



Research Findings on Young People's Perceptions of Technology and Science Education

MIRROR RESULTS AND GOOD PRACTISES

mirror
Technology taste of life

Foreword

The objective of the MIRROR project has been to increase the proportion of women in the area of technology and ICT industry. Methods used to reach the objective have been to develop motivating education and learning methods mostly in mathematics, physics and technical subjects at all levels of education as well as increasing attractiveness of the area with positive examples and role models. The three year project has been part of EU Equal program and is coordinated by Technology Industries of Finland.

In this publication, we introduce the research findings about young people's perceptions of technology and science education. These research findings are part of MIRROR projects results and good practices.

Helsinki, May 2005

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Publisher: Technology Industries of Finland
ISBN 951-817-886-0

Design: Contra Oy
Layout: Rohkea Ruusu Oy
Photographs: Rohkea Ruusu Oy/Sarri Kukkonen
and the archives of the MIRROR project
Printed by Finepress Oy, Turku 2005

Attractiveness of Science Education in the Finnish Comprehensive School

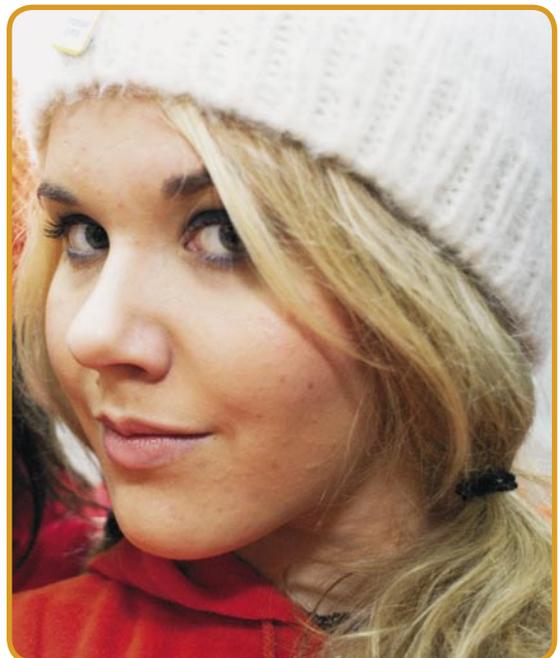
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Finnish ninth grade comprehensive school students' interest in and experiences of science and science education have been surveyed. According to the findings, it is important to be aware that boys and girls, as groups, on average, have different interests and everyday experiences in the various school subjects or scientific disciplines. Concerning the teaching of science, a specific wish was expressed to increase the number of different visits to industry and museums as well as to involve experts in the science classes. Specifically, this wish was expressed by girls.

The survey as a part of the GISEL project

The GISEL (Gender Issues, Science Education and Learning) Project being carried out by the Department of Applied Sciences of Education at the University of Helsinki has sought to find ways to influence, when choosing a career, the attitudes of girls towards science and technology, as well as to those professions applying them. In practice, within the project's framework and in cooperation with teachers from the cities of Espoo, Vantaa and Helsinki, teaching methods of science have been developed. Those teaching methods demonstrate the attractiveness of science and promote young people's, girls' in particular, interest in science; thus, motivating them to study science and to choose, especially in upper secondary school, advanced science courses.

In the GISEL Project a survey has been carried out also on the attractiveness of science education: among pupils in the ninth grade of comprehensive school. The findings of the survey were presented, immediately after a preliminary analysis, to the teachers involved in the project. The findings



were also presented at GISEL dissemination seminars and at other events of the subprojects of the MIRROR Development Partnership. The survey has channelled the GISEL Project activities in many ways. The findings have been used for justifying the eligibility of the chosen actions and their evaluation.

Finnish students had reached top ranks in the international comparison studies. Those comparisons have been performed in the framework of transnational school achievement assessment studies such as PISA (Program for International Student Assessment). The PISA Study does not, however, reveal the interests of pupils outside school, so a transnational comparison in this field is also justified. That is why it is appropriate that the findings of the GISEL Project's survey can be compared to similar surveys carried out in other countries. Accordingly, most of the survey questions were adopted from the international ROSE survey¹. Judging by the preliminary findings, the Scandinavian countries seem to form a rather homogenous group regarding the questions measuring interest.

