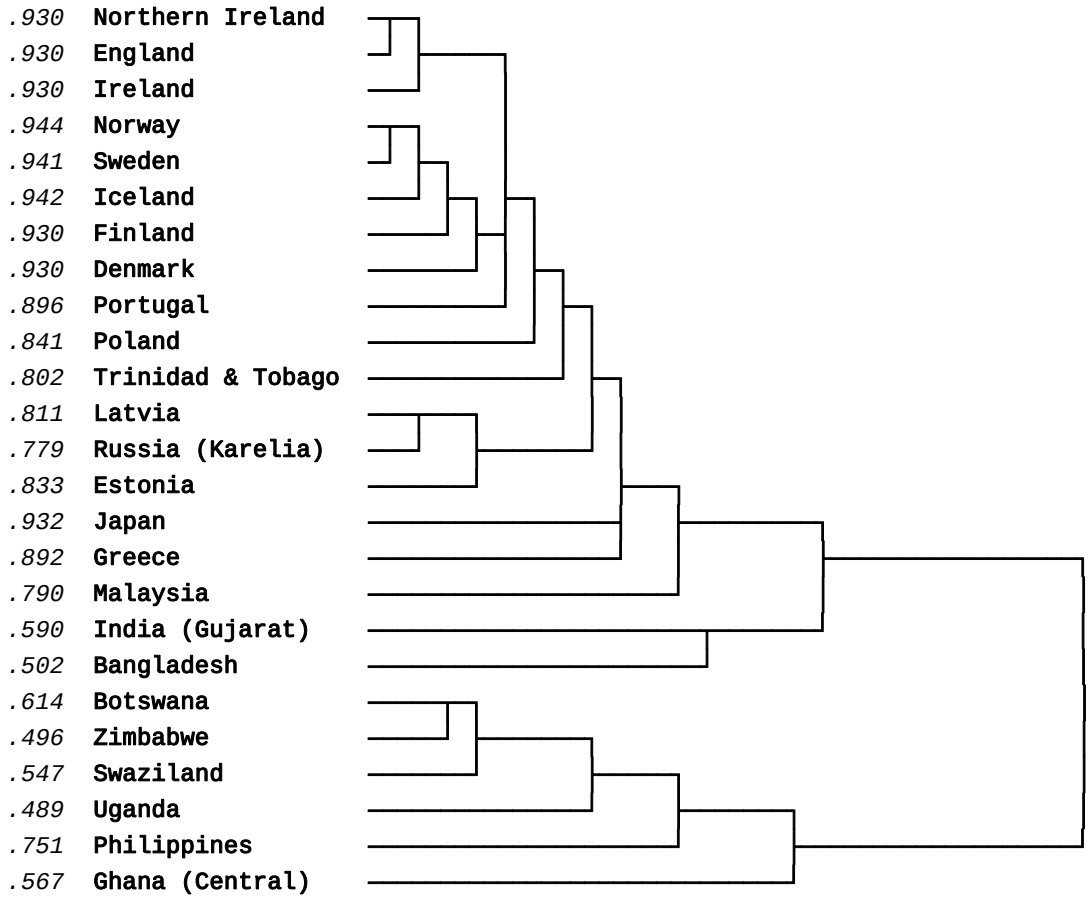



Figure 10-3. Hierarchical cluster analysis of residual ACE mean scores for all countries. Proximity measure: squared Euclidean distance. Clustering method: within-groups linkage. To the left, I have inserted a column showing the national HDI values.

First: in this analysis, too, there emerges a sub-cluster of the two Baltic countries and Karelia. This sub-cluster merges into the same group of high HDI countries, but at a later stage; below Poland, Portugal and T&T (Poland and Portugal have higher HDI values than the countries in the Baltic cluster). Second: the Oriental cluster (cluster B in Figure 10-2) did not form. The Philippines merged into the African cluster, while Malaysia, India and Bangladesh were the penultimate countries to join the meta-cluster. The sub-cluster of African countries and the Philippines was the last one to merge into the meta-cluster. In Figure 10-2, the Asian countries formed a loose sub-cluster, in the sense that they merged at a relatively late stage. This pointed towards an unstable cluster, which is confirmed in Figure 10-3.

Although this dendrogram is somewhat different from the dendrogram above, the cluster solution still supports the conjecture that there is a tendency for decreasing HDI values downwards in the diagram.

My overall impression from the sensitivity study is that the most salient features of the dendrogram in Figure 10-2 are relatively stable, and that cluster analysis seems to

function as a useful tool for establishing interest similarities between students in the ROSE sample.

## 10.4 Relationships between interests and modernity

Since the previous section indicates that students' interests in the ACE items to some extent are related to the level of human development, I will in this section study the correlation between the HDI variable and the national residual mean item scores. The purpose is to find what kind of interests (or lack of such) characterise students in modern societies. Since we have seen that interests in the ACE items show a gendered pattern, I will study girls and boys separately.

### 10.4.1 The more modernised, the more interested

Table 10-1 shows the items with the highest positive correlation coefficients with HDI values. The table only gives 20 item examples. For the girls, the list of statistically significantly correlated items is much longer. Appendix F shows the whole list. Due to the weaknesses in the material, I will not put emphasis on the exact size of the coefficients, and I will not pay any attention to items that are not statistically significantly ($p < .01$) correlated with HDI.

These items can be perceived as the ACE items that are mostly influenced by modernisation of societies. They are not necessarily the items with the highest interest scores in modern societies, neither are they necessarily extreme low-scoring items in the developing countries. But these are the items that show a *relationship* with the level of development. In modern societies, the interests for these topics have advanced: the more developed a country is, the more interested girls and boys tend to be.

| Girls | r | Boys | r |
|---|---|---|---|
| C13. Why we dream while we are sleeping, and what the dreams may mean | .88 | A12. Cloning of animals | .87 |
| E16. How to protect endangered species of animals | .87 | A34. How it feels to be weightless in space | .86 |
| C11. Life and death and the human soul | .84 | C08. The possibility of life outside earth | .82 |
| C15. Thought transference, mind-reading, sixth sense, intuition, etc. | .82 | A25. Tornados, hurricanes and cyclones | .82 |
| A38. Eating disorders like anorexia or bulimia | .82 | A22. Black holes, supernovas and other spectacular objects in outer space | .81 |
| C14. Ghosts and witches, and whether they may exist | .82 | A27. Brutal, dangerous and threatening animals | .81 |
| C12. Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | .81 | A31. Explosive chemicals | .70 |
| A34. How it feels to be weightless in space | .80 | A23. How meteors, comets or asteroids may cause disasters on earth | .69 |
| A12. Cloning of animals | .80 | C15. Thought transference, mind-reading, sixth sense, intuition, etc. | .68 |
| A25. Tornados, hurricanes and cyclones | .79 | C10. Unsolved mysteries in outer space | .67 |
| A27. Brutal, dangerous and threatening animals | .78 | A30. How the atom bomb functions | .66 |
| A22. Black holes, supernovas and other spectacular objects in outer space | .76 | A32. Biological and chemical weapons and what they do to the human body | .65 |
| A08. Heredity, and how genes influence how we develop | .76 | E42. Phenomena that scientists still cannot explain | .65 |
| C09. Astrology and horoscopes, and whether the planets can influence human beings | .73 | C14. Ghosts and witches, and whether they may exist | .63 |
| E13. How different narcotics might affect the body | .70 | A33. The effect of strong electric shocks and lightning on the human body | .61 |
| A26. Epidemics and diseases causing large losses of life | .69 | A14. Dinosaurs, how they lived and why they died out | .58 |
| C08. The possibility of life outside earth | .68 | E13. How different narcotics might affect the body | .57 |
| C10. Unsolved mysteries in outer space | .66 | E16. How to protect endangered species of animals | .55 |
| A40. How to exercise to keep the body fit and strong | .66 | A38. Eating disorders like anorexia or bulimia | .54 |
| E10. How to perform first-aid and use basic medical equipment | .64 | C11. Life and death and the human soul | .52 |

Table 10-1. The ACE items with the highest correlation with HDI, sorted by descending coefficient values. Separate lists and correlation coefficients (r) for girls and boys. All coefficients are statistically significant ($p < .01$)

There are 20 items that are statistically significantly correlated with HDI for the boys. Among these, 13 are also statistically significantly correlated for the girls. This means that the more modernised a country is, the more interested girls *and* boys are in learning about brutal, dangerous and threatening animals (A27), how to protect endangered species of animals (E16) and cloning of animals (A12). In addition to these items related to animals, they are also more interested in topics from the *Universe and enigmas* and *Mysteries* themes: The more developed a country is, the more interested the students are in pondering about how it feels to be weightless in space (A34), the possibility of life outside earth (C08), black holes, supernovas and other spectacular objects in outer space (A22), life and death and the human soul (C11), thought transference, mind-reading, sixth sense, intuition, etc. (C15), unsolved mysteries in outer space (C10) and ghosts and witches, and

whether they may exist (C14). Also, a corresponding relationship is found between HDI and girls' and boys' interests in tornados, hurricanes and cyclones (A25), how different narcotics might affect the body (E13) and eating disorders like anorexia and bulimia (A38).

These were the common items for girls and boys. Among the items that are unique for boys, especially the *Explosions and shocks* theme is well represented, with A30 (atom bomb), A31 (explosive chemicals), A32 (chemical weapons) and A33 (strong electric shocks).

Among the items that are statistically significantly correlated only for the girls, there are two more items related to animals: E24 (animals in my area) and A13 (animals in other parts of the world). For the girls, all the remaining items in the *Mysteries* theme are also correlated with HDI: C13 (what our dreams may mean), C09 (astrology and horoscopes) and C12 (alternative therapies). Also, interest related to the human body and health seem to be increasing with increasing level of development, as items in the themes *Fit/sculptured body, Human conception and maturing* and *Health* are relatively highly correlated with HDI. These items are A40 (exercise for fit body), A39 (lotions for young skin) and A41 (plastic surgery) in the *Fit/sculptured body* theme, A10 (contraception), A08 (heredity) and E31 (abortion) from the *Human conception and maturing* theme, and the health-related items E11 (HIV/AIDS), E10 (first-aid), E08 (cancer), E32 (gene technology), A26 (epidemics causing large losses) and E12 (alcohol and tobacco).

Most of the items that are correlated with HDI can be recognised from the Top 30 lists of the Selective students (Table 8-1, Table 8-5 and Table 8-6), but there are some top-scoring items that are not correlated to HDI. For the boys, the correlated items are mostly from the themes *Universe and enigmas* and *Explosions and shocks*, although there are also some items from the *Mysteries* theme, and a few related to the human body. However, particularly one theme was heavily represented in the Top list of Selective Boy, but totally lacking among the items correlated with HDI. These are the items related to technology: two items in the *Science in the making* theme related to inventions (E40 and E41), two items related to satellites and rockets (A44 and A45) and all six items in the *Technology* theme: C07 (computers), C03 (lasers in CD-players etc.), C04 (tapes, CD, DVD), C05 (radio and TV) and C06 (mobile phones). This means that although the Norwegian boys showed very high interest in these items, this interest may not be particularly associated with boys in modern societies. In addition, items from the *Animal* theme were not well represented in the Top lists of the Selective students (neither girls nor boys), whereas the theme has several items that are statistically significantly correlated with HDI (especially for the girls).

One explanation for correlations indicating a large degree of agreement between highly correlated items and the top-scoring items could lie in the correlation between HDI and the grand ACE standard deviation. Figure 10-4 shows that there is a tendency in the ACE data for the developing countries having lower standard deviations than the developed countries, but the correlation coefficient between the grand ACE standard deviation and HDI is not statistically significant.

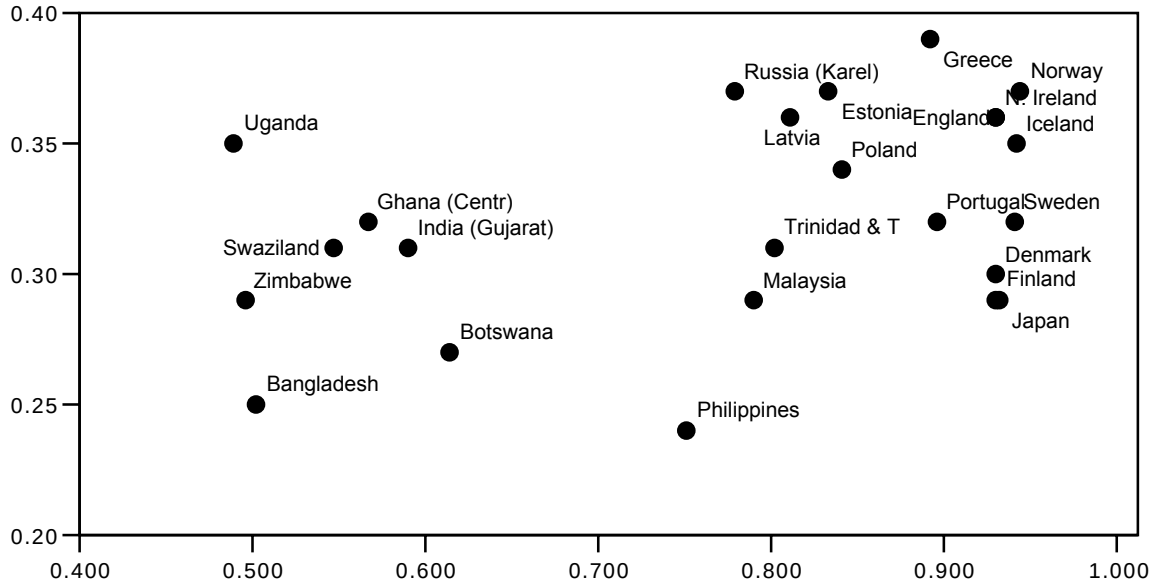



Figure 10-4. Scatter-plot: HDI values (horizontal axis) and grand ACE standard deviations (vertical axis) for all countries.

A small grand ACE standard deviation means that the mean scores in the 108 items are centred around the grand ACE mean. In some of the modernised countries, students have more pronounced expressions than students in some more traditional countries have, in the sense of giving more variance to the item mean scores[90]. This means that for some items, the high correlation may be an effect of response styles, rather than of interest differences between youth in different countries. Although this explanation may make a point, it cannot explain for example the fact that the high-scoring technology items are not correlated with HDI. The occurrence of different response styles in different countries is therefore not likely to explain more than a few aspects of these results.

### 10.4.2 The more modernised, the less interested

Table 10-2 shows the items that are most strongly *negatively* correlated with HDI. The items are sorted by descending strength of relationship with HDI (by correlation coefficients). Like in the previous paragraph, I will refer to items that are statistically significantly correlated with HDI, but there are more items than those shown in the table (see Appendix F).

[90] The data could have been standardised to correct for this pattern. This can be followed up in later studies, but will not be pursued here.

| Girls | r | Boys | r |
|---|---|---|---|
| C07. How computers work | -.88 | C02. Optical instruments and how they work (telescope, camera, microscope, etc.) | -.91 |
| C02. Optical instruments and how they work (telescope, camera, microscope, etc.) | -.88 | E37. Famous scientists and their lives | -.82 |
| E27. Electricity, how it is produced and used in the home | -.86 | E36. Why scientists sometimes disagree | -.82 |
| E36. Why scientists sometimes disagree | -.85 | A43. How the ear can hear different sounds | -.79 |
| E37. Famous scientists and their lives | -.84 | A36. How the eye can see light and colours | -.76 |
| E30. How electricity has affected the development of our society | -.83 | E26. Detergents, soaps and how they work | -.75 |
| E28. How to use and repair everyday electrical and mechanical equipment | -.81 | C17. Why we can see the rainbow | -.75 |
| A15. How plants grow and reproduce | -.81 | E27. Electricity, how it is produced and used in the home | -.74 |
| A43. How the ear can hear different sounds | -.80 | A15. How plants grow and reproduce | -.72 |
| C05. How things like radios and televisions work | -.78 | A46. How X-rays, ultrasound, etc. are used in medicine | -.71 |
| A45. The use of satellites for communication and other purposes | -.78 | C16. Why the stars twinkle and the sky is blue | -.69 |
| E26. Detergents, soaps and how they work | -.75 | E02. How the sunset colours the sky | -.68 |
| E22. How different sorts of food are produced, conserved and stored | -.74 | E18. Medicinal use of plants | -.68 |
| E06. How technology helps us to handle waste, garbage and sewage | -.74 | C06. How mobile phones can send and receive messages | -.63 |
| A48. How a nuclear power plant functions | -.72 | E03. The ozone layer and how it may be affected by humans | -.63 |
| C01. How crude oil is converted to other materials, like plastics and textiles | -.72 | E06. How technology helps us to handle waste, garbage and sewage | -.62 |
| C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.) | -.72 | E23. How my body grows and matures | -.61 |
| A04. How mountains, rivers and oceans develop and change | -.71 | E17. How to improve the harvest in gardens and farms | -.61 |
| E20. How energy can be saved or used in a more effective way | -.70 | E25. Plants in my area | -.60 |
| A36. How the eye can see light and colours | -.69 | A39. The ability of lotions and creams to keep the skin young | -.56 |

Table 10-2. The 20 ACE items with the lowest correlation with HDI, sorted by descending coefficient values. Separate lists and correlation coefficients (r) for girls and boys. All coefficients are statistically significant ($p<.01$)

The more developed a country is, the less interested the students are in learning about these items.

Among the 32 items that are statistically significantly correlated with HDI for the boys, 20 are also statistically significantly correlated for the girls. This means that the more modernised a country is, the less interested both girls and boys are in learning about the three items E36 (why scientists disagree), E37 (life of famous scientists) and E34 (religion and science in conflict) in the *Science and scientist* theme, about how the ear can hear and how the eye can see (A43 and A36), and about the ozone layer (E03), clean air and safe drinking water (E05) and handling waste (E06) in the *Environmental protection* theme.

Furthermore, the more developed a country is, the less interested the students are in learning about electricity, how it is produced and used in the home (E27), how X-rays, ultrasound, etc. are used in medicine (A46), how crude oil is converted to other materials, like plastics and textiles (C01), how different sorts of food are produced, conserved and

stored (E22) or detergents, soaps and how they work (E26). In the process of validating the items in chapter 7, all these items were excluded from any indexes. In my attempt to understand why these were hard to place, one explanation was that they may be "lacking contour, provoking no more than a shrug from virtually all the respondents". The results from this paragraph cannot confirm or reject this hypothesis, but we see that our students' lack of interest in these issues may be related to the level of development in our society.

Furthermore, there are statistically significant negative correlations for both sexes, concerning item A15 (how plants grow) and E17 (improve harvest). In the boys' list of negatively correlated items, there are several more items related to plants and farming: E25 (plants in my area), E18 (medicinal use of plants), E19 (ecological farming) and E33 (modern farming). This indicates that, particularly for the boys, there is a negative relationship between the level of development and the interests in such issues.

Moreover, the more developed a society is, the less interested the boys are in three items in the *Geo, aesthetics* theme: C16 (why the stars twinkle), C17 (rainbow) and E02 (sunset). A corresponding relationship is found for boys' interest in some items related to the human body: A07 (how the body functions), E23 (maturing body), E07 (epidemics and diseases), A39 (lotions for young skin) and A42 (radiation from solariums). One may question the importance of the negative correlation for the two latter items, as the cross-cultural consistency in interpretations of these may be weak. However, the three items listed before these two indicate that also items of more general human biology achieve lower interest scores among modern boys.

In the previous paragraph, we saw that although Norwegian boys express high interest in technology, this interest may not be related to societal development. This table (and Appendix F) indicates that the opposite may be the case. Both item C02 (optical instruments) and item C06 (mobile phones) are *negatively* correlated to HDI for both sexes. For the boys, these are the only two technology-related items that are negatively correlated with HDI, while for the girls, this list of negatively correlated items is extended with A45 (satellites), A47 (petrol and diesel engines), A48 (nuclear power plant), C03 (lasers in CD-players etc.), C04 (tapes, CD, DVD), C05 (radio and TV), C07 (computers), E41 (recent inventions) and E28 (repair everyday electrical equipment). Although most of these items do not appear in the Bottom list of the Selective Girl, we can interpret this to indicate that the more developed a society is, the less interested the girls are in technology.

Also, the girls' scores are negatively correlated with HDI for some topics that may be of a more traditional textbook character, like clouds, rain and the weather (A05), the inside of the earth (A03), how mountains, rivers and oceans develop and change (A04), atoms and molecules (A17) and chemicals, their properties and how they react (A02).

The last group of items that I want to mention, which is negatively correlated particularly for the girls, are the two items related to new energies and alternative energies: How energy can be saved or used in a more effective way (E20) and new sources of energy from the sun, wind, tides, waves, etc. (E21).

Many items from the Bottom 30 lists of the Selective students (Table 8-2 and Table 8-7) are reoccurring in this chapter as negatively correlated with HDI. So again, one may ask whether they are caused merely by the tendency for larger grand ACE standard deviations in modernised countries. Although we cannot reject the possibility that such

mechanisms may have some effect, the many items occurring in the Bottom lists that are *not* negatively correlated with HDI, undermines this conjecture. For example, both Bottom lists of the Selective students contain item E01 (symmetries in leaves and flours), but this item is not statistically significantly correlated with HDI. Such items indicate that, although Norwegian students express very low interest in the items, this lack of interest does not appear as a trait of youth in modern societies in particular. Therefore, it is unlikely that the results are an effect of the grand ACE standard deviation alone. Another comment would be whether we know how well Norwegian students function as representatives of modern response profiles in general. Some insight into this was gained in section 10.3, and the following section will provide us with some more.

## 10.5 Cross-HDI response patterns – some examples

This section will follow up the results from the previous one by giving some examples of cross-national response patterns. The following diagrams show national mean scores for girls and boys separately.

I have tried to pick items which serve as elucidating examples of different cross-national response patterns, and which I perceive to have a straightforward face value (see 10.1.7). The intention of the diagrams is to visualise some patterns of national scores across the HDI variable (cross-HDI patterns). The diagram captions report whether the correlation with HDI is statistically significant; but since I do not wish to enter into a discussion about statistically significant score differences between sexes and countries, the confidence intervals for the mean scores are not included.

Figure 10-5 gives examples of two items that exhibit a statistically significant (positive or negative) correlation with HDI for both sexes.

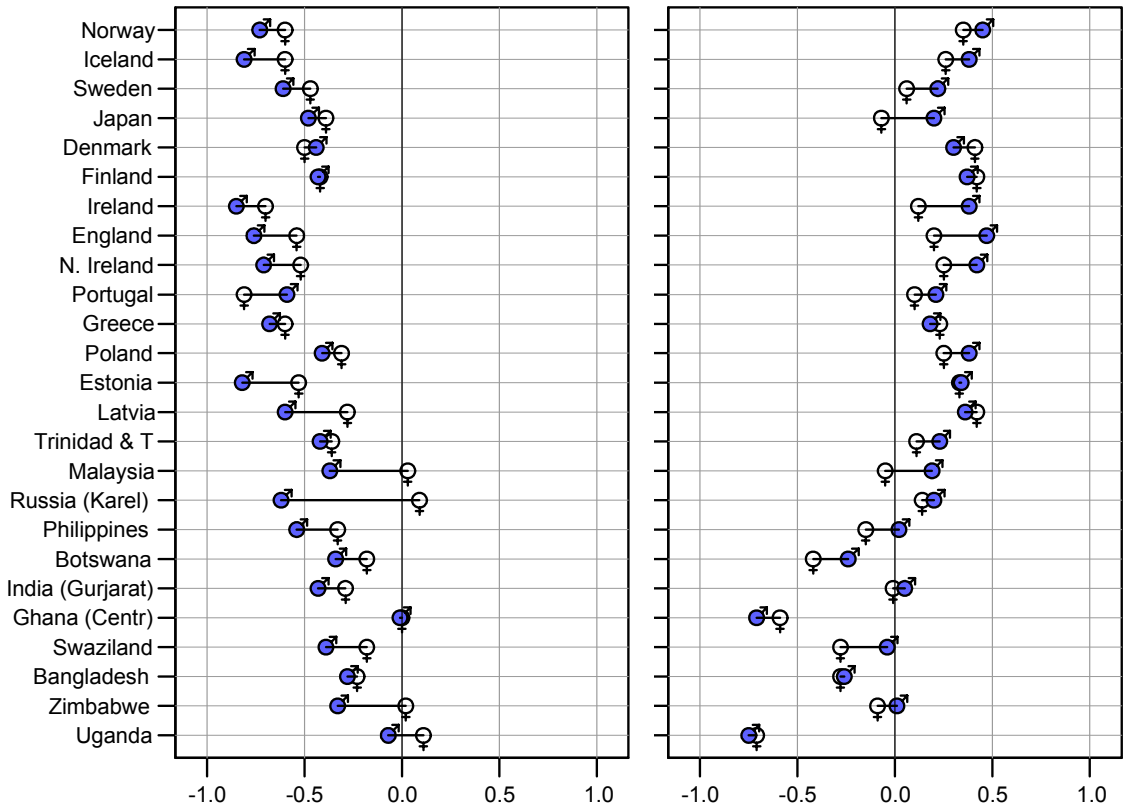



Figure 10-5. Item E26. *Detergents, soaps and how they work* (left, r: -.75* for girls, -.75* for boys) and item A25. *Tornados, hurricanes and cyclones* (right, r: .79* for girls and .82* for boys). Mean residual scores for boys (filled symbols) and girls (blank symbols) for countries sorted by descending HDI. National grand ACE means are indicated by the zero line. In this as well as in the following diagrams, asterisked correlation coefficients (r) are statistically significant ($p < .01$), while "ns" denotes *not significant*.

The more developed a society is the lower interest the students show for item E26. *Detergents, soaps and how they work* (left). Conversely, the more developed a society is, the higher interest they express for item A25. *Tornados, hurricanes and cyclones* (right). The sex differences are small, although there is a tendency for girls being more interested in soap, and boys being more interested in tornados. In both items, the Norwegian scores fit well with the pattern of the other high HDI countries. Corresponding patterns occur for many of the other items that were found to be positively or negatively correlated with HDI for girls and boys in the previous sections.

For other items, the correlation between HDI and national scores is insignificant for one sex and considerable for the other. Typically, these are items in themes with a pronounced sex-specific appeal in modern societies.

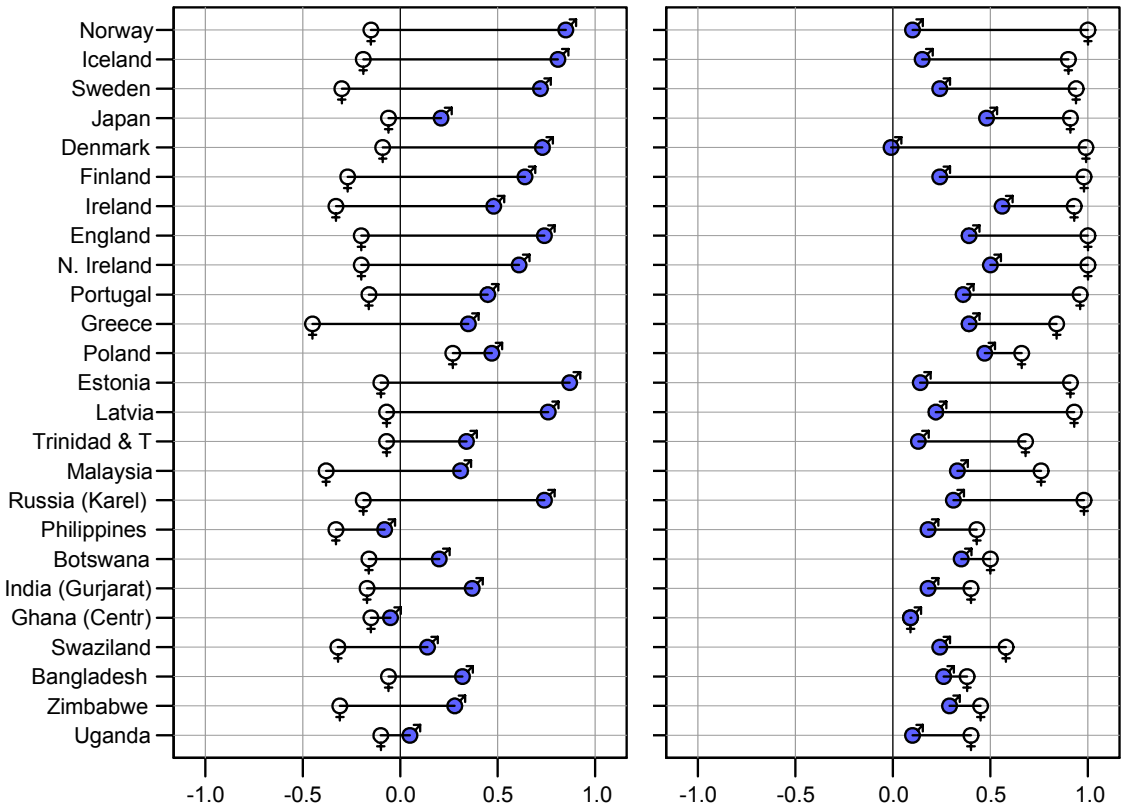



Figure 10-6. Item A30. *How the atom bomb functions* (left, r: ns for girls, .66* for boys) and item C13. *Why we dream while we are sleeping, and what the dreams may mean* (right, r: .88* for girls, ns for boys). Mean residual scores for boys (filled symbols) and girls (blank symbols). See caption in Figure 10-5 for more explanations.

Figure 10-6 shows scores for A30. *How the atom bomb functions* (left) and C13. *Why we dream while we are sleeping, and what the dreams may mean* (right). The diagrams have in common that the scores for one of the sexes (girls in the left diagram and boys in the right) are uncorrelated with HDI, while the scores for the other sex are positively correlated.

In the diagram to the left, most of the girls' national means lie just below the zero line. The girls express close to average interest in how the atom bomb functions, while the boys are more interested the more developed the country is. The diagram to the right shows that that the more developed a country is, the more interest the girls express for our nights' dreams, while the cross-HDI pattern for the boys do not show any clear trend.

These were two examples of "typical" response patterns for the *Explosions and shocks* and *Mysteries* themes. Figure 10-7 shows corresponding examples for the *Technology* and *Health* themes.

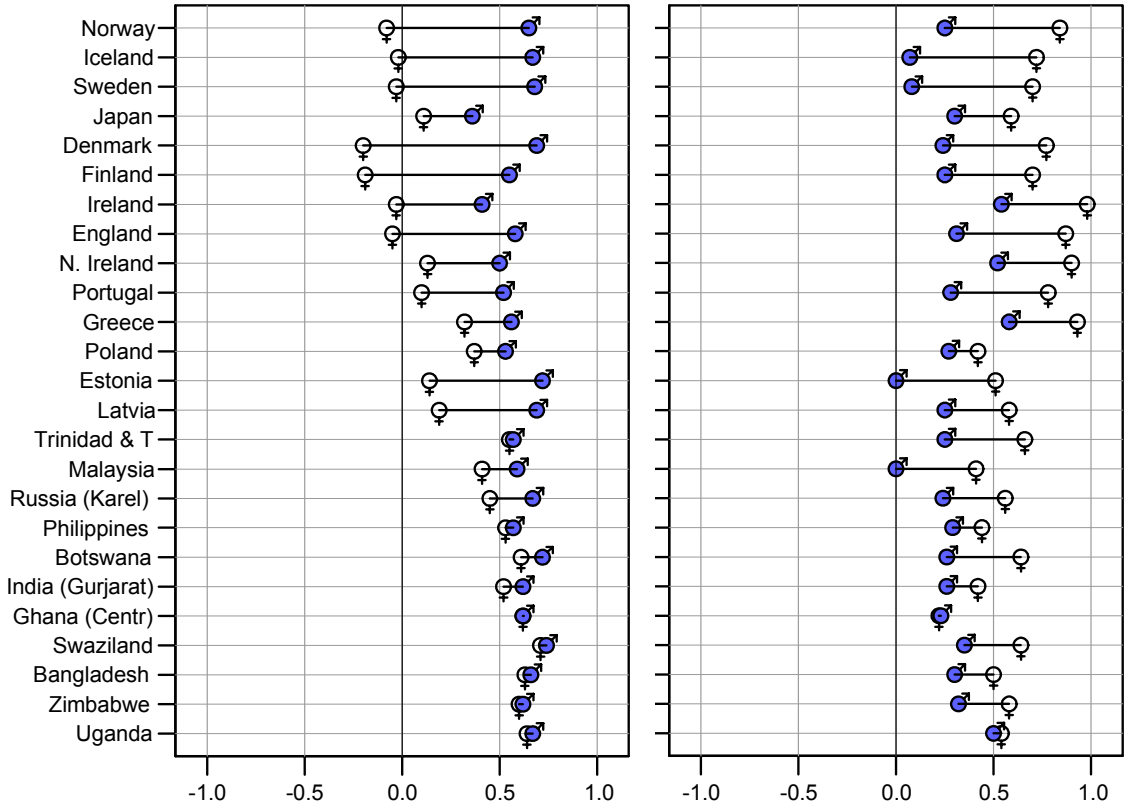



Figure 10-7. Item C07. *How computers work* (left, r: -.88* for girls, ns for boys) and item E08. *Cancer, what we know and how we can treat it* (right, r: .60* for girls, ns for boys). Mean residual scores for boys (filled symbols) and girls (blank symbols). See caption in Figure 10-5 for more explanations.

The diagram for item C07. *How computers work* (left) shows interest scores for the boys that seem unrelated to HDI, while the girls express less interest the more developed the country is. Also for item E08. *Cancer, what we know and how we can treat it* (right) the boys' correlation with HDI is insignificant, while the girls' show a relationship, but this time in the opposite direction: The more developed a country is, the more interest the girls express for learning about cancer.

Both in Figure 10-6 and Figure 10-7 the scores of the Norwegian students fit the cross-HDI pattern. This response pattern implies larger sex differences in more developed countries. There are no ACE items with an opposite pattern – with a tendency for girls and boys approaching the interest level of each other with increasing level of development.

Naturally, the cross-HDI patterns can have a variety of forms. For example, patterns may appear as combinations of those we have seen above: Both sexes may be negatively or positively correlated (as in Figure 10-5), but one sex may have a steeper slope than the other. Item E27 (electricity in home) and C14 (ghosts and witches) may serve as examples of such patterns. Both are statistically significantly correlated with the same sign (minus in E27 and plus in C14) for both sexes. Furthermore, both are represented in a Top or Bottom list of the Selective Girl (E27 in Bottom and C14 in Top). This means that, although the slopes of the boys and the girls are leaning in the same direction, the girls' slopes are steeper; this results in increasing sex differences with increasing level of development.

Furthermore, many items are not correlated with HDI for either of the sexes. This may indicate that there are no noteworthy differences between the countries (E15. *How*

*loud sound and noise may damage my hearing*, left diagram in Figure 10-8) or that there are some differences between the countries, but that they do not show any relationship with HDI (A29. *Deadly poisons and what they do to the human body*, right diagram in Figure 10-8).

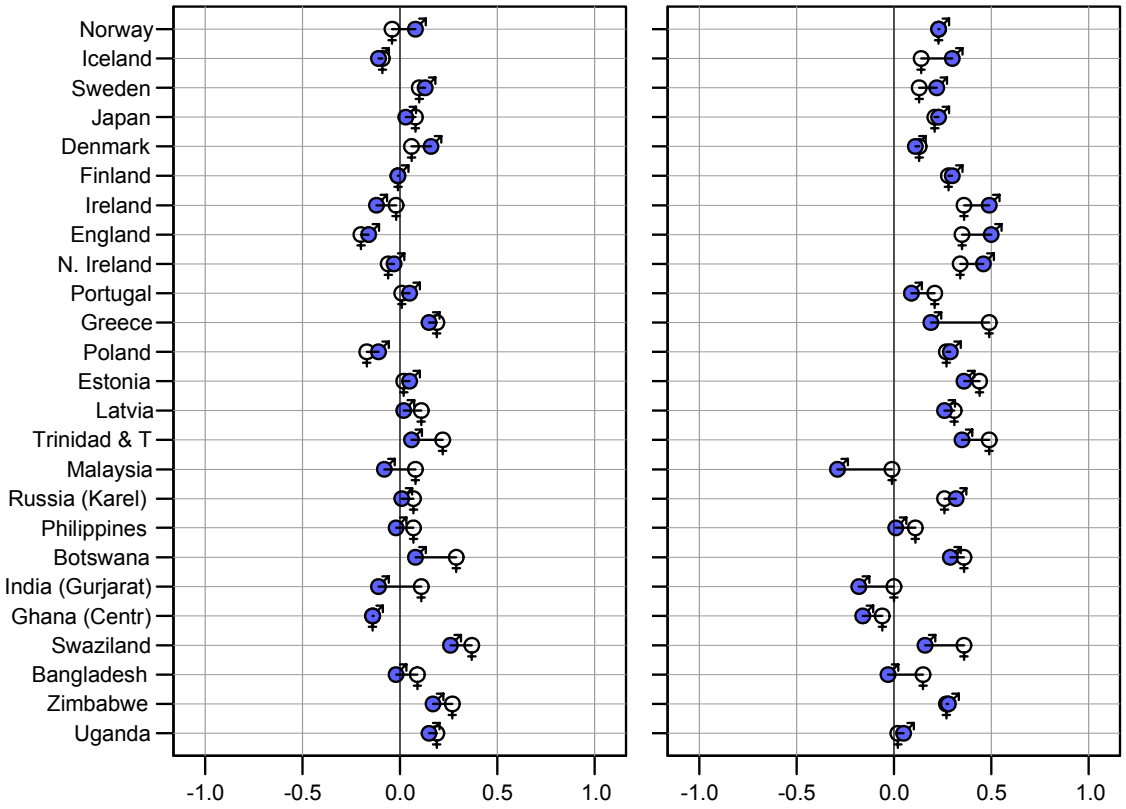



Figure 10-8. Item E15. *How loud sound and noise may damage my hearing* (left, r: ns for both sexes) and A29. *Deadly poisons and what they do to the human body* (right, r: ns for both sexes). Mean residual scores for boys (filled symbols) and girls (blank symbols). See caption in Figure 10-5 for more explanations.

In the previous section, I found that there seems to be a relationship between HDI and students' interests in animals. Before I close this section, I will look a little closer into the items in the *Animal* theme. Among the four items in the theme that show some correlation with HDI, item A27. *Brutal, dangerous and threatening animals* and E16. *How to protect endangered species of animals* are positively correlated for both sexes.

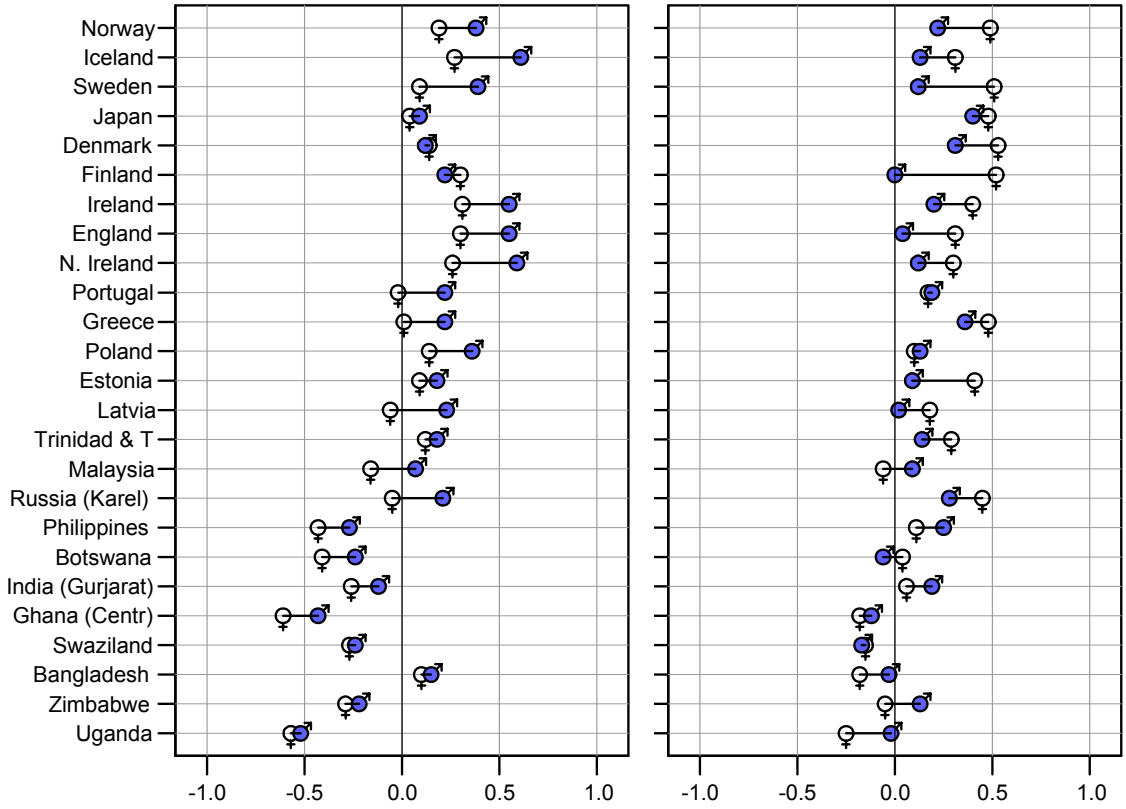



Figure 10-9. Item A27. *Brutal, dangerous and threatening animals* (left, r: .78* for girls, .81* for boys) and item E16. *How to protect endangered species of animals* (right, r: .87* for girls, .55* for boys). Mean scores for boys (filled symbols) and girls (blank symbols). See caption in Figure 10-5 for more explanations.

One may speculate on (like in 8.4) whether the high interest among youth in modern societies for item A27. *Brutal, dangerous and threatening animals* (left diagram in Figure 10-9) is related to the high interest in item A25. *Tornados, hurricanes and cyclones* (right diagram in Figure 10-5). These items may have in common some horrifying and threatening aspects of nature. But this explanation does not bring our understanding any further for item E16. *How to protect endangered species of animals* (right diagram in Figure 10-9). In 10.4.2, we saw that for many items related to environmental protection, the students were less interested the more modernised societies they lived in.