The ROSE questionnaire has been prepared through international cooperation, and it is aimed at pupils towards

the end of secondary school (Sjøberg & Schreiner, 2002). The aim of the survey was to explore what pupils in different countries think of science education in school as well as of science from the point of view of everyday life. The findings of the survey help teachers and researchers to make science education and learning more interesting. The survey has been carried out in 32 countries with responses from 36 000 pupils. The questionnaire includes questions about the pupils themselves, their experiences and interests concerning science, applied science health and environmental issues, as well as questions on the teaching of these subjects at school and outside school. In the questionnaire there are also some questions exploring pupils' interests in supernatural phenomena. As the questionnaire is meant to be answered in a number of countries, some of the questions appear somewhat strange from a Finnish viewpoint. The focuses of the survey are not fully applicable to Finnish education either because, in contrast to many other countries, in Finland, physics, chemistry, biology and earth sciences are taught as separate subjects. (Schreiner & Sjøberg, 2004)

Students interest in science and their out of school experiences

In the industrialised countries, school development experts and education policy makers have expressed concern that young people are not interested in science; in upper secondary school, they do not opt for courses in these subjects. In addition, after upper secondary school they do not apply for studies in mathematics and science or in other subjects where these are applied (Black & Atkin 1996). Even if there are many reasons for this phenomenon, one important reason is deemed to lie in the subjects themselves, the issues they deal with and how these issues are dealt with in the classroom. Attracting students to science has been considered such a central priority that it has been set as one of the objectives of education in the national core curriculum and in the school-specific curricula.

Numerous studies indicate that a student's interest in the subject matter leads to deep learning, so that the student is able to apply what he or she has learnt to new situations (Krapp 2002). Many researchers, however, make a distinction between individual interest and situational interest (Krapp, Hidi and Renninger 1992). Individual interest in a subject matter develops gradually, it affects the individual's knowledge and values, and it is of constant character. It is difficult for the school to contribute to this interest. Situational interest can arise even rapidly in certain situations, its nature is emotional and it can be of short duration (Hidi 1990). Yet situational interest can develop gradually into individual interest.

Answers to the question about what could inspire youngsters' situational interest to study science has been sought by

¹ROSE (The Relevance Of Science Education) is a transnational project with about 40 countries involved. It is coordinated by professor Svein Sjøberg and researcher Camilla Schreiner from Oslo University with support from the Research Council of Norway. Reports and detailed information can be found at: www.ils.uio.no/forskning/rose

mapping students' interest in: (1) science and technology in general, (2) subject matters studied in science, (3) contexts in which physical concepts are encountered (e.g. technological or environmental context), and (4) teaching methods and the use of information and communication technology (Simon 2000, Hoffman 2002, Osborne 2003). Student's interest is also influenced by (5) the gender, (6) relevance of the subject as perceived by the student, as to his or her future studies or career, and (7) factors relating to the quality of teaching, the amount of work and the competence in the subject.

Typically, a solution for promoting students' interest has been sought in so-called context-based teaching reform approaches (Context-based –, Science – Technology – Society (STS) –, Applications-led -Approach, Science for all movement). In the context-based approaches, students are directed to encounter concepts of science in situations or contexts that

are known or believed to interest them or they are shown that science can be of use, for instance in everyday life, in further studies or in work (Bennett, Hogarth and Lubben 2003). For instance, Osborne (2003) has suggested that student's interest and internal motivation can be aroused by choosing an approach that motivates him or her to study. Therefore, the approach applied in teaching does influence student's interest and learning (Byman 2002).

The objective of the study is to explore students' interest in school subjects or scientific disciplines, applied science and in connection with health and environmental issues. In the questionnaire, there are also some questions exploring pupils' interests in supernatural phenomena. The second objective of the study is to explore what approaches or teaching methods are currently used in teaching science and what teaching methods students would like to use.

Data collection

We randomly chose 75 schools from the list of Finnish-speaking comprehensive schools in Finland. In each of these schools, about 65 students were asked to answer the survey, which meant about three classes from each school. In one school there were only 20 students, in two schools about 30 students, and in two schools about 40 students. The schools were not chosen completely randomly: rather they were weighted by the number of students at grade 9. This meant that big schools had a greater chance of being selected for the survey. The overall effect was that students were selected randomly from the whole age cohort across the country. In total, we selected 4954 pupils to participate in the survey, and we received replies from 3626 pupils.