Although the scores of both sexes in both diagrams in Figure 10-9 are positively correlated with HDI, the right diagram has a noteworthy pattern. For this item, there is a tendency towards swapping directions in the sex differences from the developing to the developed countries. In the lower half of the diagram, the boys tend to score higher than the girls, while in the upper half the girls' scores exceed the boys'. In both halves, the sex differences are small, so this attention to the gender pattern may seem unwarranted. In spite of this, I found it worthy of notice. The reason is that exactly the same tendency appears for the two other items in the animal theme that are correlated to HDI: E24. *Animals in my area* and A13. *Animals in other parts of the world*. (These two items are only correlated for the girls' scores.) May this interest in animals be read as concern and care for some values that are described in theories about the post-material society?

## 10.6 Discussion

Although there are some weaknesses in the data quality, I argue that the most salient overall results from this analysis are unlikely to be caused by measurement bias. In this section, I shall reflect on issues related to the credibility of the results.

The sample contains a relatively large number of countries; many of them with representative data of high quality. In some sense, the representative samples can function as yardsticks and means for strengthening the reliability of neighbouring non-representative data.

For example, due to meeting points in the geography and history of Estonia, Latvia and Russia (Karelia), one could expect the students in these three countries to appear as relatively similar. The ROSE researchers in Estonia applied a method for probability sampling by randomly drawing a stratified sample from 15 counties. They achieved a fairly high response rate (83 percent). Consequently, the data from Estonia should have the capacity to represent the Estonian target population of grade nine students. On the other hand, neither in Latvia nor in Russia (Karelia) were random samples drawn. In both countries, schools were selected on the basis of convenience. Latvia selected two thirds of the classes from schools with Latvian as the language of instruction and one third from schools with Russian as teaching language. In Figure 10-2, and through the sensitivity study in 10.3.2, Estonia, Latvia and Russia (Karelia) were very consistently forming one compact cluster, meaning that the students in these samples show similar response patterns through the ACE question. Since these results can be perceived as reasonable and credible, they strengthen the trustworthiness of the Russian and Latvian data, at least to the level of details in the present analyses.

Among the three countries of the British Isles, no samples meet the requirements for representative data in terms of sampling method or response rate. Therefore, in this context there is no sample that can be perceived as a yardstick and as a standard for judging the quality of the data for the neighbouring countries. However, also these three countries formed a very compact cluster in Figure 10-2, that was sustained through the sensitivity study in 10.3.2. This credits the reliability of the data from these three countries as well.

The questionnaire was developed through extensive cooperation between ROSE partners from all continents, in order to ensure that the questionnaire items are relevant in all countries. In spite of this, there is no doubt that some items do not function in all cultures or countries. Some items are immersed as a natural part of the discourses of youth in modern societies, whereas the same issue may be unfamiliar or even not recognised or understood in developing countries. This may for example apply to items addressing issues like cloning, eating disorders, alternative therapies, ghosts, thought transference, astrology, exercising for fit body and black holes. Of course, this line of thought could be extended to apply to any item in the ACE question. On the other hand, we have seen that many items that were validated and grouped into *themes* and *indexes* in chapter 7, have appeared relatively consistently also through the analysis in this chapter. This may indicate that many items do carry the same meaning across nations.

Furthermore, items within one theme or index have in some instances occurred as related to HDI for only one of the sexes, but not for the other. If the items have not been

understood in some countries, one would not expect different response profiles for girls and boys.

I have applied the HDI values for each country as an indication of the national level of modernisation. The construct validity of this measure can be questioned. Modernisation is not the same as human development and human development is not completely captured by HDI (see section 4.8). Although developments in economy and education are essential driving forces in modernisation processes, a country may have a solid economy and a developed educational system, but still not be extensively modernised. Conversely, a country may be poor in terms of economical resources but still heavily influenced by Western and modern ways of thinking and understanding. (See 10.1.2 and compare with how Japan and T&T clustered in Figure 10-2 and Figure 10-3. Although Japan has a HDI far above the value of T&T, T&T appears as more similar to the more modernised countries.)

Furthermore, there may be a sample bias along the HDI scale. In the low end of the scale, there is an over-representation of African countries, whereas the high end of the scale is heavily represented by Western European countries. The middle part of the HDI rank is only scantily represented in the ROSE sample. One may question whether the HDI-gradient in the item responses is a measure of differences between African and Western European cultures. I cannot disregard the possibility of this effect having influenced the results.

In spite of the weaknesses that may be inherent in my analysis, I believe that this chapter has shown some robust and interesting results, which I intend to bring into the summary and discussions in the next chapter.

# 11 CONCLUSION, SUMMARY AND DISCUSSION

Explanations of why the students responded the way they did in the ROSE questionnaire can be sought in a variety of disciplines, for example in sociology, anthropology, biology, psychology or educational theory[91]. One could apply a range of explanatory variables, such as curriculum, teacher behaviour, teaching methods, genes, sex, gender, individual experiences, peers, class, race and socioeconomic status of the home. And even within one field, e.g. within sociology, there may be different theories, directions and explanations (Elster, 1989; Martinussen, 1999)[92].

My project is to interpret my results against a theoretical framework of the late modern society. Most of the students' responses will be seen as identity expressions. I assume that, as in most other arenas in life, they will express their identities also when filling in the ROSE questionnaire. They will want to show the ROSE researchers, their science teacher, and their peers sneaking a look into their questionnaire, what kind of young persons they are. They will also want to strengthen and confirm their own perception of themselves. I will see the students' responses through this lens. It may be seen as an experiment, but I believe that these perspectives can deepen our understanding of the results, as well as inform the science education research area. I will return to what we can learn from youth sociology later, but first, I will sum up and conclude from the empirical analysis.

## 11.1 Conclusions and summary

The ROSE material may illuminate a range of important and topical discussions in the science education community, for example issues such as curricular content vs. students' interests, cultural diversity, students' disenchantment with their science classes and students' perceptions of science in society. Results from my analysis may possibly also inform such discussions. In the discussion in chapter 9 (section 9.6), I summarised some views held by the students on their science classes, S&T careers and environmental protection; and wider discussions on such issues are taking place in other publications

[91] For example, Zuckerman explains the sex differences in sensation seeking on a biological basis, e.g. by correlating sensation seeking with the testosterone hormone in men (Zuckerman, 1994). One could understand, for example, boys' interests in the *Explosions and shocks* theme (see 7.4.20) with such theories.

[92] For example, people can be perceived as actors with intentions and motives behind their choices. According to this perspective, the students in the ROSE survey respond e.g. because they *intend* to express their identity. This is what Martinussen calls *interaction analysis*. Another explanation, the *condition analysis*, involves seeing people's actions as determined by the social context and position. Then, the students' responses in the ROSE questionnaire would be seen as a result of the students' values, their understanding of the situation in which they are situated, and other conditions in the social context (Martinussen, 1999). Both approaches can give important contributions to our understanding, but none of them have the capacity to provide extensive explanations of the students' responses. Which explanation that will be perceived as the most fruitful depends on the research focus, and on what aspects the researcher wishes to illuminate (Heggen, 1993).

based on the ROSE material (see e.g. Anderson, Sjøberg & Mikalsen, 2006; Jenkins, 2005; Jidesjö & Oscarsson, 2004; Lavonen, Juuti, Uitto, Meisalo & Byman, 2005; Ogawa & Shimode, 2004; Trumper, 2004)

However, my research aims have been to develop a typology and to characterise the student types' orientations towards science. The results summarised below have emerged from the following research objectives:

*I* *Develop a student typology based on the Norwegian students' orientation towards science*

*II* *Describe the interests of the student types developed in I*

*III* *Describe the student types' relations to some other aspects of science and science education*

*IV* *Study Norwegian youth's interests against a background of students from less modernised countries*

The summary and conclusions in this section will be continuations of these objectives, and I will not pay much attention to the other discussions outlined above. My results can be broadly summarised under three main conclusions:

- Norwegian students can be divided into five student types with distinct orientations towards science
- Students' interests in science are sex-specific
- There are some characteristic cross-national patterns in youth's interests that follow a modern–traditional divide

In the following, I will summarise the results under these three headings. But first, I will briefly describe the analysis and my way through the data.

### 11.1.1 Exploring the data material

As accounted for in the introduction (in 1.3.1), my approach to the data has been explorative and data-driven. I have successively adjusted the next step of my analysis according to the results of the previous step. At the outset of my analysis, I was hesitant to divide students into categories of sex. I thought that there might be other and more appropriate ways of categorising students in order to describe their orientations towards science. I started out with dividing the Norwegian respondents into clusters based solely on their interests (responses in question ACE. *What I want to learn about*); independent of the students' sex, school, number of books in the home, etc. After some trials, I decided on a typology with *five* student types. This number was not "given" from the data. I could have decided on fewer and I could have decided on more, but I found the five clusters distinctive and interesting. Each cluster was seen as representing one *student type*.

I expected to find student types with distinct interest orientations, i.e. different groups of students showing interest in different topics. But this did not happen – or, at least, only to a limited extent. Only two out of the five clusters showed distinctive profiles that conformed to my expectations. These two clusters turned out to be sex-specific – one

girls' and one boys' cluster. The most salient feature of the interest profiles of these student types was their fluctuating profiles, and thereby their *selective* interest. These student types were called the *Selective Boy* and the *Selective Girl*.

The three other clusters were mixed in terms of sex. The main characteristic of these was the different general level of interest. The items in the ACE question address a range of very different topics, related to very different subjects. In spite of this diversity in subject matters, the three student types displayed uniform and regular interest profiles; i.e. *unselective* interests. Almost regardless of topic, the three student types showed low, medium and high interest, and they were labelled the *Unselective Reluctant*, the *Unselective Undecided* and the *Unselective Enthusiast* respectively.

The response profiles of the Unselective clusters were standardised in relation to each other by removing the differences in general interest levels. Next, the three clusters were merged into one, and after that, the respondents were divided into clusters on the basis of their interest profiles. Again, by constructing two clusters, the result was two more or less sex-specific clusters: the Unselective Girl and the Unselective Boy. Although the Unselective Girl and the Unselective Boy fluctuated with much smaller span between the extreme values than the two Selective student types did, the interest profiles of these two sex-specific Unselective clusters turned out to be remarkably similar to the corresponding profiles of the Selective Girl and the Selective Boy.

This result is, as stated above, not in line with my initial assumptions. That is to say, I am not surprised that there are sex differences in students' interests. No less than I would be surprised to find differences between students living in rural and urban areas, between students with high or low socioeconomic status of their parents, etc. However, I had not expected that even through my explorative approach to the data, sex would appear as an important factor for explaining youth's interests. I expected that my approach to the data would reveal different kinds of interests across the sex categories, and that the phrasing of my conclusion could be inspired by Brickhouse and her colleagues' expression "... we need to know more than that they are girls. We need to know what kinds of girls they are" (Brickhouse & al., 2000, p. 457).

This means that although the five *student types* would not have appeared if the students from the outset were categorised according to their sex, sex appeared as an important factor for understanding the students' typical *interests*.

### 11.1.2 Sex differences in interests

In the introduction (in 1.3.1), I stated that only *robust* results would be pursued. My empirical chapters have brought forward a variety of results that can characterise girls, boys, students in different countries, as well as the five student types. Yet, in the following, I will not dive into details and nuances. In order to present well-founded characteristics of the students, only results that appear as stable and convincing will be summarised.

In chapter 2, I drew on perspectives stating that while a person's identity is to a lesser extent inherited or handed down from traditions and family background, sex remains an inborn quality. Consequently, young people will lean on, cling to and emphasise their sex as an evident identity symbol, especially in the earliest teenage years.

This leads to larger differences between the sexes in modernised countries. Sex differences can also be explained by different socialisation processes for girls and boys. Furthermore, girls and boys will in general have different plans for the future. For example, Norway is among the countries in the modernised world with the most sex-segregated labour market (Birkelund & Petersen, 2003). Since their plans for the future will influence their understanding of themselves in the present, this may also lead to sex differences.

One can assume from the results described above, that dividing students into categories of boys and girls will be a fruitful approach for describing young people's interests in science (or, more precisely, their interests in the ACE topics). If students' interests can be seen as signs of their identities, the results support the idea that sex is an important attribute for youth's identity construction. Similarly, Lyng found that all her student types were sex-specific (except the Nerd, see 2.4.2).

The most interesting issue from the analysis described above is perhaps not the particular topic interests of girls and boys, but rather the fact *that* the sex-specific patterns emerged. Girls' and boys' interests in the ACE topics are not very different from what one could expect from the literature review in chapter 3, and probably not very surprising for parents, teachers or others spending much time with young people. The interest profiles form clear sex-stereotypes: while girls are interested in the feminine, boys are interested in the masculine and the "tough stuff".

Based on the answers of the Selective Boy and the Selective Girl, we may say that boys are interested in spectacular phenomena, such as supernovas, bombs, weapons, shocks and explosives. They are not very interested in animals in general, but if the subject is angled somewhat more provocatively, e.g. towards cloning of animals or dangerous animals, their interest increases. They are not interested in their surrounding nature in general; while more spectacular natural phenomena, such as tornados, hurricanes, earthquakes and volcanoes, are more interesting.

Boys are also interested in technology. This includes satellites, rockets and space technology, as well as advanced technology like TV, radio, computers, mobile phones and DVDs. They are also interested in technology with a more mechanical character, such as petrol and diesel engines, and repairing everyday mechanical equipment.

Influential discoveries and recent inventions, cutting-edge science, and "science in the making" arouse their curiosity too. Their interests increase when a topic is framed as cutting-edge science. For example, they are not interested in environmental protection in general, but they are interested in new sources of energy.

Both boys and girls are interested in enigmas like dinosaurs, the origin of life and mysteries in the universe. Girls also have a general interest in most mysteries and things we still cannot explain, such as what our dreams may mean, thought transference, ghosts and witches, the human soul, alternative therapies, astrology and horoscopes. Boys are not interested in these topics.

Boys do not share girls' high interest in eating disorders, lotions, plastic surgery, solariums, abortion, babies and alternative therapies, and they are only middling interested in human health. However, boys *are* interested in how to exercise to keep the body fit (and possibly in more topics related to shaping a fit *masculine* body, see 8.4.1). In general,

girls are interested in most topics related to the human body, including human biology, health issues and how to keep and shape a fit body.

Girls are also interested in spectacular natural phenomena, such as volcanoes and tornados; but beyond these topics, girls do not share boys' interest in explosives and other horrifying matters. On the contrary, such topics, as well as technology, are among the subjects that girls are *not* interested in. Nor are they interested in atoms, molecules and chemicals.

Many of the subjects that are of greatest interest to students of one sex are of least interest to those of the other sex. This may display incongruent and sex-stereotyped youth identities. We have, however, also found several meeting points. For example, both sexes express interest for enigmas and phenomena we still cannot explain. The universe seems to be a "sex neutral" area, in which both girls' and boys' identities can be managed.

Moreover, the natural world may be regarded as more or less neutral, since neither girls nor boys are much interested in topics such as the weather, the sunset, how mountains and rivers develop and change, plants, farming or environmental protection. The only exceptions are, as mentioned before, earthquakes, volcanoes, tornados and hurricanes. And neither girls nor boys are interested in learning about how scientific knowledge develops and the work and life of scientists; or in general everyday matters such as detergents and soaps, plants in the local area and how food is produced and conserved.

Some of these results might be explained by various sociological theories referred in chapter 2. One can see interest in human biology, body shape and health issues as results of the late modern body project (Shilling, 2003), students' interest in paranormal phenomenon and alternative views of science could be sought explained by individualism and relativism (Sjödin, 2001), interest for spectacular phenomena may be seen in relation to the media society and the age of boredom (Qvortrup, 1991), lack of interest in environmental protection can be seen as a symptom of meaninglessness and alienation (Brunstad, 2002), one can try to explain students' lack of interest in the work and life of scientists with weakened authorities (Giddens, 1991) and so on and on. Although I believe that such associations make some interesting points, I will not try to explain the particular interests (or lack of such) among youth or the possible reasons for the sex differences. The main point in this paragraph is that girls and boys' interests are *different*. Broadly speaking, boys are interested in the classical masculine and not interested in the classical feminine, while girls are interested in the classical feminine and not interested in the classical masculine. As the two Selective clusters are relatively sex-specific, the Selective Girl and the Selective Boy can function as the typical feminine and the typical masculine expressions.

### 11.1.3 The five Norwegian student types

While the result described in the previous paragraph was unplanned and surprising, the results summarised below have emerged from my research objectives *I-III*. Objective *I* resulted, as explained above, in five student types, and objective *II* and *III* involves characterisations of the student types. Some general results from *III* are summarised in

chapter 9.6, and will not be repeated here. In this section, I will mainly sum up characteristics of the five student types.

Like Lyng did in her study (see 2.4.2), I will interpret the student type characteristics as signs of their social identity. Young people play different roles on different stages in their lives. Here, I will describe their *student* role on the *school* stage. I will not speculate on roles they might play on other stages.

As this survey was carried out in a school science context, we do not know to what extent the student type characteristics can be generalised to other subject classes or to other arenas in the school context. Costa and Aikenhead discuss "the world of school science" against other lifeworlds, such as the worlds of family and friends, and the world of school in general (see 3.4.1 and 3.4.2). In Costa's typology, some student types relate differently to the world of school science than to the general school world, while others do not single out science. This makes a valid point, as we know that many students have a particularly disagreeable relationship with science and mathematics, but not with all subjects and not with school in general. In Lyng's typology, the student types *consistently* perform their roles across any school context, including the breaks. Although her student types relate differently to different school subjects, a student would hardly be a Nerd in one subject, a Macho Boy in another and a Geek in the breaks. Lyng describes student types as school committed or school rejective.

In my typology, this will be an unanswered question. We may find one hint of an answer in question F05. *I like school science better than most other subjects* (Figure 9-3). In this question, the students compare school science with "most other subjects"; and it then appears that the Reluctant and the Selective Girl have negative relationships with science in particular.

I will try to find similarities between my student types and the student types of Costa and Lyng. Costa's typology (see 3.4.1) is relevant, because it relates to science in particular. Lyng's student types (see 2.4.2) are perhaps even more suitable for my analysis; first, her typology is developed in a Norwegian context; second, it is developed for students of the same age and at the same school level as my students; and finally, Lyng draws on sociological perspectives on youth and youth's identity construction to interpret the types, like I do. These two typologies should in any case not be seen as resembling my typology. They are based on other research interests and developed through different methodologies. The three typologies cannot compete for being the "truest". What they *can* do, is to inform, strengthen and enrich one another.

As discussed in section 6.6, I acknowledge that the students in one cluster are diverse, and that characterisations of the student types will inevitably do injustice to the individuals in the clusters. The emergence of the Unselective Girl and the Unselective Boy (in 8.3.4), as well as the distinctive interest profiles of the two sub-clusters of the Selective Girl (see 8.2) illustrate this point. Most of the students would probably not feel that they are fairly described when they are represented by a mean score together with all the other students in the cluster. On the other hand, the focus of my study is on the typical rather than on the particular. The student types represent the typical. They appear as prototypes, described by average scores of the students in the student type clusters. This means that the injustice to the individuals is a compromise that this study

has made. The student type is a *component* of the identity of the student, and one facet of her/his youth subculture. One cluster may contain several social identities and youth subcultures. For example, we have seen, both from my analysis and from the literature, that late modern youth identities are tightly connected with sex. Hence, the three sex-mixed Unselective clusters cover *at least* two different subcultures; one for girls and one for boys.

The following descriptions of the five student types are mainly based on my empirical typology, but I have enlarged the portraits by drawing on Costa and Lyng and my image of the student types.

**The Unselective Enthusiast**

The Enthusiast has an unchanging positive and progressive attitude towards all matters raised in the questionnaire.

The interest profile of the Enthusiast shows relatively indiscriminating high interest in all topics. Almost regardless of subject matter, the Enthusiast responds with eagerness and interest. But her/his interest is not irresponsive to the topic; for example, *symmetries and patterns in leaves and flowers* are not perceived as very interesting. But even the least interesting topics do not achieve low interest scores, compared with the scores of the other student types.

In this sex-mixed cluster, we find the Enthusiast Girl and the Enthusiast Boy. Probably, the interest profiles of these are not very different from other girls' and boys' interests, except that the Enthusiast is relatively more interested in learning about environmental protection.

The Enthusiast finds school science interesting, useful and not too difficult; but the science classes are not more interesting than most other school subjects. S/he sees the benefits of science in society, and is personally engaged in the environmental issue. S/he ranks environmental protection before personal economy. The Enthusiast wants to work with and help other people, rather than working with hands and tools, and s/he is less concerned about power, glory and money than the other student types.

The Enthusiast Girl and the Enthusiast Boy possibly resemble Costa's Potential Scientist. In Lyng's type gallery, they may resemble the Golden Girl, the Dude and the Nerd. These are the school-committed student types; they like science and school, they appreciate the value of education and science, and know that their education will be their door to the future. They are positive, progressive and willing. They have socially acceptable attitudes, and they want to make a good impression on the science teacher and the ROSE researchers. The ROSE instrument has not assessed the students' performance in science, but in Costa and Lyng's typologies, these students are high achievers. As described elsewhere (Schreiner & Sjøberg, 2006b), many of the students in this cluster plan to take an advanced education[93].

[93] *Advanced education* means an education that is equivalent to a postgraduate university degree, such as doctor, dentist, psychologist, architect, lawyer, graduate engineer, veterinary, researcher, biologist, historian and archaeologist.

**The Unselective Reluctant**

The Reluctant appears as an opposite of the Enthusiast. S/he is aloof and unwilling, and wishes to make clear to her/his environment that science is not her/his kind of stuff. Regardless of topic, the Reluctant uses moderate expressions. "Superb" does not exist in her/his vocabulary, at least not when the questionnaire is answered in the school science context. S/he strongly disagrees that science is better than most other school subjects.

With a few exceptions, s/he is not much interested in learning about any of the topics in the ROSE questionnaire. The interest profiles of the Reluctant Girl and the Reluctant Boy curve relatively similarly to profiles of other girls and boys, although at a lower level. The Reluctant types are not interested in health and body issues in general, but they are somewhat more interested in issues related to sculpturing a fit body. Compared to the other types, these show low interest for puzzles like the universe and science in the making.

S/he does not see much benefit of science in society, does not have much good to say about the science classes, and compared to the other student types s/he shows little engagement for environmental protection (although even the Reluctant shows some engagement in environmental issues; see sections 9.4 and 9.6). In a future job, s/he wishes, like all youth, to realise her/himself, but most of all s/he wants to earn lots of money. S/he would work with something involving the use of hands and tools. S/he is quite sure that s/he will not be a scientist or work with technology. In general, s/he does not plan for a job that requires an advanced education (Schreiner & Sjøberg, 2006b)

The Reluctant Girl and the Reluctant Boy resemble Costa's Inside Outsiders and Outsiders and Lyng's Wild Cat. Possibly, the Mouse and the Geek in Lyng's typology are represented in this cluster too. They achieve low or medium grades and have negative attitudes towards school science in particular and possibly also towards school in general.

**The Unselective Undecided**

I labelled this student type the Undecided, and there are two reasons for this. First, the student type seems to be undecided: in most cases, s/he will tick the two middle response categories in the questionnaire. This can be seen as indifference, and as avoiding taking clear stances. Her/his expressions are not enthusiastic, not reluctant – but in-between. S/he is not interested and not disinterested – but in-between. The science classes are not useful, not easy, not useless, not difficult – but in-between. In virtually all variables, they lie in-between the Enthusiast and the Reluctant. Therefore, I see this student type as undecided.

The second reason for the label is that *I* find this student type to be more or less invisible. I perceive her/his contour as unclear, and her/his identity as hard to pin down and define. The most notable characteristic of the Undecided is, besides the indifference, that s/he shows more interest for some of the indexes in the *Concern* interest orientation in 8.4.2; for example, in items related to farming and advancing nature and environmental protection. Environmental protection is also ranked as a prioritised goal for society.

The Geek and the Mouse in Lyng's type gallery may be represented in this cluster, as well as Costa's "I Don't Know" Students. Possibly, her/his grades are not good, not poor

– but in-between; and perhaps, s/he is not school-committed, not school-rejective – but in-between.

I do not think that the Undecided has a strong desire for expressing her/his identity, neither for me nor for others in her/his surroundings. Although I have described the Norwegian society as modern, not *all* young people are equally modernised; Norwegian youth may be more or less modern, and more or less traditional. It may be that some of the more traditional students are found in this cluster.

**The Selective Girl**

The Selective Girl is exactly that – she is selective and she is a girl. She resembles Costa's Other Smart Kids and Lyng's Babe. She is modern, reasonable, outspoken and self-expressive. Furthermore, she is critical and has conscious preferences and attitudes. Although we mainly know her from a school science context, I would anticipate that also in other school classes, she expresses herself through strong commitments and rejections.

She knows who she is and wants to be, and who she is *not* and does *not* want to be; and she shows this through energetic expressions in the questionnaire. She has the typical girls' interests described above, and she rejects the masculine topics. Her identity is connected to the late modern female expressions, and she emphasise this by refusing the masculine symbols.

One example of her conscious and critical attitudes is her view of the role of science in society: Whether science benefits society depends on the issue. Science is good for medicine research, but she also sees the harmful effects. She wants more emphasis on medical research, while further technological developments are not that important.

School science is somewhat difficult, and not very interesting; she prefers other subjects much more. Compared with other student types, she is relatively concerned about environmental protection. In her future job, she wishes to realise herself through working with people. The chance that she will become a scientist or an engineer is negligible.

As an experiment, I chose to divide the Selective Girl cluster into two sub-clusters and study their interest profiles separately. Above, I revealed that the result of the initial cluster analysis was different from what I had expected. What I actually expected, was to find interest profiles that were more analogous to the interest profiles of the two Selective Girl sub-clusters. Both profiles show selective and conscious preferences, and indicate clearly defined identities; but the two interest profiles – and assumable also the two identities – are of *different* kinds:

The Selective B Girl is virtually only interested in learning about the human body (therefore the B in her label): how it works, how it is built, how it matures, issues related to sculpturing and keeping the body fit, health issues, etc. Like the Reluctant, she is *not* interested in puzzles like the universe or science in the making.

The Selective W Girl is also interested in topics related to the human body; but in addition, she is interested in certain *other* subjects. In particular, one topic serves to distinguish between these two sub-clusters: mysteries and wonder. As distinct from the Selective B Girl, the Selective W Girl likes to wonder (therefore the W in the label) about the universe, mysteries and enigmas.

These two student types can serve as examples of how one cluster contains a range of different kinds of student types and identities, and how femininity has a variety of expressions. Also the other clusters could have been divided into sub-clusters; and with a large enough sample, one could continue and continue to divide clusters into sub-clusters, and presumably continue and continue to find interesting differences in interest profiles.

**The Selective Boy**

This is the male version of the Selective Girl. Costa would probably have labelled him Other Smart Kids, and Lyng would have called him the Macho boy. Like the Selective Girl, he is outspoken and self-expressive, with critical and conscious attitudes and with intense, precise and discriminating preferences.

Like the Selective Girl, the Selective Boy has clear ideas about who he is, and he shows his identity in most school contexts. In the ROSE survey, he shows his identity by expressing very high interest in masculine topics, e.g. technology, and by rejecting feminine topics, such as horoscopes. In this way, he demonstrates for me, his teacher, his peers and himself that "I am *this* kind of guy – not *that* kind!"

His interests are connected to the stereotype masculine, as described above, and he distances himself from the feminine values. He is modern and reasonable; he can be enthusiastic when the teaching suits him, and probably less cooperative when the learning situation address issues that he sees as irrelevant for himself.

He thinks that school science is not very difficult, rather it is interesting – but it is not his favourite when compared to other subjects. He believes that science benefits society, he is moderately concerned about the environment, and he thinks that environmental protection is somewhat important. He wishes to fulfil himself through his work, and he would like to work with his hands and with tools. Working with people is not important for him; he would rather work with technology.

### 11.1.4 Cross-national patterns in youth's interests

In the last empirical chapter, I wanted to see the interests of Norwegian girls and boys against a background of youth in other countries at other levels of modernisation, as I wished to see whether I could find empirical support for my assumption that interests in science are related to modernisation of societies.

Due to some weaknesses in the sample quality and the validity of my operationalisation of the notion *degree of modernisation*, the results in the international chapter need to be examined in the light of these reservations (see 4.8, 10.1 and 10.6).

I found that geographical closeness and level of modernisation were the two factors that seemed to connect the countries together. The latter, in particular, was of interest for my research objective.

We know from before that Norwegian girls and boys have characteristic and different interests. From the cross-national analysis, I infer that their interests in some of these themes may be related to modernity, others not. For example, the interest in mysteries, enigmas and the universe are particularly associated with youth in modern societies. Youth in modernised societies may be more concerned about animals. Boys in

developed countries show a particular enthusiasm about explosives, while girls seem more interested in the human body, human health and issues related to developing and sculpturing a fit body. In contrast, such a body-interest among boys seems to decrease with increasing level of development.

This last conclusion describing modern boys' interest in the human body may be an artefact deriving from the questionnaire design, and thereby too bold and crude. Norwegian boys express a very high interest in how to exercise to keep the body fit and strong. Therefore, the questionnaire items related to *developing a fit body* may be biased towards girls' means of body sculpturing (see 8.4.1). Furthermore, I have questioned how well the items related to this issue function in a cross-cultural context. On the other hand, the topics related to human health, biology and how the human body matures are, as far as I can see, more balanced in respect to relevance for boys' and girls' bodies; so, for these themes I infer that the boys seem to put more distance between themselves and such issues, the more modernised the country is.

Norwegian boys' pronounced interest in technology cannot be explained by degree of development. It would be a fallacy, however, to say that this interest is not connected with the modernisation of societies. Technology in itself (as defined by the technology-related items in the questionnaire) is a product of industrialisation, and industrialisation is one of the driving forces in the modernisation processes. Traditional societies, unaffected by modernisation and globalisation processes, hardly exist any more and are therefore not represented in the ROSE material. This means that my analysis cannot capture the interests of students in societies that are unaffected by technological developments and Western culture. My discussion can merely address matters of *more or less* developed, industrialised and modernised countries. But the results of my analysis indicate that the boys' interest in technology is not related to the *degree* of development. The interest in advanced technology seems to be high among boys in more *and* in less developed countries. In contrast, the girls' interest in technology seems to decrease the more developed a society is.

We have also seen that the more developed a society is, the less interested the students seem to be in learning about environmental protection, the work and life of scientists, and issues related to plants and farming. Boys in modernised societies are also less interested in some aspects related to the natural environment and surroundings.

The chapter has some diagrams showing girls and boys' scores in miscellaneous topics. These diagrams suggest that there is a characteristic worldwide pattern of sex differences. There is a tendency for all girls to be interested in the same topics, and similarly for all boys. This can be seen as a sign of the global scope and extent of the modernisation processes. Another interesting pattern appearing from the diagrams is that we often find larger sex differences in more developed countries, and that among the items in the ACE question, there were no topics with the opposite pattern; i.e. with a tendency for girls and boys to approach each other's interests with an increasing level of development. This can be understood in light of sociological perspectives, which state that sex is an important attribute in youth's identity construction, and that young people in late modern societies tend to emphasise their sex identity:

The more modernised a country is, the larger the sex differences are. This can be understood as follows: The more modernised a country is, the more girls accentuate that they are girls and boys accentuate that they are boys. (This may be perceived as paradoxical, since more gender equity is perceived to be an outcome of modernisation processes.)

I want to close this paragraph of international analysis with a notion of the multifaceted property of data material of this kind – multifaceted in terms of data quality, response traits and item meanings, but most of all in terms of the complexities in interest formations. Human behaviour is complex, and influenced by a wide range of factors operating at many levels, and one theory alone cannot claim to provide complete explanations, or provide precise predictions. There is a large diversity of theories aiming to explain and understand people's interests, and there is a consensus within the social sciences that the mechanisms are complex and impenetrable, and that one needs to draw on more than one model in order to explain interest differences among people. I have emphasised the perspective of modernisation processes, and searched for signs of the way in which modernity may influence students' interests. This explanation is not complete, and some results may be affected by weaknesses in my research design. Nevertheless, my analysis has undoubtedly produced some hints about relationships between development and young peoples' interests that can be pursued in future research.

### 11.1.5 Discussion

These are only some few and detached comments to the analysis and the results:

Neither of the Selective Girl and Selective Boy clusters were pure single-sexed. In both clusters, there were a few students of the opposite sex to that of the cluster label. Gilbert and Calvert explain: "It was clear [...] that *some* women are attuned to and identify with aspects of the masculine [...]. It is also clear that some men are attuned to, and identify with, aspects of the feminine" (Gilbert & Calvert, 2003, p. 876, authors' emphasis). The students with the opposite sex in the Selective clusters are possibly attuned to the identity of this sex. Alternatively, some students have given a flippant sex response on the questionnaire cover sheet. With hindsight, I believe that these respondents should have been deleted from the clusters, because I perceive these students as what Lyng would have called Typeless. When constructing the clusters in chapter 6, I excluded flippant and Typeless respondents. In order to be consistent, the students with opposite sex of the Selective student type could have been deleted too. But I do not see their presence as problematic for my results. In fact, I would hypothesise that the Typeless students have weakened, not exaggerated, the cluster differences.

I will raise three questions that emerge from my analysis and my results (although they may be more relevant for youth sociology than for science education). Clear answers to these questions would be speculation, so they will not be pursued here:

**Are girls more modern than boys?**

In chapter 2, I referred to perspectives on modern youth, which propose that girls' culture is more modern than boy's culture, because the boys' culture is lagged behind by its roots

in the industrial society. Literature, as well as my results, also indicate that girls have more post-material values than boys. Have we seen any indications of a more modernised youth culture among the girls than among the boys? Is it possible that girls' well-developed curiosity about mysteries and wonders, which can be seen as carrying notions of post-modernity and relativism, indicate a more modern girl culture than boy culture? In the chapter with the international analysis, we found that the girls had far more items than the boys that were correlated (positively and negatively) with the modernisation level. May this be an indication of the same?

**Is the Selective type more modern than the Unselective?**

Are the Selective Girl and the Selective Boy more modern than the Reluctant, the Undecided and the Enthusiast? An evident pattern in the international analysis was the increasing sex differences appearing with increasing level of development. We have seen that the Selective student types make a clearer distinction between themselves and the opposite sex than the Unselective do. Is this a sign of more modernised youth cultures? Are the amplifying tendencies of modernity mirrored in the amplified responses of the Selective student types?

**Problematic, modern and post-modern portraits of student types?**

In 2.5.5, I referred to Eckersley's three portraits of youth: the *problematic*, the *post-modern* and the *modern*. The portraits describe different depths or aspects of youth, rather than three categories into which youth can be classified. I am nevertheless tempted to ask: Does the Reluctant student type tend to converge towards the *problematic* portrait, and the Enthusiast towards the *modern* portrait, while the two Selective student types may be better described by the *post-modern* portrait?

Again, answers based on the present analysis would be speculative.

## 11.2 Issues of research quality – and further research

This section will end my discussion of the data. I will draw attention to some weak points in the data and my interpretations, and some of these can point towards issues for further research. The trustworthiness of the international data and the relevance of the inferences about cross-national differences and similarities are discussed in section 4.8, 10.1 and 10.6. The focus in this section will consequently be on the analysis of the Norwegian data.

### 11.2.1 Data quality, inferences and further research

Although I have argued that the Norwegian data are of sufficient quality for my research objectives, analysis sophistication and level of detail, the quality could naturally have been better. Compared to the TIMSS and PISA sample sizes, my sample is small. For small samples, random selection does not guarantee a representative sample. It only guarantees that sample weaknesses have occurred by chance and not by systematic bias. Furthermore, my sampling routine selected school classes, and not individual students. One problem with cluster sampling is that the respondents within one cluster, i.e. the students in one

classroom, may be more similar to each other (e.g. because of common place of living and similar school experiences) than randomly selected individuals. The sampling error in a cluster sample is therefore larger than in a sample constituted by randomly sampled individuals. Moreover, the coding procedure could have been of higher quality by involving inter-coder reliability testing.

In spite of such weaknesses, I doubt that my conclusions would have come out noteworthy different if the sample was drawn again with more sophisticated sampling methods or larger sample size or if the coding routines were better. I have only pursued the robust and sturdy results, my student typology communicates well with student types in other studies, and there are no clear conflicts between my results and results from other studies of girls' and boys' interests and attitudes related to science and science education. Nevertheless, some of the data quality issues can be illuminated in later studies. For example, multilevel analysis techniques (see e.g. Hox, 1995) can clarify how the clustered sample has influenced the results.

Missing responses can also illuminate some issues related to data quality. The questionnaire has no response category for "I do not understand the question". Instead, each question is introduced by *If you do not understand, leave the line blank*. This means that a missing response may not be a misprint, an oversight or some other kind of slip, but rather a "do not know" or "do not understand" statement. In light of this, missing responses may be valid and even interesting. Appendix G shows missing rates for all questions except the open-ended ones. (The rates are given for the Norwegian sample constituting the five student types, i.e. without the 49 cases excluded in 6.3 due to high ACE missing rate). In question ACE. *What I want to learn about* and B. *My future job*, the missing rates generally lie below one percent. Question D. *Me and the environmental challenges* and G. *My opinions about science and technology* have overall higher missing rates than question F. *My science classes*. This may indicate that the students found it more demanding and difficult to take a stance on question D and G. Particularly item D03, D06, G06, G10, G13 and G15 have higher missing rates (close to or above four percent). Among these, only data from item D06. *I can personally influence what happens with the environment* and G06. *The benefits of science are greater than the harmful effects it could have* are used in my analysis. Since both items are incorporated in indexes, the item weaknesses will have less effect on the results. Question L. *Goals for society* is the very last question in a long and maybe after a while tiresome questionnaire. The relatively high missing rate in this question (ca. 3.5-5 percent) may be due to lack of time and/or lack of motivation to continue.

Also in question H. *My out-of-school experiences* [94] there are some items with peaking missing rates. Particularly item H34. *used a water pump or siphon*, H36. *used a science kit* and H57. *used a crowbar* have noticeably higher missing rates than the other items. I consider this as strengthening the reliability of the data. These items address rather

[94] As the data from question H are not analysed in this thesis, I have not referred to this question earlier. It asks the students about their out-of-school experiences, and is an inventory of activities, each with a four-point Likert scale ranging from *Never* to *Often*. The question provides information about students' experiences out of school. The activities may have bearing on their interests in S&T and/or provide experiences for the learning of science at school.

peculiar issues, probably unfamiliar for some Norwegian students. These and other peaking missing rates may indicate that many students have left the response categories blank in incomprehensible questions. Possibly, most of the students did as we encouraged them to do; to think carefully and give answers that reflected their own thinking and to leave the line blank if they did not understand.

I have interpreted the students' orientations towards science as signs of late modern identities. The validity of this can be questioned. I assume that inferences drawn by another researcher could have come out differently. Indisputably, my theoretical framework cannot explain *all* the results. But I have found the interplay between my results and the theory informing, exciting and fruitful – and largely credible.

The validity of explaining the typology with modernity perspectives can be pursued by studying typologies emerging from other national samples. From my theoretical perspective, I expect that one will find typologies more or less similar to mine in other highly modernised countries, and that data from more traditional countries will give less pronounced student types. Here the ROSE material still has unexploited potentials.

The relevance of interpreting the results in the light of theories on late modernity can be further scrutinised by studying the student types against some still untouched questionnaire variables. Rhetoric of late modernity is the notion of cultural liberation and the idea that everybody is free to develop his or her own biography. In this context, an ever-reappearing question is how different structural variables come into play in young peoples' attitudes, choices, future orientations, etc. ROSE provides data on which school the students attended. This variable can indicate for example how students living in rural areas differ from students living in the cities. Furthermore, the students have answered a question about the number of books in their home. This information can be used as proxy for the socioeconomic status of the parents. The relationship between this variable and students' orientations towards science can be followed up in later research.

### 11.2.2 Further research beyond the ROSE material

Another question that my study leaves unanswered, is to what extent the five student types portray orientations towards science in particular, and whether these orientations are general for the whole schooling exercise. The ROSE material does *not* have the potential to illuminate this issue. For example, we do not know how the students in the Reluctant cluster relate to other school subjects. The Reluctant student type's aloof expressions in *all* questions, including the questions that are less related to science, indicate that this is a general attitude, also beyond the science classes. On the other hand, we do not know how the students are influenced by the survey context, i.e. that the survey was conducted by the science teacher in a science lesson. While Costa sees some of her student types as expressing an attitude that is specific for their relationship to the science classes, Lyng's student types express *general* school commitment or school rejection. The student types have subject preferences, but Lyng does not specify which student types favour or disfavour science. Answers to this question can be seen as deciding factors for the implications of my results for schooling in general and science education in particular.

I assume that the school or science rejecters confront schools and teachers with challenges that go beyond schools' traditional teaching-and-learning tasks. This necessitates a better understanding of why students develop school or school science rejecting identities. For example, I would like to see studies focusing on the connection between students' school performance and school identities, and studies of how schooling can facilitate the development of more committed student identities. Aikenhead suggests the science teacher as a travel-agent or a tour-guide who bridges the lifeworlds of the students with the lifeworld of science. In my terminology, this would be a science teacher that is sensitive and responsive to youth's culture, to young people's identity projects and to their views on and hopes for the future.

In order to achieve a deeper understanding of how the late modern zeitgeist influences young people's orientations towards science and science-related problems facing our society, I would like to see more comparative research on such issues. This can also be illuminated through further cross-national comparisons in the ROSE material. Whatever such findings may say – the prevailing level of interest, attitudes and concern among young people cannot be changed inside the science classrooms alone. In order to design a suitable science and general education for today's young people, some rethinking needs to be done (and is, indeed, occurring) regarding curriculum content and structure, teaching methods, teacher education and in-service training, and development of suitable resources. Suggestions of such reforms go beyond the scope of this thesis. The following section is more narrowly addressing the meeting between schools and youth culture.

## 11.3 Reflections: Science, school and youth culture

This is my last objective:

*V Discuss how sociological perspectives on modern youth can inform the area of science education*

Although the following discussion is inspired by my empirical results, it will go beyond the data. One cannot deduce from my results any remedies for the science teaching. The suggestions in this section are based on my personal perceptions and interpretations. Others may have different views.

I have three reasons for including this last objective. First, I believe that sociological perspectives on youth referred to in this thesis are fruitful and under-articulated in relation to some of the challenges facing science in society and in the school context (outlined in chapter 1 and 3). I will now revisit some of these challenges, but this time by drawing on sociological perspectives on youth in late modernity. Second, I feel in a way obligated to address the *so what*-question raised by my (and any) research. I have argued that my study will provide information that can make science educators better equipped to meet young people in their culture, priorities and concerns. Here, I want to be more concrete. Finally, I have declared that I will promote a school science that aims to empower the individual to make a better world. I have referred to literature indicating a conflict between modern young peoples' hopes for the future of the globe, and their consumption and lifestyle patterns. I want to discuss some aspects of this.

My reflections are not meant as a voice in the grand philosophical, political and ideological school discussions, taking place nationally and internationally, now as always. Instead, the framework for this discussion is narrowly defined: I will take *youth culture*, *youth lifestyle* and *youth's identity construction* as my starting points. Rather than referring to nationally and internationally established authorities in ambitious pedagogical discussions, I will mainly refer to authors who can shed light on the meeting points between Norwegian compulsory school and late modern youth culture.

### 11.3.1 "The integrated human being"

The school arena is important in many ways. In addition to providing a place where young people can get "a broad general education so that they can become useful and independent persons in their private lives and in society" (as stated in the core part of the Norwegian curriculum, UFD, 1996), the school is, besides leisure and home, a principal youth ground. The school arena is about young people's present-day life as well as their life in the future. Besides developing competencies in reflecting over the society and the world, young people shall develop the individual strength needed to take responsibility for their own life and actions.

The Norwegian Core Curriculum describes a number of dual aims related to the schools' endeavour to develop "the integrated human being". The following are a few examples:

> Education has a number of seemingly contradictory aims:
> - to convey our culture's moral commonality, with its concern for others – *and* to foster the ability to plot one's own course
> - to overcome self-centeredness and belief in the right of the strongest – *and* to inspire strength to stand alone, to stand up, to dissent and not to knuckle under or cave in to the opinions of others
> - to develop independent and autonomous personalities – *and* the ability to function and work as a team
> - to teach and tend our national heritage and local traditions in order to preserve variety and uniqueness – *and* to meet other cultures openly in order to find pleasure in the diversity of human expression and to learn from contrast
> - to inspire respect for facts and sound argument – *and* to train critical abilities to attack prevailing attitudes, contend with conventional wisdom and challenge existing arrangements (UFD, 1996, author's emphasis)

The school should develop young people's competencies in coping with and balancing these contradictions. In a sociological perspective, changes and developments in the individual happens in groups and in social and cultural structures (Frønes, 1997).

### 11.3.2 "Stop demonizing individualism"

As touched upon in chapter 2, there is not necessarily a conflict between, on the one hand, identity development, self-realisation and enjoying oneself, and, on the other hand, care for others, and engagement and concern about one's surroundings and making the world better. Such mechanisms can rather be seen as mutually inclusive, strengthening and enriching one another (Beck & Beck-Gernsheim, 2002). For example, a person may be enthusiastic about environmental protection, and environmental engagement and a green

lifestyle may constitute significant elements of the person's identity and self-realisation project.

Beck and Beck-Gernsheim make an appeal to people, to "stop demonizing individualism, which has already become a reality, and instead acknowledge it as a desirable and inevitable product of democratic evolution" (Beck & Beck-Gernsheim, 2002, p. 161). Their understanding of the fact that "the 'me generation' may participate in demonstrations and in circulation petitions" but they "hate [political] organizations for their formalism and their convoluted and dishonest call for 'selfless' commitment" (ibid, p. 158) is worth quoting at length. According to these authors, insight into this seemingly paradoxical situation is blocked by certain public fundamental assumptions:

> 1 The equation and confusion of commitment with membership – if membership lists are the only things that show commitment, then non-members are of necessity egoists.
> 2 The self-sacrifice assumption, that only by ignoring oneself can one live for others.
> 3 Silent help of the *housewife syndrome*, conveying that the dignity of serving others is that it remains invisible, that is, unpaid and unacknowledged, done at the behest of others who are in control (ibid, p. 160, authors' emphasis)

In other words, membership lists do not provide a good measure of young people's commitment and concern. Selflessness and invisibility might have been admired in the past, but in this modern world, they are outdated. The same applies for the image of the heroic helper-and-nothing-but and the selflessly performed service (Beck & Beck-Gernsheim, 2002).

There is only one direction for the modernisation processes: The processes cannot be reversed, and modernised societies can never return to the conditions of pre-modernity (Fornäs, 1995). The societal transformations are irreversible, and cannot be undone. Traditional values presuppose traditional societies. Appeals for re-vitalising yesterday's words of honour, like *obedience*, *conscientiousness, humbleness* and *self-effacement* would fall flat among young people, as the individualisation processes have already shaped the individuals' ways of thinking about themselves and their surroundings. Consequently, the individualisation processes can neither be rejected nor denied. Rather than praising dated values as selflessness and invisibility, and accusing late modern people for lack of such, the school should aim at *bridging* individual uniqueness and prestige with solutions to problems facing our world.

Although there may be little evidence that today's youth are less materialistic than their parents, materialism should not be seen as being in diametric opposition to social engagement. Material goods and consumption function as symbols of lifestyle and identity (Brusdal & Frønes, 2003). Or, with Bauman and May's words: "Tell us what you buy, why you buy and where you go shopping, and we'll tell you who you are, or want to be" (Bauman & May, 2004, p. 192, my translation). The market forces create fashions, and media communicate the message that if you want to maintain your identity, you need to replace your old stuff with something new. Goods are thrown away, not because they do not function, but because they are no longer useful for expressing the identity one strives for. There is not, however, necessarily an antagonism between materialism and making the

world better. One may fancy material goods, and *concurrently* regard peace, democracy, solidarity, social justice and environmental protection as imperative issues.

One event that may serve as an example is the *coloured wristband* tend in Western societies this year (2005). In 2004, the cancer survivor and champion cyclist Lance Armstrong started a new trend by launching yellow Livestrong wristbands. The bands have been sold all over the Western world, and the income supports the battle against cancer. The trend has been picked up by other charity organisations, so now one may also find red wristbands for the benefit of the HIV/Aids problem, white wristbands in aid of combating poverty, etc. These items have been (and still are) in great demand, especially among young people. In the wake of the trend have followed wristband copies from business companies that try to exploit the market. The wristbands have stimulated considerations and discussions among young people. For example, they discuss which social problems they see as the most imperative, they state that they want the *original* bands, as the copies "do not support work of charity", and if they pay more than the minimum price, they brag about it to their friends.

I see this wristband trend as a synthesis of, on the one hand, fashion and materialism[95], and on the other, post-materialism and a desire to make a better world. On the top of that, the wristbands are identity expressions, communicating for example that the wearers want to be seen as up-to-date, concerned and responsible young world citizens. Undeniable, wristbands are connected with consumption and materialism, but they also reveal idealism and post-materialistic values.

### 11.3.3 Schools' meeting with youth culture

Individualisation in society and schools (see 2.3.5) has provided the students with more decision-making powers. The new "negotiation students" have the right to be heard, and expect that their voice will be taken into account. This influences the relations between students and teachers. There is less general acceptance of strong authoritarian teachers, and the new teacher has left the blackboard and works on the floor among the students (Lyng, 2004a).

After the release of the Norwegian PISA 2003 report, concluding with disturbingly low science achievements among Norwegian students (Kjærnsli & al., 2004), some 15 year-olds said in a Norwegian newspaper that "the social environment at school is more important than the results of the OECD-study". They stated that "EQ [Emotional Quotient] is just as important as IQ", where EQ is "to have good contact with one's own feelings, and the backbone to follow them" (Yttervik, 2004, my translation). Precisely this is what today's youth may perceive as the most important and meaningful. In a recent newspaper interview, Frønes says that today's young people are more concerned about "the good life" than about school performance and career (in Meek, 2005). According to

[95] My notion of a relation between charity wristbands and *consumption*, *materialism* and a *desire for material goods* refers to how these bands function in the Norwegian *youth culture*. The wristbands may function differently in other parts of the population. Among youth in the early teenage, the bands represent a trend on level with any other youth fashion, and relates to rapidly evolving fashions and corresponding consumer behaviour.

Ziehe, the weakened capacity of traditions and grand narratives to define the individual has lead to greater emphasis on *subjective meaning* (Ziehe & Stubenrauch, 1993). In every area of life, including school classes, young people will reflexively consider the subjective meaningfulness of what is being taught.

Aagre (2003) argues that youth culture is seen as an alien intruder into the Norwegian school. Schools meet impulses from the youth culture with hostility, stony silence and incompetence. He refers to the following text in the Norwegian Core Curriculum:

> [Young people's] increasing exposure to the mass media *places them in the passive role of spectators* [...]. The narrowing of the young people's contact with the practical world outside the school and the consequent reduction of interaction with adults, is often exacerbated by an *introverted and introspective peer culture.* (UFD, 1996, my emphasis)

According to Aagre's definition of youth culture (see section 2.4), it develops in a symbiosis with the media. The negative image of media stated in this curriculum quote above conveys a negative image of one of the central components of youth's culture. The school should aim to "meet other cultures openly in order to find pleasure in the diversity of human expression and to learn from contrast" (UFD, 1996, from the curriculum quote in 11.3.1). Nonetheless, on another page in the same curriculum, youth culture is portrayed as "an introverted and introspective" obstacle, rather than as a resource for the teaching.[96]

Results from TIMSS 2003 show that Norwegian science teachers draw attention to three main obstacles for their teaching: Students' lack of interest in the subject, their low schoolwork morale and students that disturb the teaching. In an international context, Norwegian schools have "exceptionally rowdy and unmotivated students" (Grønmo & al., 2004, p. 312, my translation). From PISA 2003, we know that

> Norwegian classrooms are seemingly, to a large extent, characterised by noise, unrest and wasting of time. Relative to the OECD mean, Norwegian students experience their teachers as less supportive, and they report less positive relationships with their teachers. And not least alarming: they express a less positive view of the value they get from their schooling (Kjærnsli & al., 2004, p. 232, my translation).

The PISA researchers see these challenges, as well as the low student achievements in science, in the light of the democratisation processes and the increased student participation that characterise recent school developments (see 2.3.5):

[96] The youth culture is, in any case, a part of the culture of the society in which it develops. Young people wish to realise themselves, and do something they find meaningful; but what they perceive as meaningful is influenced by the societal discourse. Newspapers, magazines, commercials and broadcast media (driven by generations older than the youth generation) focus on how each and everyone can develop one's body, one's friendships, one's sexual life, one's culinary skills, one's health, one's belief in oneself – as well as material goods like one's wardrobe, one's home, one's country place, one's car and one's money. I would argue that youth culture criticism such as quoted above – "an introverted and introspective peer culture" (UFD, 1996) – will boomerang back on the criticisers.

> With increased student participation, it follows that the students' views of what is fun, not to mention "cool", plays a larger role. Young people today live in a time dominated by entertainment; in particular, the TV-medium has contributed to the notion that even information should function primarily as entertainment. *Infotainment* is the English term for this phenomenon. The school is in danger of falling into this trap, unless it dears to take a deliberate stance opposing this tendency of the time, because there is no "cool" shortcut to knowledge. (Kjærnsli & al., 2004, p. 259, authors' emphasis, my translation)

I see these quotes from the Norwegian curriculum and PISA report as examples of how the schooling is challenged by the youth culture.

Aikenhead uses the metaphors *tour-guide* and *travel-agent* for describing teacher positions (see 3.4.2). Hodson (1998) refers to how the teacher has been portrayed as a *broadcaster* and a *gardener*, and he adds to this list *the teacher as an anthropologist*. This last suggestion is imaginably not very different from *the teacher as a sociologist:* The science education community may develop a better understanding of today's young people, their concerns and their relationship to school and science, by drawing on perspectives from youth sociology. When we know and are aware of the rules and requirements imbedded in the youth culture, we can challenge young people's views and encourage them to explain, justify and develop their own line of reasoning. Norwegian girls and boys grow up in a late modern society, which makes their adolescence *different* from that of previous generations. How they can be met, and the norms for how young people should function and behave, should be in accordance with the present-day society.

There may be many different suggestions for how schools can relate to youth culture. One model could be to put students into groups according to their student type. The groups could have different teachers with skills in managing and interacting with different types of youth, and the teaching methods could be attuned to the student types' needs. We do not have any tradition for streaming students in Norway, and I will not pursue this model. Rather, I will describe three school models developed by Aagre (2003):

**"The scholastic school"**

The school culture can aim at standing as a counter-culture to the youth culture. Lyng found that the student types that were most rejective to school were also those who most forcefully requested strict teachers. Lyng interprets this as showing self-insight: These students know that unless the teacher has the authority to prohibit their saboteur behaviour, their student role will not allow them to work committedly with the subject. This may be in line with the Norwegian PISA researchers' suggestion for meeting the discipline problems in the Norwegian classrooms (referred above): "A restoration of the teacher authority appears to be a tremendous challenge for the Norwegian school." (Kjærnsli & al., 2004, p. 259, my translation)

In Aagre's description of *the scholastic school*, the teacher holds the *school subject* at the centre of attention. This teachers' attention towards the students is closely connected with the students' interest and achievements in the subject. S/he believes that aiming to meet the students in their culture would come at the expense of the subject to be taught, and lead to a reduction of learning quality. The teacher in the scholastic school argues that the teaching should be clearly defined by precise and well-defined goals in the

curriculum. The teacher notes that many students are absorbed in "matters in the youth culture", but does not see this as applicable to her/his teaching situation.

Aagre anticipates that this kind of teaching would function well in schools where a large proportion of the parents have higher education and give much support to the teaching idea of the scholastic school; but he also predicts that the level of frustration among the teachers will rise with time. They will think that the students suffer from concentration problems, or that "the students through media and youth culture are concerned about superficial matters, and consequently they avoid hard and long-term work" (Aagre, 2003, p. 141, my translation).

Within the youth group, Aagre envisages polarisations between the school-committed and the school-rejective students. The committed ones will regard the rejecters as destroying the good learning situation. The rejective students might be separated from the others as "problem students". The largest student group would presumably be a passive and somewhat indifferent "mainstream" group.

**"The cool school"**

The fact that today's youth does not choose to pursue S&T studies may indicate that school science does not succeed in presenting the subject as personally meaningful. In the empirical chapters, we have seen that young people are interested in learning about a variety of topics that may function as gateways into science teaching and learning. But can or should school science continually adapt to the prevalent spirit and ideas of the time? Would changing the science curriculum according to the current youth culture be at the expense of presenting high quality accepted science?

TIMSS and PISA measure achievements, and may therefore easily be seen as projects advocating the scholastic school. ROSE, on the other hand, taps into students' perspective, and people may thereby believe that this project aims to promote a school that continuously adapts to what is popular. A school like this would resemble what Aagre labels the *cool school*.

The cool school is more concerned with the general well-being among the students. This school is *a place to be,* more than *a place to learn*. The teacher understands and accepts that the students find the classes tiresome and demanding, and aims at a youthful teaching style, based on equity between the teacher and the students. The teacher accepts the many (and often so-so) suggestions from the students about the subject content and methods.

Because the teacher knows that many students are engaged in popular music, youth magazines, internet and TV series, s/he tries to prepare the lessons by actively drawing on such materials. The teacher can be seen as an entertainer, or a waiter – introducing new and varied menus, in an exciting locale with a pleasant atmosphere. The most accessible curriculum subjects are prioritised, while some more demanding parts are "sneaked" into the lessons.

However, the teacher is usually not familiar with the many and diverse contradictions between the youth sub-cultures, and will consequently not recognise the antipathies and sympathies within and between the youth groups. The teachers' idea about youth culture does not capture the cultural diversity among the youth. This will make

students with more narrow interest areas feel that too much attention is being paid to the "mainstream" youth. Furthermore, since the teacher assumes that youth culture clashes with the general school tradition, the more able and school-committed students will feel overlooked, and believe that their subject interests and efforts are not valued. The students may also have little acceptance, and indeed find it somewhat pathetic, when a teacher is trying to be "cool" on their terms.

The cool teaching method would be at the expense of content learning. Parents will have little patience with this approach. They may appreciate that the students enjoy the lessons and the school environment, but they will request some ideology or direction. The more scholastically oriented parents will be not satisfied with this school.

**"The reflexive school" for more active and engaged students**

Naturally, the science curriculum cannot be based on opinion polls among the students, and continuously adapt to the topical interests and values in the youth culture. This is neither desirable nor possible. The great diversity in students' interests point towards a curriculum that allows diversity in the ways students engage in and use the science content.

In 2.4.2, I referred to Lyng arguing that since students have to follow the recipe of their own student type: the Macho Boy, the Wild Cat and the Babe can only be actively engaged in the learning situation when they are allowed to work with symbols that are in agreement with their identity. If not, they will perform as saboteurs. Lyng suggests that the teaching must find approaches to the subjects that make it socially possible for more student types to engage in the schoolwork. This calls for differentiated teaching, in the sense that the learning situation must allow the students to approach the subject from an angle that corresponds to their student type. She puts forward project work as a teaching method opening up for this. Other studies find that students appreciate working with projects, because such work allows the students to choose subjects in accordance with their own interests and abilities (Hovdenak, 2005).

My analysis has indicated that that science is perceived as useful when the teaching addresses issues related to the students' personal interests. By reading interests as signs of identities, this can be rephrased to: *The science lessons are experienced as useful mainly when the teaching directs and involves the students' identities and their essential selves*.

Aagre suggests a dynamic meeting between the youth culture and the school culture. His notion of *the reflexive school* is based on Giddens' perspectives on reflexive modernity and the reflexive self. The following quote is from Aagre's interpretation of Giddens:

> [T]he individualistic post-traditional society emphasise the individuals' ability to put feelings into words, to give reasons for their actions, to construct a coherent narrative about their relation to the social environment, and to reflect about possible options for their choices and their development. The reflexive project of the self is, therefore, not an egocentric course of action. The self-narrative is about identity, but it can be deeply social, and a social self-identity can to a large extent contribute to stability and mutuality. The search for and construction of meaning in a social context are central in the reflexive project of the self. Classrooms and workshops are good arenas for such processes (Aagre, 2003, p. 143, my translation).

Reflexivity involves self-confrontation. Rather than accept and adopt, or reject and deny the youth culture, schools can, as in any reflexive meaning-making, confront the students with their own values. In the reflexive school, the students are challenged to reflect on their culture and their priorities.

In a reflexive school, the teacher is allowed to be provoked by the youth culture, but not to neglect or repress it. The teacher can be honest and explicit about her/his reactions, and invite the students to give reasons for their views. The meetings between teacher and students may be conflicting, and the conflicts can be used to illustrate the teacher's and the different students' views, and how the views represented by the youth cultures clash with the general culture or with their wishes for the future.

The reflexive school sees the youth's interests and culture, including conflicts between sub-cultures and their expressions, as resources that can be utilised for developing more active and engaged students. The school aims at detecting exciting meeting points between youth cultures and the subject matter. When the youth culture is taken seriously, the students themselves have to put words to and give reasons for their values, concerns and priorities. The teaching utilises students' interests and concerns as gateways into other more unfamiliar subject matters. It facilitates argumentation and conflicting views, and encourages the students to reflexively take a deliberate stance towards their own culture and views.

The reflexive school seeks conflicts and tensions between the subject and the students' interests and culture. *The teacher will pick up the students' associations and objections, and challenge the students to take conscious and informed stances.* This makes a fruitful chaos that may develop new insights both for students and for the teacher. The teacher will develop skills, and a general understanding of contemporary youth issues. S/he may even develop her/his scientific knowledge further, as her/his general knowledge will be continually confronted by other ways of seeing and understanding.[97] In some areas, e.g. in human biology, quasi-science, technology, explosives and the universe, the students might even have more knowledge than the teacher, and s/he then has to learn from the students. The teacher and the students have to accept incomplete conclusions and open-ended summaries.[98]

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[97] The reflexive school may challenge the science teacher beyond her/his competencies, and this will have some implications for teacher education. Nevertheless, the teachers must be regarded as the key actors in, and supporters of, the reflexive school. They represent an opportunity to improve the schooling, rather than a problem and a hindrance.

[98] One example of a teaching situation can be project work, or a prepared debate, on the subject of *medicine*. The approach to the subject may be left to the students' individual choice. When presenting the work in the classroom, the Selective Girl will propose some strong and convincing arguments for acupuncture, while the Reluctant will make a partly unprepared presentation about drugs. The Enthusiast presents a detailed and well prepared work on traditional school medicine, while the Selective Boy shows the movie he has made about biotechnology. The Undecided gives a résumé of an interview of her/his grandfather, who is a doctor. For all contributions, the teacher counters their arguments, stimulates the debate among the students and reveals conflicting views. The students and the teacher will gain knowledge and new insight into the human body and medicine, communicating science, the nature of science, societal controversies, critical questioning and argumentation, etc. Moreover, the students will be confronted with mismatches between their own view and views of their peers, teacher, textbook, etc., and thereby be challenged to reflexively develop their beliefs and attitudes.

This school model involves developing teacher skills in meeting the students in a mutual learning relationship and in finding a balance between, on the one hand, the fostering of responsible attitudes, and on the other, avoiding indoctrination and moralisation.

### 11.3.4 The school rejecter challenging schools

The Norwegian sociologist Thomas Nordahl accuses schools of appreciating conformity and students that uncritically adapt to the school culture, while the critical, autonomous, creative, self-assertive and forceful students are valued to a lesser extent (Nordahl, 2000). In the light of the curriculum aim of developing "the integrated human being" (a key point in the Norwegian Core Curriculum, quoted in 11.3.1) this appears as paradoxical. According to Lyng, schools normally provide the school-committed student types with a privileged position. The school culture fits the obeying and devoted Enthusiast, Golden Girl, Nerd and Dude – but how can schools facilitate meaning-making also for the school and/or school science rejecters (from now called only school rejecters)? I believe that some answers to this question can be found in the reflexive school, but there will always be some school-rejecters who represent a challenge for the teachers. Aikenhead (1996) gives no suggestions for how to include and engage the Outsiders and the Inside Outsiders in science classes (see 3.4.2), and Lyng's Macho Boy and Wild Cat can only be actively engaged in the learning situation when the subject is optional (see 2.4.2).

School rejection is unfortunate in various ways. The rejective students do probably not experience their everyday life at school as meaningful and satisfying, and the teachers' job satisfaction is probably challenged as well. Some school rejecters will choose not to pursue an education. In today's education society, these represent at-risk youth, with increased likelihood for marginalisation and social exclusion (Frønes & Brusdal, 2001; Hammer, 2003).

One may ask what factors lie behind the students' development of particular identities. Probably, the roles they adopt are influenced by peers, family background, home conditions, leisure activities, lifestyle, school experiences, abilities and many other factors. As described in 3.4.1 and 3.4.2, Costa and Aikenhead propose that students' home and peer background is the factor that explains their student type: Whether students become Potential Scientists or not, can be explained by how well their worlds of family and friends overlap the world of school and school science. A possible mismatch can be met by different ways of crossing the borders between the lifeworlds, for visiting the place called *science class.* The students must get help from the teacher's gentle leading and supervision in the alien science world.

Flores-González (2002) explains school rejecters differently. Her work takes its starting point in the tremendous challenges facing Latino students in US schools, where the dropout rate is exceptionally high. Flores-González describes how young students shape their group-identities. She finds two Latino youth identities: *school kids* and *street kids.* After some time, the school kid graduates and the street kid drop out. She found no close relationship between the students' identities and their home background, so her discussion of how schools can facilitate the development of school kid identities is based on the assumption that *the schooling* is the cause of the student identities:

The school kids are offered support from their teachers and peers, recognition and rewards, close and warm relationships with their teachers, positive feedback for their adequate performance as students, opportunities to explore and incorporate various other school-related identities, etc. Flores-González appeals to the school staff, that they should help the students in developing the school kid identity. Her recommendations for what schools can do, involve helping students to construct ambitious, yet realistic, plans for their future. The students should be confronted with life's realities, and told "how it is" (ibid., p. 156). (Among other things, the students must be prepared to deal with race discrimination.)

I find it reasonable to assume that in a Norwegian school context the students' school experiences influence their student type development. Norwegian kids enter school at the age of six; and at the age of 15[99] they will have developed a student type and a social identity. How can we understand their student type? An interaction analysis approach to this question (see footnote 92) may for example suggest that young people will evaluate the student type gallery they meet at school, and choose the type that they believe suits them. Seeing their student type as an outcome of their previous experiences at school, would be a condition analysis approach. Then the student type can be seen as a response, and as a coping strategy for life in school.

Following this latter line of thought, one may ask: How can schools hinder students in developing a school rejecter student type? And – as youth identities are not stable across time – one may ask: How can schools help a rejecter student type to develop her/his identity into a more school accepting attitude?

Following the argument of Flores-González, the reflexive school can confront the school rejecters with their position, and with the challenges young people may meet in their post-school life. Young people in today's education and risk society are detraditionalised and individualised. Their future life is theirs to shape; and whether they succeed in reaching their goals is, among other things, dependent of their priorities and their choices. The reflexive school can stimulate the students' self-confrontation with their own priorities and choices.

### 11.3.5 Recruitment to S&T studies

Young people in late modern societies feel culturally, socially and geographically liberated (Ziehe & Stubenrauch, 1993). Regardless of home background, they see themselves as free to choose their address, religion, social group, politics, education, profession, sexuality, lifestyle and values (Beck & Beck-Gernsheim, 2002). This fosters the feeling that one's life, including one's choice of education, has a range of possible ways ahead.

The empirical analysis shows that Norwegian students want their future job to be interesting and meaningful, to harmonise with their identity, and to open up for self-realisation and self-development. The girls want to work with, and help, other people. Furthermore, they have a relative positive view of many aspects of S&T in society and they consider school science rather interesting. However, they perceive it as less interesting

[99] The age of the Norwegian ROSE respondents.

than most other school subjects. Some boys see themselves working with technology, while the girls do not share this view. Moreover, neither girls nor boys want to be scientists.

I will make two points, which may illuminate the low and gender-imbalanced recruitment of students in modern societies to S&T studies:

1. The issues that are perceived as important and meaningful for young people depend on the country's level of modernisation.
2. An educational choice is an identity choice. Young people wish to *be passionate* about what they are doing, and they wish to realise themselves. Among the many possible and accessible ways ahead, they will choose what is for them the most interesting education.

These two points and some implications for the science teaching are briefly discussed below.

**Meaning - linked to the level of development in a country**

Youth's values and views are developed in symbiosis with the culture in which they are growing up. Young people wish to work with something they find meaningful – but what meaning do they put into the concept *meaningful*?

Whether a job in S&T is perceived as meaningful for the individual may be closely related to the country's level of development. The pronounced interest for a job in S&T in developing countries (see comparative analysis of the ROSE material in Schreiner & Sjøberg, 2005b; Schreiner & Sjøberg, 2006a) may indicate that youth in these countries find S&T meaningful. In developing countries, an important challenge for the society is naturally related to economic growth and to improvement of the social welfare system. Further material development of the society is a major political and public issue, and in this respect, S&T are seen as fundamental driving forces and therefore main concerns in the societal discourse (Malcolm & Alant, 2004). One may assume that in such societies, in which jobs in S&T are perceived as important for *society*, such jobs are also perceived as meaningful for the *individual*.

When today's modern societies were in the era of early industrialisation, the political and social focus was directed towards *progress*, *growth* and *building the country*. Consequently, precisely this goal – to build the country – was perceived as important for the *society*, and as meaningful for the *individual*. It may be that we now have passed the era in which the work of technicians and engineers are seen as crucial for people's life and well-being. Studies indicate that in poorer countries, young people have a more heroic image of scientists as persons than in highly developed Western societies (Sjøberg, 2002b).

According to Inglehart, late modern societies can be characterised as post-materialistic societies, emphasising values like environment, democracy, care for others, creativity and self-realisation. The recruitment of Western students into medicine, biology and environment studies is *not* falling; and in these areas, girls often outnumber boys. This may indicate that modern youth believes that the most important challenges facing our society are not related to further technological developments, but rather to health and environmental issues, and consequently that these fields can offer meaningful jobs.

**Non-modern identities associated with S&T?**

The mechanisms behind young people's educational choices are multifaceted and difficult to understand, and no theory alone has the capacity to give a complete explanation of youth's rejection of S&T studies and jobs. In this paragraph, I will draw on some perspectives on youth's identity construction.

Boaler et al. (2000) argue that when students develop an identity that does not correspond with the discourse of mathematics, they will, regardless of abilities, not choose to continue with mathematics studies. In 2.3.6, I referred to Heggen and Illeris et al. claiming that when students choose an education, they also choose and express an identity.

Students recognise that S&T are important for society, and they value the goods and the welfare following the development, but they are reluctant to have a job within these fields. We have seen from the empirical analysis that young people hope to get a job in which they can develop themselves, their talents and abilities. They also want to earn lots of money, and to have lots of time for their hobbies, interests, friends and family. Many young people want also to work with and help other people.

While the recruitment of students into S&T studies is decreasing, education institutions for actors, journalists and media experience an increasing number of applicants. The situation can be illustrated by "Something to do with movies", a Norwegian documentary addressing the following theme:

> I wanted to be something special.
> I wanted to be something exciting.
> I wanted to be something original.
> I wanted to be – something to do with movies.
>
> Before, young people were dreaming of a safe and stable job. Now many want to be "something to do with movies". The job is no longer a means for providing money to keep body and soul together, but a part of a larger life project. Before, professions such as engineer and doctor gave status. Now one should rather work with something creative and artistic – preferably something to do with movies.
> (from the movie introduction, Skog, 2002, my translation)

Frønes says that "to be an actor or a journalist is often seen as 'unconventional' and as a means for 'self-realisation' outside the standard life; while what actually would have been unconventional, would be to become a mathematics teacher" (Meek, 2005, in a newspaper interview).

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

Boaler and her colleagues argue that youth's identity development is an important, but neglected, factor in mathematics education (Boaler, 2002; Boaler & al., 2000). In order to understand why some of the "able" students continue with mathematics studies, while others do not, the authors take note of the youth's identity construction. Through their mathematics lessons, the students learn "how to *be* a mathematics student", i.e. how to work, how to cope, how to act, how to think, how to discuss, etc. (Boaler & al., 2000).

Thereby, they get an impression about the role, or the identity, of a mathematician. Boaler and her colleges infer that most high-achieving students want to be successful in school mathematics, so that they can have access to the job or education they want. But when mathematics is no longer compulsory, they reject the subject, as they do not want to "belong" to the mathematics culture, or to carry the identity of a mathematician.

Correspondingly, one may infer that young people, especially girls, do not want to have the *identity* that is seen to be connected with being a physicists or an engineer. May it be that young people, especially girls, perceive the identity of engineers and physicist as incongruent with their own? The masculine image of S&T and S&T careers is discussed in the literature (Lightbody & Durndell, 1996; Sjøberg, 2000b). This may, naturally, have an effect on the girls' rejection of identities connected with S&T educations and jobs. Besides – may it be, that although young people appreciate the technology, they would rather like to have jobs more strongly associated with an identity conveying late modern values? Such values may be self-realisation; creativity and innovation; working with people and helping others; and/or earning lots of money. From my analysis, we have seen that the modern, self-expressive and selective girl with the wondering mind wants to realise all these values. Furthermore, she expresses that she will not become a scientist or work with technology. Does she believe that such jobs cannot offer the aspects that she apparently values so high or the identity conveying such values?

If this perspective has a point, the fall in the recruitment to the S&T subjects may be met by upgrading the images associated with the subjects and with persons working within these fields. Similar to students' image of mathematics (Boaler's study referred above), one can assume that the science lessons are decisive for students' image of science. Possibly, the reflexive school can present to the students a subject with more opportunities for individual meaning-making. If young people in Inglehart's post-material society are not concerned about further national economic growth, or further technological developments, but see themselves with an identity coherent with the late modern values, school science could show the students that S&T play crucial roles in accomplishing some of these values.

Not *all* students can reach their goals through an education and job in S&T. For example, the salaries in many S&T jobs are not high compared to some other professions, and students that want to work in relation to the late modern ideas about creativity and "unconventionality" (ref. Frønes above) should probably not opt for a career in S&T. But many young people want to help others and make a better world. In order to find better solutions to our way of living, the society needs scientists and engineers. The students can be reminded that in addition to developing even broader bridges, faster airplanes, newer techniques for pumping up fossil oil, tinier mobile phones, and faster computers with larger storing capacities, the physicist and the engineer develop methods for utilising alternative energy sources, technologies for eliminating landmines, methods for more animal-friendly food production, solutions for protection against weapons, new instruments for treating diseases, etc. The driving force behind their work is their internal motor, fired by their values, interests and desires for helping others and making the world better. Even though the level of welfare in modernised societies is high, S&T are still facing huge and unsolved tasks for improving the conditions for life on earth. Such issues

might show that S&T still can provide meaning and relevance for young people – even in rich, modern societies.

### 11.3.6 Future pessimism and individual action

In chapter 2, I presented results from studies of young people's images of the future. Such studies find that Western youth believe that their own private future will be fine, but that the prospects for the planet are poor. War, ecological catastrophes, overpopulation and famine are their main global fears, and they expect a continuation or worsening of these problems in the future. People feel that this development will go on irrespectively of their actions, and that there is little they can do to influence it. In Barstad and Hellevik's (2004) analysis of the relationship between the direction of the societal development and people's hopes for the national and international future, they conclude by stating that the most worrying tendencies of our time is the widespread pessimism: "The first condition is the belief that it is of any use" (Barstad & Hellevik, 2004, p. 129, my translation), i.e. that the first precondition for a development towards a future that is closer to the one people prefer, is that people believe that their efforts make a difference.

As quoted in the introduction (in 1.4.3), Klafki argues that it is meaningless to discuss schooling without seeing it against a background of the challenges facing the society in which the school is situated. In international comparisons Norway is repeatedly found to be the world's best country to live in: Norwegians live long and healthy lives, they have access to education and they have a decent standard of living (UNDP, 2001, 2002, 2003, 2004, 2005). Naturally, even Norway has social problems on the national, regional and individual level. However, in this section I will rather address the more large-scale challenges mentioned above.

I see it as important that school science (and schooling in general) aim to develop in young people a feeling that they can influence the development at a personal as well as at a wider local, national and even global level. Only if they believe that they, individually and in groups, can make a difference, will they become active participants in society.

Hicks (1996a) refers to available sources of expertise and experiences on how to empower students for acting towards a better future, and argues that these sources so far have not been sufficiently utilised by science educators. Other valuable resources may be found in Stapp et al. (Stapp, Wals & Stankorb, 1996), Gidley & Inayatullah (2002) and the World Yearbook of Education edited by Hicks and Slaughter (Hicks & Slaughter, 1998). One common denominator in many such strategies of education for empowerment seems to be the rousing of students' awareness of what kind of future they prefer. People seem to know what they fear, and what they would fight *against*, but are under-articulated about what they would fight *for*. Empowering young people for action towards a future better than the one they expect, should consequently involve visualising the alternatives and the goals they want to work towards.

I suggest that science education should engage students in describing the world they have and the world they want, and in articulating, discussing and eventually acting on particular problems. In addition to going through *what we know* about the subject, the teaching should look into the world of tomorrow, and address issues such as: what the students hope and fear in relation to the particular problem, what possible courses of

action could be taken, and when and how one can evaluate the outcome and measure the success.

Discussions about these issues should also elucidate connections between the individual and the development of the world, by showing how "everything is connected to everything" (Klafki, 2001). Some examples are (as outlined in 1.4.3): consumption by the individual (which is related to fossil fuel combustion and global warming, which in turn is related to hunger, famine and social injustice), imbalanced trade (e.g. farmers receiving market payments that are lower than the costs of production, leading to cycles of poverty, pesticide pollution and deforestation) and population growth. Valuable resources for effective teaching and learning of socio-scientific issues may be found in the science education literature, for example in Ratcliffe and Grace (2003). This book discusses various issues related to science in society (e.g. the world food problem, energy conservation and sustainable development), from scientific, political, cultural, social and ethical angles, and through a variety of teaching methods and learning approaches. Another source would be Reiss' (2003) book chapter, addressing science education for social justice beyond the classroom. Reiss gives examples of activities related to learning about food, nuclear power, and individual differences between people.

However, teachers may also hold pessimistic images of the global future, and might therefore lack the ability to facilitate progressive and positive hopes and visions among the students. More confidence-building approaches can be found in non-governmental organisations (NGOs). *Changemaker* [100] is one example of an international youth movement (initiated by Norwegian Church Aid). Their slogans are "Of course we can change the world!" and "Knowledge without action is cowardice, and action without knowledge is stupidity!" This organisation devotes special attention to various global challenges of our time. Another example is the UN campaign web-pages, advocating how the individual can act in pursuing the UN Millennium Development Goals[101]. Although these organisations have not developed materials for educational purposes as such, they may still offer valuable resources for inspiration to believe that individual actions *can* make a difference.

## 11.4 Afterword

It appears to me, that most people have the same hopes for the future of our society and our globe. Democracy, peace, equity, human rights, social justice, environmental protection and sustainable development seem like universal values. Furthermore, one may argue that traits of the late modern lifestyles will lead the development in a different direction. One relevant example for the science education context is the conflict between, on the one hand, lifestyles involving high level of consumption, and on the other, combating the global warming problem.

I have aimed at describing how young people understand themselves, their surroundings and the world, and at discussing how schools in general and school science in

[100] www.changemaker.no (accessed 2005-08-16)

[101] www.un.org/millenniumgoals (accessed 2005-08-31)

particular can meet young people in their concerns. There are many contradictions in these perspectives. Aagre's reflexive school allows such contradictions, since the reflexive school can:

- meet young people in their culture – *and* represent a counterculture
- accommodate youth's identity projects – *and* challenge them to deviate from their student roles
- accentuate collective efforts for the future – *and* develop the students to become autonomous individual actors

I hope my thesis can contribute to deepening our understanding of the views of the learners, and that we thereby can be better skilled to develop the young individuals' sense of autonomy and independence to make priorities and to choose actions in accordance with these.

*All our scientific methods*
*become helpless theory*
*because what seemed to be*
*storm and heavy showers*
*became a beautiful and calm sunny day*
*thanks to the breath of wind*
*from the flaps of a butterfly's wings*

*Butterfly wings can change the world*
*change bitter to sweet*
*and hot to cool*
*when the river flows too fast*
*and makes too many sudden turns…*

– then I am glad we all are created with butterfly wings[102].

[102] This is a piece of the lyrics in the song which I mentioned in the foreword (Preus, 1998, my translation) addressing the *butterfly effect* (Lorenz, 1963). The *butterfly effect*, first described in 1963 by the American mathematician and meteorologist Edward Lorenz, illustrates the essential idea of the *chaos theory*: Interactions in complex multi-systems can result in an apparent randomness. Since the complicated meteorological processes are extremely sensitive to initial conditions, weather systems will be unpredictable in a long-term perspective. Pushed to its logical conclusion, this randomness could cause "the flap of a butterfly's wings in Brazil [to] set off a tornado in Texas" (Lorenz, 1972).

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# Appendix A Questionnaire

At the next pages follows a copy of the English version of the ROSE instrument. The questionnaire was printed on A4 paper size.

# ROSE
# 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 interes-ted* | | | *Very interes-ted* |
|---|---|---|---|---|---|
| 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 interes-ted* | | | *Very interes-ted* |
|---|---|---|---|---|---|
| 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 Instructions to participants

This extract from the *ROSE Handbook* accounts for the guidelines and practicalities related to target population and sampling. More details on instructions given to ROSE partners for organizing and carrying out the survey are given in Schreiner and Sjøberg (2004).

**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.

# Appendix C Question ACE cluster values

Question ACE mean scores and standard deviations for the Norwegian sample constituted by the five clusters: the Selective Boy (cluster 1), the Unselective Reluctant (cluster 2), the Unselective Undecided (cluster 3), the Unselective Enthusiast (cluster 4) and the Selective Girl (cluster 5).

| cluster | 1 | | 2 | | 3 | | 4 | | 5 | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. |
| **A01** | 2.99 | .858 | 1.83 | .865 | 2.59 | .794 | 3.25 | .739 | 2.73 | .854 | 2.72 | .934 |
| **A02** | 2.56 | .999 | 1.66 | .891 | 2.20 | .855 | 2.75 | .945 | 1.60 | .743 | 2.12 | .997 |
| **A03** | 2.10 | .733 | 1.39 | .586 | 2.18 | .726 | 2.62 | .865 | 2.00 | .728 | 2.07 | .820 |
| **A04** | 1.96 | .785 | 1.43 | .621 | 2.36 | .766 | 2.59 | .792 | 1.97 | .804 | 2.07 | .847 |
| **A05** | 1.81 | .777 | 1.42 | .648 | 2.25 | .733 | 2.44 | .819 | 2.16 | .789 | 2.04 | .831 |
| **A06** | 2.87 | .890 | 1.89 | .899 | 2.69 | .852 | 3.35 | .720 | 2.67 | .866 | 2.72 | .950 |
| **A07** | 2.36 | .806 | 1.93 | .886 | 2.65 | .857 | 3.16 | .790 | 3.07 | .801 | 2.69 | .932 |
| **A08** | 2.22 | .896 | 1.68 | .798 | 2.55 | .794 | 3.13 | .827 | 2.81 | .914 | 2.53 | .976 |
| **A09** | 2.50 | .943 | 2.01 | .997 | 2.57 | .797 | 3.05 | .734 | 3.00 | .892 | 2.68 | .948 |
| **A10** | 2.19 | .946 | 1.98 | 1.051 | 2.57 | .823 | 3.07 | .868 | 3.34 | .760 | 2.71 | 1.024 |
| **A11** | 1.79 | .724 | 1.63 | .794 | 2.35 | .785 | 2.85 | .923 | 3.09 | .836 | 2.43 | 1.001 |
| **A12** | 2.84 | 1.020 | 1.83 | 1.022 | 2.34 | .925 | 3.15 | .928 | 2.53 | 1.028 | 2.57 | 1.072 |
| **A13** | 2.39 | .953 | 1.88 | 1.007 | 2.65 | .870 | 3.11 | .860 | 2.58 | .943 | 2.54 | .996 |
| **A14** | 3.09 | .852 | 1.89 | 1.017 | 2.66 | .943 | 3.31 | .858 | 2.36 | 1.096 | 2.67 | 1.080 |
| **A15** | 1.63 | .697 | 1.20 | .470 | 2.02 | .719 | 2.37 | .869 | 1.47 | .598 | 1.72 | .784 |
| **A16** | 1.91 | .741 | 1.53 | .695 | 2.43 | .756 | 2.74 | .834 | 2.05 | .818 | 2.14 | .868 |
| **A17** | 2.19 | 1.104 | 1.39 | .720 | 2.05 | .938 | 2.46 | 1.052 | 1.43 | .712 | 1.88 | 1.005 |
| **A18** | 2.76 | .924 | 1.72 | .853 | 2.38 | .805 | 3.19 | .792 | 2.05 | .841 | 2.41 | .980 |
| **A19** | 2.82 | .910 | 1.67 | .840 | 2.31 | .838 | 3.15 | .779 | 2.03 | .874 | 2.39 | .994 |
| **A20** | 2.43 | .910 | 1.61 | .821 | 2.57 | .828 | 3.24 | .791 | 2.29 | .917 | 2.44 | .988 |
| **A21** | 1.87 | .965 | 1.57 | .980 | 2.16 | .925 | 2.26 | 1.027 | 1.84 | .942 | 1.94 | .991 |
| **A22** | 3.40 | .865 | 1.87 | .946 | 2.63 | .937 | 3.59 | .729 | 2.60 | 1.051 | 2.84 | 1.090 |
| **A23** | 3.39 | .772 | 1.90 | 1.001 | 2.77 | .899 | 3.65 | .554 | 2.82 | 1.000 | 2.94 | 1.030 |
| **A24** | 2.78 | .849 | 1.86 | .872 | 2.65 | .764 | 3.21 | .731 | 2.64 | .843 | 2.66 | .906 |
| **A25** | 3.01 | .833 | 2.08 | .943 | 2.79 | .764 | 3.37 | .691 | 2.77 | .849 | 2.83 | .904 |
| **A26** | 2.24 | .879 | 1.74 | .856 | 2.49 | .746 | 3.31 | .735 | 2.95 | .867 | 2.61 | .972 |
| **A27** | 2.87 | .923 | 2.02 | .985 | 2.72 | .879 | 3.25 | .771 | 2.63 | .890 | 2.71 | .961 |
| **A28** | 1.97 | .879 | 1.52 | .768 | 2.36 | .878 | 2.88 | .911 | 2.11 | .907 | 2.18 | .969 |
| **A29** | 2.63 | .941 | 1.88 | .964 | 2.55 | .848 | 3.39 | .700 | 2.69 | .910 | 2.66 | .982 |
| **A30** | 3.54 | .690 | 2.08 | 1.070 | 2.77 | .903 | 3.41 | .736 | 2.19 | .987 | 2.78 | 1.074 |
| **A31** | 3.48 | .747 | 2.14 | 1.096 | 2.60 | .928 | 3.22 | .828 | 1.89 | .896 | 2.62 | 1.099 |
| **A32** | 3.30 | .821 | 1.88 | 1.014 | 2.53 | .842 | 3.37 | .762 | 2.12 | .979 | 2.63 | 1.071 |
| **A33** | 3.06 | .823 | 1.98 | .976 | 2.57 | .779 | 3.31 | .711 | 2.48 | .902 | 2.69 | .951 |
| **A34** | 3.54 | .774 | 2.43 | 1.085 | 2.94 | .885 | 3.67 | .615 | 3.18 | .918 | 3.19 | .954 |
| **A35** | 2.51 | 1.016 | 1.52 | .761 | 2.46 | .897 | 3.20 | .876 | 2.56 | 1.033 | 2.49 | 1.057 |
| **A36** | 2.16 | .871 | 1.43 | .685 | 2.46 | .793 | 2.94 | .823 | 2.24 | .878 | 2.27 | .937 |
| **A37** | 2.00 | .998 | 2.03 | 1.131 | 2.60 | .944 | 3.10 | .998 | 3.47 | .840 | 2.73 | 1.141 |
| **A38** | 1.42 | .667 | 1.67 | .941 | 2.21 | .875 | 2.98 | .997 | 3.41 | .813 | 2.45 | 1.167 |
| **A39** | 1.35 | .668 | 1.58 | .943 | 1.95 | .892 | 2.58 | 1.124 | 3.16 | .973 | 2.23 | 1.170 |
| **A40** | 2.85 | 1.039 | 2.61 | 1.144 | 3.10 | .863 | 3.55 | .699 | 3.61 | .686 | 3.20 | .959 |
| **A41** | 1.53 | .790 | 1.46 | .832 | 1.86 | .859 | 2.58 | 1.009 | 2.92 | 1.059 | 2.16 | 1.110 |
| **A42** | 1.61 | .726 | 1.51 | .744 | 2.29 | .858 | 2.97 | .932 | 3.03 | .878 | 2.37 | 1.059 |

| cluster | 1 | | 2 | | 3 | | 4 | | 5 | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. |
| **A43** | 2.04 | .866 | 1.34 | .614 | 2.45 | .758 | 2.89 | .790 | 2.20 | .802 | 2.21 | .908 |
| **A44** | 3.47 | .739 | 1.59 | .843 | 2.54 | .837 | 3.18 | .888 | 2.12 | .939 | 2.59 | 1.084 |
| **A45** | 3.03 | .905 | 1.38 | .642 | 2.31 | .751 | 3.04 | .829 | 1.78 | .731 | 2.30 | 1.011 |
| **A46** | 2.14 | .810 | 1.37 | .658 | 2.36 | .726 | 3.12 | .796 | 2.37 | .955 | 2.31 | .964 |
| **A47** | 2.95 | 1.014 | 1.92 | 1.098 | 2.49 | .947 | 2.62 | 1.110 | 1.55 | .794 | 2.25 | 1.116 |
| **A48** | 3.09 | .887 | 1.49 | .782 | 2.30 | .877 | 2.94 | .941 | 1.48 | .689 | 2.22 | 1.083 |
| **C01** | 1.72 | .818 | 1.20 | .470 | 1.92 | .729 | 2.15 | .891 | 1.26 | .504 | 1.62 | .784 |
| **C02** | 2.50 | .979 | 1.32 | .578 | 2.28 | .760 | 2.77 | .928 | 1.67 | .745 | 2.10 | .964 |
| **C03** | 3.03 | .893 | 1.83 | .888 | 2.46 | .836 | 3.01 | .930 | 1.79 | .817 | 2.39 | 1.029 |
| **C04** | 2.98 | .894 | 1.94 | .963 | 2.65 | .847 | 3.08 | .927 | 2.15 | .930 | 2.54 | 1.012 |
| **C05** | 2.88 | .943 | 1.82 | .922 | 2.51 | .794 | 2.99 | .930 | 2.18 | .925 | 2.47 | .997 |
| **C06** | 2.85 | .953 | 1.99 | .964 | 2.65 | .822 | 3.13 | .894 | 2.63 | .956 | 2.68 | .984 |
| **C07** | 3.28 | .850 | 2.05 | 1.067 | 2.77 | .841 | 3.17 | .894 | 2.33 | .959 | 2.71 | 1.031 |
| **C08** | 3.44 | .842 | 1.96 | 1.075 | 2.71 | .982 | 3.74 | .622 | 3.30 | .834 | 3.10 | 1.045 |
| **C09** | 2.12 | .987 | 1.53 | .873 | 2.24 | .901 | 3.15 | .940 | 2.76 | 1.056 | 2.42 | 1.100 |
| **C10** | 3.24 | .933 | 1.66 | .932 | 2.64 | .942 | 3.59 | .743 | 2.91 | 1.032 | 2.87 | 1.106 |
| **C11** | 2.25 | 1.033 | 1.66 | .910 | 2.43 | .926 | 3.36 | .812 | 3.05 | .951 | 2.62 | 1.094 |
| **C12** | 1.60 | .802 | 1.46 | .784 | 2.19 | .896 | 3.01 | 1.000 | 2.85 | 1.015 | 2.29 | 1.107 |
| **C13** | 2.43 | 1.126 | 2.07 | 1.092 | 2.77 | .952 | 3.55 | .727 | 3.62 | .680 | 2.98 | 1.094 |
| **C14** | 2.18 | 1.234 | 1.91 | 1.128 | 2.12 | 1.088 | 3.18 | 1.055 | 3.02 | 1.101 | 2.55 | 1.232 |
| **C15** | 2.52 | 1.149 | 1.90 | 1.003 | 2.39 | 1.005 | 3.46 | .839 | 3.33 | .920 | 2.80 | 1.138 |
| **C16** | 2.36 | 1.037 | 1.36 | .655 | 2.42 | .924 | 3.16 | .928 | 2.63 | 1.009 | 2.44 | 1.080 |
| **C17** | 1.95 | .950 | 1.27 | .542 | 2.34 | .869 | 2.90 | .938 | 2.32 | .992 | 2.20 | 1.021 |
| **C18** | 2.07 | .982 | 1.36 | .682 | 2.30 | .879 | 2.86 | .970 | 2.13 | .916 | 2.16 | 1.003 |
| **E01** | 1.14 | .415 | 1.12 | .429 | 1.61 | .697 | 1.68 | .825 | 1.28 | .549 | 1.36 | .639 |
| **E02** | 1.67 | .777 | 1.28 | .553 | 2.38 | .822 | 2.72 | .995 | 2.26 | .977 | 2.10 | .986 |
| **E03** | 2.19 | .925 | 1.36 | .629 | 2.56 | .825 | 3.17 | .785 | 2.11 | .917 | 2.28 | 1.001 |
| **E04** | 1.90 | .862 | 1.26 | .567 | 2.39 | .820 | 2.91 | .868 | 1.72 | .726 | 2.02 | .944 |
| **E05** | 2.34 | .871 | 1.64 | .838 | 2.91 | .836 | 3.43 | .719 | 2.48 | .872 | 2.58 | .998 |
| **E06** | 2.01 | .839 | 1.37 | .702 | 2.46 | .788 | 2.87 | .833 | 1.75 | .746 | 2.07 | .927 |
| **E07** | 2.21 | .876 | 1.72 | .917 | 2.79 | .834 | 3.54 | .700 | 3.05 | .872 | 2.72 | 1.034 |
| **E08** | 2.46 | .932 | 1.99 | 1.011 | 2.93 | .809 | 3.65 | .570 | 3.45 | .680 | 2.97 | .995 |
| **E09** | 2.44 | .990 | 1.97 | 1.000 | 2.78 | .854 | 3.40 | .768 | 3.45 | .681 | 2.89 | 1.014 |
| **E10** | 2.57 | .946 | 1.97 | .991 | 2.92 | .860 | 3.60 | .643 | 3.33 | .754 | 2.95 | .996 |
| **E11** | 2.34 | .960 | 1.91 | 1.008 | 2.95 | .808 | 3.58 | .639 | 3.38 | .720 | 2.91 | 1.020 |
| **E12** | 2.61 | 1.041 | 2.16 | 1.080 | 2.87 | .878 | 3.41 | .744 | 3.37 | .785 | 2.95 | 1.009 |
| **E13** | 2.57 | 1.065 | 2.06 | 1.068 | 2.79 | .883 | 3.50 | .729 | 3.33 | .842 | 2.92 | 1.045 |
| **E14** | 2.62 | 1.039 | 1.70 | .877 | 2.56 | .822 | 3.36 | .721 | 2.73 | .891 | 2.64 | 1.004 |
| **E15** | 2.33 | .994 | 1.63 | .795 | 2.66 | .789 | 3.15 | .804 | 2.40 | .819 | 2.45 | .958 |
| **E16** | 2.48 | 1.005 | 2.06 | 1.115 | 3.01 | .823 | 3.45 | .727 | 2.82 | .962 | 2.78 | 1.031 |
| **E17** | 1.67 | .817 | 1.35 | .616 | 2.43 | .828 | 2.53 | .935 | 1.68 | .722 | 1.92 | .903 |
| **E18** | 2.07 | .911 | 1.57 | .809 | 2.72 | .839 | 3.22 | .812 | 2.21 | .953 | 2.35 | 1.024 |
| **E19** | 1.56 | .766 | 1.31 | .624 | 2.44 | .882 | 2.69 | .996 | 1.70 | .898 | 1.92 | .989 |
| **E20** | 2.41 | .875 | 1.55 | .782 | 2.72 | .795 | 3.19 | .787 | 1.96 | .781 | 2.35 | .970 |
| **E21** | 2.62 | .906 | 1.52 | .736 | 2.83 | .745 | 3.24 | .822 | 1.94 | .817 | 2.41 | 1.005 |
| **E22** | 1.91 | .831 | 1.33 | .584 | 2.38 | .750 | 2.75 | .855 | 1.93 | .852 | 2.07 | .909 |
| **E23** | 2.37 | .955 | 1.83 | .992 | 2.79 | .838 | 3.29 | .793 | 3.22 | .808 | 2.77 | 1.015 |
| **E24** | 1.82 | .900 | 1.64 | .938 | 2.60 | .940 | 2.70 | .975 | 2.22 | 1.022 | 2.21 | 1.037 |
| **E25** | 1.35 | .529 | 1.21 | .520 | 2.21 | .854 | 2.28 | .910 | 1.58 | .730 | 1.72 | .839 |
| **E26** | 1.45 | .602 | 1.18 | .479 | 2.06 | .775 | 2.32 | .908 | 1.75 | .823 | 1.76 | .838 |

| cluster | 1 | | 2 | | 3 | | 4 | | 5 | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. |
| **E27** | 2.52 | 1.021 | 1.54 | .833 | 2.48 | .766 | 2.76 | .946 | 1.65 | .719 | 2.16 | .987 |
| **E28** | 2.89 | .961 | 1.87 | 1.076 | 2.67 | .886 | 2.86 | .993 | 1.78 | .910 | 2.38 | 1.081 |
| **E29** | 2.92 | 1.003 | 1.49 | .769 | 2.43 | .814 | 3.20 | .856 | 2.34 | 1.015 | 2.50 | 1.061 |
| **E30** | 2.52 | .948 | 1.49 | .728 | 2.49 | .733 | 2.95 | .802 | 1.80 | .737 | 2.23 | .943 |
| **E31** | 1.70 | .776 | 1.60 | .881 | 2.50 | .849 | 3.13 | .848 | 3.27 | .827 | 2.53 | 1.088 |
| **E32** | 2.27 | .952 | 1.57 | .819 | 2.62 | .865 | 3.36 | .798 | 2.96 | .913 | 2.62 | 1.048 |
| **E33** | 1.63 | .751 | 1.25 | .497 | 2.33 | .777 | 2.57 | .935 | 1.63 | .736 | 1.87 | .886 |
| **E34** | 1.65 | .895 | 1.31 | .643 | 2.27 | .936 | 2.86 | 1.000 | 1.79 | .863 | 1.97 | 1.015 |
| **E35** | 1.80 | .859 | 1.36 | .580 | 2.40 | .792 | 3.04 | .768 | 2.24 | .952 | 2.19 | .978 |
| **E36** | 1.72 | .847 | 1.20 | .453 | 2.07 | .876 | 2.67 | .986 | 1.64 | .794 | 1.85 | .939 |
| **E37** | 1.75 | .905 | 1.14 | .382 | 1.92 | .873 | 2.37 | 1.001 | 1.49 | .721 | 1.73 | .897 |
| **E38** | 2.64 | 1.049 | 1.53 | .796 | 2.50 | .870 | 3.15 | .938 | 2.21 | .985 | 2.42 | 1.063 |
| **E39** | 1.81 | .885 | 1.21 | .543 | 2.15 | .827 | 2.80 | 1.007 | 1.69 | .833 | 1.93 | .977 |
| **E40** | 2.99 | .962 | 1.69 | .839 | 2.75 | .785 | 3.42 | .691 | 2.45 | .941 | 2.67 | 1.015 |
| **E41** | 3.17 | .957 | 1.70 | .911 | 2.68 | .773 | 3.37 | .739 | 2.18 | .982 | 2.62 | 1.067 |
| **E42** | 3.31 | .885 | 1.86 | 1.047 | 2.84 | .898 | 3.64 | .637 | 2.76 | 1.159 | 2.91 | 1.109 |

# Appendix D Question B, D, F, G, L cluster values

Question B, D, F, G and L mean scores and standard deviations for the Norwegian sample constituted by the five clusters: the Selective Boy (cluster 1), the Unselective Reluctant (cluster 2), the Unselective Undecided (cluster 3), the Unselective Enthusiast (cluster 4) and the Selective Girl (cluster 5). The table includes only items that are discussed in the text.

| cluster | 1 | | 2 | | 3 | | 4 | | 5 | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. |
| **B01** | 2.06 | .949 | 1.99 | 1.092 | 2.45 | .966 | 3.00 | .910 | 3.08 | .911 | 2.58 | 1.063 |
| **B02** | 2.25 | .954 | 2.30 | 1.101 | 2.61 | .997 | 3.11 | .856 | 3.18 | .846 | 2.74 | 1.020 |
| **B03** | 1.61 | .907 | 1.73 | 1.039 | 2.22 | 1.062 | 2.35 | 1.064 | 2.27 | 1.043 | 2.06 | 1.065 |
| **B04** | 1.50 | .722 | 1.40 | .706 | 1.98 | .903 | 2.25 | .970 | 1.73 | .839 | 1.77 | .884 |
| **B05** | 1.97 | 1.015 | 1.98 | 1.023 | 2.13 | .945 | 1.92 | .960 | 1.98 | .968 | 1.99 | .981 |
| **B06** | 2.63 | 1.163 | 2.36 | 1.219 | 2.49 | 1.077 | 2.30 | 1.114 | 1.67 | .886 | 2.23 | 1.137 |
| **B07** | 2.74 | 1.096 | 2.27 | 1.192 | 2.39 | 1.138 | 2.13 | 1.114 | 1.50 | .792 | 2.15 | 1.138 |
| **B08** | 2.10 | 1.092 | 1.83 | 1.063 | 2.38 | 1.018 | 2.50 | 1.081 | 2.43 | 1.067 | 2.28 | 1.090 |
| **B09** | 3.48 | .705 | 2.99 | 1.040 | 3.43 | .776 | 3.73 | .535 | 3.52 | .742 | 3.45 | .792 |
| **B10** | 2.72 | 1.044 | 2.20 | 1.073 | 2.66 | .980 | 3.07 | .938 | 2.87 | 1.036 | 2.74 | 1.049 |
| **B11** | 2.86 | 1.014 | 2.21 | 1.098 | 2.80 | .912 | 3.27 | .870 | 2.92 | .997 | 2.85 | 1.027 |
| **B12** | 3.28 | .788 | 3.23 | .962 | 3.14 | .869 | 3.36 | .884 | 3.55 | .675 | 3.34 | .832 |
| **B13** | 3.35 | .714 | 3.14 | .948 | 3.31 | .718 | 3.67 | .605 | 3.58 | .608 | 3.44 | .733 |
| **B14** | 2.66 | .922 | 2.45 | 1.016 | 2.62 | .956 | 2.78 | .973 | 2.71 | .945 | 2.66 | .963 |
| **B15** | 3.32 | .803 | 2.96 | .963 | 3.34 | .814 | 3.75 | .486 | 3.59 | .661 | 3.43 | .787 |
| **B16** | 3.11 | .926 | 2.77 | 1.069 | 3.15 | .849 | 3.55 | .628 | 3.42 | .763 | 3.23 | .881 |
| **B17** | 3.17 | .856 | 2.92 | .955 | 3.20 | .814 | 3.30 | .854 | 3.44 | .719 | 3.24 | .844 |
| **B18** | 2.62 | 1.014 | 2.34 | 1.058 | 2.58 | .982 | 2.99 | .965 | 2.82 | .953 | 2.69 | 1.009 |
| **B19** | 3.20 | .798 | 2.77 | 1.062 | 2.94 | .827 | 3.41 | .810 | 3.23 | .856 | 3.14 | .891 |
| **B20** | 3.59 | .716 | 3.35 | .861 | 3.04 | .900 | 3.24 | .856 | 3.35 | .736 | 3.33 | .822 |
| **B21** | 2.24 | 1.055 | 2.11 | 1.031 | 2.04 | .965 | 2.03 | 1.007 | 1.87 | .866 | 2.04 | .982 |
| **B22** | 2.24 | 1.124 | 2.22 | 1.135 | 2.24 | 1.033 | 2.17 | 1.120 | 2.15 | 1.118 | 2.20 | 1.107 |
| **B23** | 3.29 | .835 | 3.06 | .959 | 3.18 | .817 | 3.18 | .884 | 3.22 | .810 | 3.19 | .856 |
| **B24** | 2.55 | 1.041 | 2.40 | 1.054 | 2.38 | 1.078 | 2.38 | 1.097 | 2.28 | 1.027 | 2.39 | 1.058 |
| **B25** | 3.37 | .704 | 2.89 | 1.006 | 3.30 | .748 | 3.66 | .558 | 3.29 | .776 | 3.32 | .793 |
| **B26** | 2.93 | .863 | 2.60 | 1.004 | 2.84 | .906 | 3.22 | .847 | 3.08 | .843 | 2.96 | .905 |
| **D01** | 1.99 | 1.086 | 2.26 | 1.130 | 1.80 | 1.033 | 1.45 | .834 | 1.73 | .849 | 1.82 | 1.007 |
| **D03** | 2.32 | 1.005 | 2.37 | 1.070 | 2.12 | .937 | 1.98 | .990 | 2.08 | .918 | 2.16 | .986 |
| **D05** | 2.37 | .896 | 2.07 | .985 | 2.60 | .850 | 2.97 | .950 | 2.54 | .912 | 2.53 | .955 |
| **D06** | 2.79 | .970 | 2.54 | 1.053 | 3.05 | .902 | 3.39 | .809 | 3.06 | .925 | 2.99 | .966 |
| **D07** | 3.54 | .722 | 3.11 | .978 | 3.49 | .724 | 3.69 | .593 | 3.52 | .696 | 3.49 | .758 |
| **D08** | 2.41 | 1.042 | 2.56 | 1.032 | 2.23 | .964 | 2.10 | 1.029 | 2.31 | 1.035 | 2.32 | 1.032 |
| **D10** | 3.09 | .878 | 2.90 | .968 | 3.19 | .829 | 3.50 | .802 | 3.26 | .843 | 3.20 | .878 |
| **D12** | 2.90 | .934 | 2.62 | 1.093 | 3.13 | .895 | 3.51 | .703 | 3.25 | .846 | 3.11 | .933 |
| **D13** | 2.54 | 1.030 | 2.57 | 1.072 | 2.38 | .957 | 2.15 | 1.008 | 2.26 | 1.011 | 2.36 | 1.025 |
| **F01** | 2.17 | 1.050 | 2.62 | 1.074 | 2.42 | 1.009 | 2.33 | 1.083 | 2.74 | 1.014 | 2.47 | 1.063 |
| **F02** | 3.12 | .971 | 2.30 | 1.109 | 3.01 | .841 | 3.43 | .707 | 2.61 | .992 | 2.89 | 1.007 |
| **F03** | 2.69 | 1.032 | 2.08 | .935 | 2.51 | .899 | 2.70 | .980 | 2.10 | .937 | 2.40 | .996 |
| **F04** | 2.05 | .965 | 1.53 | .825 | 2.13 | .873 | 2.48 | 1.036 | 1.63 | .809 | 1.94 | .960 |
| **F05** | 2.25 | 1.122 | 1.60 | .934 | 2.18 | .987 | 2.41 | 1.071 | 1.70 | .924 | 2.01 | 1.053 |

| cluster | 1 | | 2 | | 3 | | 4 | | 5 | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. | mean | std. dev. |
| **F06** | 3.08 | 1.046 | 2.13 | 1.163 | 3.12 | .911 | 3.49 | .819 | 2.89 | 1.063 | 2.96 | 1.088 |
| **F07** | 2.80 | .991 | 2.01 | .961 | 2.86 | .889 | 3.27 | .805 | 2.62 | .977 | 2.72 | 1.005 |
| **F10** | 2.83 | 1.072 | 1.79 | .923 | 2.67 | .891 | 3.40 | .856 | 2.68 | 1.071 | 2.70 | 1.087 |
| **F11** | 2.12 | .892 | 1.68 | .845 | 2.54 | .902 | 3.00 | .960 | 2.11 | .940 | 2.28 | 1.003 |
| **F12** | 2.30 | .917 | 1.64 | .762 | 2.56 | .831 | 3.11 | .813 | 2.13 | .907 | 2.34 | .969 |
| **F13** | 2.17 | .895 | 1.87 | .938 | 2.73 | .831 | 2.99 | .945 | 2.59 | 1.002 | 2.49 | 1.002 |
| **F14** | 1.69 | .935 | 1.22 | .558 | 1.72 | .963 | 2.04 | 1.101 | 1.26 | .596 | 1.56 | .897 |
| **F15** | 2.00 | 1.013 | 1.35 | .671 | 1.95 | .944 | 2.33 | 1.060 | 1.47 | .755 | 1.80 | .961 |
| **F16** | 2.76 | 1.105 | 1.50 | .884 | 2.13 | .999 | 2.36 | 1.149 | 1.31 | .635 | 1.97 | 1.101 |
| **G01** | 3.51 | .807 | 2.81 | 1.102 | 3.15 | .867 | 3.55 | .716 | 3.04 | .994 | 3.22 | .945 |
| **G02** | 3.24 | .883 | 2.77 | 1.008 | 3.13 | .822 | 3.59 | .684 | 3.35 | .759 | 3.25 | .862 |
| **G03** | 3.26 | .849 | 2.47 | 1.036 | 2.89 | .852 | 3.33 | .820 | 3.02 | .899 | 3.02 | .931 |
| **G04** | 2.86 | .992 | 2.22 | 1.119 | 2.57 | .851 | 3.03 | .880 | 2.64 | .917 | 2.68 | .981 |
| **G05** | 3.10 | .927 | 2.37 | 1.094 | 2.78 | .767 | 3.16 | .787 | 2.60 | .941 | 2.80 | .952 |
| **G06** | 2.96 | .929 | 2.23 | 1.032 | 2.69 | .812 | 3.06 | .849 | 2.68 | .908 | 2.74 | .943 |
| **L01** | 2.95 | .766 | 2.59 | .890 | 2.74 | .794 | 2.94 | .760 | 2.75 | .738 | 2.80 | .792 |
| **L02** | 2.74 | .831 | 2.40 | .992 | 2.95 | .858 | 3.21 | .779 | 2.86 | .836 | 2.85 | .886 |
| **L03** | 2.97 | .885 | 2.73 | .965 | 3.13 | .779 | 3.54 | .666 | 3.52 | .609 | 3.23 | .829 |
| **L04** | 2.93 | .794 | 2.65 | .902 | 3.17 | .722 | 3.49 | .605 | 3.08 | .756 | 3.08 | .798 |
| **L05** | 2.85 | .831 | 2.81 | .940 | 3.08 | .727 | 3.33 | .700 | 3.33 | .666 | 3.11 | .796 |
| **L06** | 2.96 | .800 | 2.65 | .936 | 3.05 | .717 | 3.34 | .695 | 3.15 | .727 | 3.05 | .797 |
| **L07** | 3.16 | .773 | 2.29 | .903 | 2.76 | .702 | 3.14 | .733 | 2.48 | .784 | 2.76 | .849 |
| **L08** | 2.57 | 1.151 | 2.22 | 1.207 | 2.67 | 1.036 | 2.79 | 1.058 | 2.41 | 1.145 | 2.53 | 1.135 |
| **L09** | 2.76 | .854 | 2.53 | .981 | 2.90 | .846 | 3.06 | .862 | 2.81 | .893 | 2.82 | .898 |
| **L10** | 1.60 | .784 | 1.55 | .811 | 2.04 | .952 | 2.16 | 1.036 | 1.95 | .880 | 1.87 | .923 |
| **L11** | 3.04 | .903 | 2.88 | .977 | 3.13 | .826 | 3.39 | .739 | 3.35 | .760 | 3.18 | .853 |
| **L12** | 3.30 | .911 | 3.35 | .906 | 3.20 | .867 | 3.12 | .916 | 3.28 | .850 | 3.25 | .888 |
| **L13** | 2.28 | .945 | 2.43 | 1.037 | 2.69 | .919 | 2.98 | .922 | 3.17 | .789 | 2.76 | .973 |
| **L14** | 3.27 | .713 | 3.03 | .916 | 3.28 | .674 | 3.59 | .580 | 3.42 | .614 | 3.34 | .713 |
| **L15** | 2.49 | .967 | 2.35 | 1.092 | 2.98 | .917 | 3.14 | .912 | 3.19 | .800 | 2.87 | .983 |
| **L16** | 3.30 | .877 | 3.10 | 1.076 | 3.39 | .783 | 3.53 | .740 | 3.49 | .758 | 3.38 | .850 |

# Appendix E Final ACE factor structure

Factor analysis of 78 ACE items: Principal Axis Factoring extraction method and Oblimin rotation method with Kaiser normalisation. 16 factors were ordered. The shading shows how items are merged into indexes in 7.5.1.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A37** | .68 | | | | | | | | | | | | | | | |
| **A38** | .47 | | | | | | | | | | | -.16 | | .17 | | |
| **A39** | .70 | | | | | | | | | | | | | | | |
| **A40** | .61 | | | | | | | | | | | | | | | |
| **A41** | .49 | | | | | | | | | | | | | | | |
| **A42** | .62 | | | | | | | | | | | | | | | |
| **E03** | | .18 | | | | | | | | | | | | | | .71 |
| **E04** | | | | | | | .16 | | | | | | | | | .76 |
| **E05** | | | | | | | | | | | | -.19 | | | | .52 |
| **E06** | | | .24 | | | | | | | | | | | | | .32 |
| **A01** | | .52 | | | | | | | | | | | | | .16 | |
| **A06** | | .32 | | | -.18 | | | | | | | | | | .27 | |
| **A14** | | .35 | | | | .35 | | | | | | | | | | |
| **A22** | | .55 | | | | | | | | | | | | | | |
| **A23** | | .49 | | | | | | | | .22 | | | | | | |
| **C08** | | .67 | | | | | | | | | -.18 | | | | | |
| **C10** | | .67 | | | | | | | | | -.22 | | | | | |
| **E29** | | .52 | | | .15 | | .20 | | | | .26 | | | | | |
| **A44** | | .47 | | | .17 | | | | | .16 | .30 | | | -.16 | | |
| **A45** | | .38 | .17 | | | -.18 | | | | | .27 | | | -.22 | | |
| **C03** | | | | .64 | | | | | | | | | | -.15 | | |
| **C04** | | | | .82 | | | | | | | | | | | | |
| **C05** | | | | .88 | | | | | | | | | | | | |
| **C06** | | | | .75 | | | | | | | | | | | | |
| **C07** | | | | .62 | | | | | | | | | | -.16 | | |
| **C16** | | | | | .76 | | | | | | | | | | | |
| **C17** | | | | | .71 | | | | | | | | | | | |
| **E02** | | | | | .41 | | | | | | | | | .21 | | .27 |
| **A13** | | | | | | .60 | | | | | | | | | | |
| **A20** | | | | | | .47 | | | | | | | | | | |
| **A27** | | | | | | .54 | | | | | | | | | | |
| **E16** | | | .22 | | | .48 | | | | | | -.15 | | | | |
| **E24** | | | .20 | | | .53 | | | | | | | | | | |
| **C09** | | .37 | | | | | | | | | -.38 | | | | | |
| **C11** | | | | | | | | | | | -.48 | -.15 | | | | |
| **C12** | .26 | | | | | | | | | | -.38 | | | | | |
| **C13** | | | | | .23 | | | | | | -.44 | | | .16 | | |
| **C14** | | | | | .23 | .18 | | | | | -.49 | | | | -.21 | |
| **C15** | | | | | .21 | | | | | | -.58 | | | | | |
| **E34** | | | .17 | | | | .48 | | | | | | | | | |
| **E36** | | | | | | | .57 | | | | | | | | | |
| **E37** | | | | | | | .57 | | | | | | | | | |
| **E38** | | | | | | | .49 | | -.31 | | | | | | | |
| **E39** | | | | | | | .61 | | -.15 | | | | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A07** | .16 | | | | | | | .33 | | | | -.15 | | | .30 | |
| **A08** | | | | | | -.16 | | .28 | | | -.15 | | | | .35 | |
| **A09** | | | | | | | | .74 | | | | | | | | |
| **A10** | | | | | | | | .68 | | | | | | | | |
| **A11** | .20 | | | | | | | .47 | | | | | | .21 | | |
| **E23** | | | | | | | | .41 | | | | | -.16 | | | |
| **E31** | .22 | | | | | | | .23 | | | | -.21 | | .21 | | |
| **E12** | | | | | | | | .20 | | | | | -.63 | | | |
| **E13** | | | | | | | | .22 | | | | -.19 | -.63 | | | |
| **E07** | | | | | | | | | | | | -.76 | | | | |
| **E08** | | | | | | | | | | | | -.77 | | | | |
| **E09** | | | | | | | | .36 | | | | -.43 | | | | |
| **E10** | | | | | | | | | | | | -.50 | | | | |
| **E11** | | | | | | | | | | | | -.63 | | | | |
| **E32** | | | | | | | .15 | | | | | -.35 | -.16 | | | |
| **E40** | | | | | | | .25 | | -.61 | | | | | | | |
| **E41** | | | | | | | | | -.57 | | | | | | | |
| **E42** | | .31 | | | | | .16 | | -.36 | | -.19 | | | | | |
| **E15** | | | .16 | | | | | | | | | | -.55 | | | |
| **E14** | | | | | | | | | | | | | -.62 | | | |
| **E17** | | | .60 | | | .18 | | | | | | | | | | |
| **E18** | | | .43 | | | | | | | | -.18 | -.22 | | | | |
| **E19** | | | .59 | | | | | | | | | | | | | .17 |
| **E33** | | | .54 | | | | .21 | | | | | | | | | |
| **E20** | | | .41 | | | | | | -.31 | | | | | | | .24 |
| **E21** | | | .30 | | | | | | -.32 | | | | | | | .26 |
| **A24** | | | | | | | | | | .77 | | | | | | |
| **A25** | | | | | | | | | | .79 | | | | | | |
| **A30** | | | | | | | | | | | | | | -.74 | | |
| **A31** | | | | | | | | | | | | | | -.78 | | |
| **A32** | | | | | | | | | | | | | | -.77 | | |
| **A48** | | | | | | | | | | | | | | -.59 | | |
| **A04** | | | | | | | | | | | | | | | .53 | |
| **A05** | | | | | | | | | | | | | | | .53 | |

# Appendix F ACE correlations with HDI

The tables show items that are statistically significantly correlated ($p < .01$) with HDI in the international residual data for girls (first table) and boys (next table). Correlation coefficients (r) are shown in the right column. (r).

| Girls | r |
|---|---|
| C13. Why we dream while we are sleeping, and what the dreams may mean | .88 |
| E16. How to protect endangered species of animals | .87 |
| C11. Life and death and the human soul | .84 |
| C15. Thought transference, mind-reading, sixth sense, intuition, etc. | .83 |
| A38. Eating disorders like anorexia or bulimia | .82 |
| C14. Ghosts and witches, and whether they may exist | .82 |
| C12. Alternative therapies (acupuncture, homeopathy, yoga, healing, etc.) and how effective they are | .81 |
| A34. How it feels to be weightless in space | .81 |
| A12. Cloning of animals | .80 |
| A25. Tornados, hurricanes and cyclones | .79 |
| A27. Brutal, dangerous and threatening animals | .78 |
| A22. Black holes, supernovas and other spectacular objects in outer space | .76 |
| A08. Heredity, and how genes influence how we develop | .76 |
| C09. Astrology and horoscopes, and whether the planets can influence human beings | .73 |
| E13. How different narcotics might affect the body | .70 |
| A26. Epidemics and diseases causing large losses of life | .69 |
| C08. The possibility of life outside earth | .68 |
| C10. Unsolved mysteries in outer space | .66 |
| A40. How to exercise to keep the body fit and strong | .66 |
| E10. How to perform first-aid and use basic medical equipment | .64 |
| E12. How alcohol and tobacco might affect the body | .62 |
| E24. Animals in my area | .61 |
| E08. Cancer, what we know and how we can treat it | .61 |
| A13. Animals in other parts of the world | .57 |
| E31. Biological and human aspects of abortion | .56 |
| A41. Plastic surgery and cosmetic surgery | .56 |
| A23. How meteors, comets or asteroids may cause disasters on earth | .56 |
| E32. How gene technology can prevent diseases | .55 |
| E11. What we know about HIV/AIDS and how to control it | .53 |
| A06. The origin and evolution of life on earth | .53 |
| A10. Birth control and contraception | .53 |
| A39. The ability of lotions and creams to keep the skin young | .52 |
| E02. How the sunset colours the sky | -.51 |
| A19. Light around us that we cannot see (infrared, ultraviolet) | -.52 |
| E03. The ozone layer and how it may be affected by humans | -.52 |
| E15. How loud sound and noise may damage my hearing | -.53 |
| E34. Why religion and science sometimes are in conflict | -.55 |
| E21. New sources of energy from the sun, wind, tides, waves, etc. | -.55 |
| C06. How mobile phones can send and receive messages | -.58 |
| E05. What can be done to ensure clean air and safe drinking water | -.58 |
| A21. How different musical instruments produce different sounds | -.59 |
| A46. How X-rays, ultrasound, etc. are used in medicine | -.59 |
| A05. Clouds, rain and the weather | -.59 |
| A03. The inside of the earth | -.60 |
| E17. How to improve the harvest in gardens and farms | -.62 |
| E39. How scientific ideas sometimes challenge religion, authority and tradition | -.65 |
| C04. How cassette tapes, CDs and DVDs store and play sound and music | -.65 |
| A16. How people, animals, plants and the environment depend on each other | -.65 |

| Girls (cont.) | |
|---|---|
| E41. Very recent inventions and discoveries in science and technology | -.66 |
| A17. Atoms and molecules | -.66 |
| A02. Chemicals, their properties and how they react | -.67 |
| A47. How petrol and diesel engines work | -.68 |
| A36. How the eye can see light and colours | -.69 |
| E20. How energy can be saved or used in a more effective way | -.70 |
| A04. How mountains, rivers and oceans develop and change | -.71 |
| C03. The use of lasers for technical purposes (CD-players, bar-code readers, etc.) | -.72 |
| C01. How crude oil is converted to other materials, like plastics and textiles | -.72 |
| A48. How a nuclear power plant functions | -.72 |
| E06. How technology helps us to handle waste, garbage and sewage | -.74 |
| E22. How different sorts of food are produced, conserved and stored | -.74 |
| E26. Detergents, soaps and how they work | -.75 |
| A45. The use of satellites for communication and other purposes | -.78 |
| C05. How things like radios and televisions work | -.78 |
| A43. How the ear can hear different sounds | -.80 |
| A15. How plants grow and reproduce | -.81 |
| E28. How to use and repair everyday electrical and mechanical equipment | -.81 |
| E30. How electricity has affected the development of our society | -.83 |
| E37. Famous scientists and their lives | -.84 |
| E36. Why scientists sometimes disagree | -.85 |
| E27. Electricity, how it is produced and used in the home | -.86 |
| C02. Optical instruments and how they work (telescope, camera, microscope, etc.) | -.88 |
| C07. How computers work | -.88 |

| Boys | r |
|---|---|
| A12. Cloning of animals | .87 |
| A34. How it feels to be weightless in space | .86 |
| C08. The possibility of life outside earth | .83 |
| A25. Tornados, hurricanes and cyclones | .82 |
| A22. Black holes, supernovas and other spectacular objects in outer space | .81 |
| A27. Brutal, dangerous and threatening animals | .81 |
| A31. Explosive chemicals | .70 |
| A23. How meteors, comets or asteroids may cause disasters on earth | .69 |
| C15. Thought transference, mind-reading, sixth sense, intuition, etc. | .68 |
| C10. Unsolved mysteries in outer space | .67 |
| A30. How the atom bomb functions | .66 |
| A32. Biological and chemical weapons and what they do to the human body | .65 |
| E42. Phenomena that scientists still cannot explain | .65 |
| C14. Ghosts and witches, and whether they may exist | .63 |
| A33. The effect of strong electric shocks and lightning on the human body | .61 |
| A14. Dinosaurs, how they lived and why they died out | .58 |
| E13. How different narcotics might affect the body | .57 |
| E16. How to protect endangered species of animals | .55 |
| A38. Eating disorders like anorexia or bulimia | .54 |
| C11. Life and death and the human soul | .52 |
| A05. Clouds, rain and the weather | -.51 |
| E33. Benefits and possible hazards of modern methods of farming | -.52 |
| E05. What can be done to ensure clean air and safe drinking water | -.52 |
| E22. How different sorts of food are produced, conserved and stored | -.52 |
| E34. Why religion and science sometimes are in conflict | -.52 |
| A17. Atoms and molecules | -.52 |
| E07. How to control epidemics and diseases | -.53 |
| E19. Organic and ecological farming without use of pesticides and artificial fertilizers | -.53 |

| **Boys (cont.)** | |
|---|---|
| A16. How people, animals, plants and the environment depend on each other | -.54 |
| A42. How radiation from solariums and the sun might affect the skin | -.54 |
| A07. How the human body is built and functions | -.55 |
| C01. How crude oil is converted to other materials, like plastics and textiles | -.56 |
| A39. The ability of lotions and creams to keep the skin young | -.57 |
| E25. Plants in my area | -.60 |
| E17. How to improve the harvest in gardens and farms | -.61 |
| E23. How my body grows and matures | -.61 |
| E06. How technology helps us to handle waste, garbage and sewage | -.62 |
| C06. How mobile phones can send and receive messages | -.63 |
| E03. The ozone layer and how it may be affected by humans | -.63 |
| E18. Medicinal use of plants | -.68 |
| E02. How the sunset colours the sky | -.69 |
| C16. Why the stars twinkle and the sky is blue | -.69 |
| A46. How X-rays, ultrasound, etc. are used in medicine | -.71 |
| A15. How plants grow and reproduce | -.72 |
| E27. Electricity, how it is produced and used in the home | -.74 |
| C17. Why we can see the rainbow | -.75 |
| E26. Detergents, soaps and how they work | -.75 |
| A36. How the eye can see light and colours | -.76 |
| A43. How the ear can hear different sounds | -.79 |
| E36. Why scientists sometimes disagree | -.82 |
| E37. Famous scientists and their lives | -.82 |
| C02. Optical instruments and how they work (telescope, camera, microscope, etc.) | -.91 |

# Appendix G Norwegian missing rates

Percentages missing responses for the sample constituted by the five Norwegian clusters for the whole questionnaire (not the open-ended questions).