Based on international surveys, such as PISA and TIMSS (OECD, 2001; Välijärvi et al., 2002), we know that there are only minor differences between students' achievements in different parts of Finland. Therefore, it is reasonable to discuss national averages. The population of Finland can be classified to be quite homogeneous and "mono-cultural" compared with countries with larger populations, several nationalities,

and religions. In Finland, there are a relatively small number of immigrants.

The questionnaire was sent to the schools on 27 March 2003, and the principals were asked to organise the survey and return the completed questionnaires by 20 April 2003. The national and international purposes of the survey were carefully explained on the cover sheet. One of the purposes outlined was how a new kind of in-service training could be organised by the National Board of Education based on the information acquired by the survey. The letter was signed by the Head of the Department of Teacher Education and the Director of the National Board of Education.

Altogether, 26 reminders (37% of the selected schools) were sent by 10 May 2003 to those principals who had not returned the survey in time. The purpose of the survey was explained once again, and they were asked to return the completed questionnaires on 25 May 2003. The survey was answered by 3626 students in 61 schools, which corresponds to 73% of pupils in 81% of the selected schools.

Students' interest in science subject

In parts A, C and E of the ROSE questionnaire, there are questions measuring students' interest in different science subjects such as physics, chemistry, biology and earth sciences. Some of the questions concerned sub-disciplines of the sciences such as geology, meteorology, geophysics, ecology and other environmental sciences, human biology, zoology and botany etc. A significant number of the questions dealt with applied disciplines such as technology, medicine, agricultural sciences and health science. The sections also include questions measuring a student's interest in science and technology in general, as well as in non-scientific phenomena (mysticism) such as horoscopes and UFOs. The questionnaire asks students: "How interested are you in learning about the following?" Students answered by ticking the appropriate box on a four-point rating scale, the extreme categories being **Not interested** and **Very interested**. The responses were scored 1, 2, 3 and 4. Even if the scale is an ordinal one, it is easier to discern the findings when they are presented in the form of means of the students' responses.

Responding to the questions a student, in a manner of speaking, classifies things that are interesting or uninteresting. The questions are designed so that a student encounters things from a certain school subject or scientific discipline in diverse contexts. For example, the following questions measured a student's interest in content without a context: "Atoms and molecules" and "How the human body is built and functions". The following questions are in a technological context: "How a nuclear plant works", "How crude oil is converted to other materials, like plastics and textiles".

Because there are many questions in parts A, C and E, they have to be grouped for presenting the findings. Basically, grouping can be done in many different ways. Questions can be grouped, e.g., into different contexts or different subjects or disciplines. In the following, the grouping is based on the subject matter as it appears in the Finnish school system, in which case it is possible to form one group from the newly introduced school subject, health education. Some of the

questions do not relate directly to school subjects or they represent clearly a subgroup of a subject in which case they are grouped according to the discipline or related applied discipline (e.g. biology and medicine, physics and technology). Some of the questions by their nature could fit into another group as well (e.g. human biology and health education). In this presentation, however, an attempt has been made to distinguish between them on the grounds that only questions having the most explicit connection with health care have been included in health education. In addition to the distinct school subjects, questions relating to the nature of science, technology and non-science form their own groups. In this chapter, then, we try to determine what school subjects or disciplines students are interested in. It is possible, also, to draw some conclusions on which contexts the students find interesting. Both questions are studied from the perspectives of girls and boys alike.

The findings are arranged in a way that the subject or discipline about which the students considered the questions the most interesting is presented first and the one that they considered the least interesting is last. Each figure caption shows the mean (M) of the questions relating to the subject or discipline as well as separate means for girls (M_g) and boys (M_b). Within each subject or discipline, the questions have been arranged according to girls' preference rate. The middle point of the scale corresponds to 2.5. Consequently, we can conclude that when the mean falls below 2.5, the majority of the students are not interested in the subject matter. In contrast, when the mean is above 2.5, the majority of the students are interested in the subject matter.

Yet we must remember that there are no 'average' students. There are always boys and girls that are more interested in an issue than others are and, correspondingly, there are boys and girls that are totally disinterested in a particular issue. Therefore, we should not make straightforward generalisations from the findings such as: "All girls want to..." or "All boys are not at all interested..."

Figure 1. Students' interest in non-scientific (mystical) phenomena ($M = 2.67$, $M_g = 2.93$, $M_b = 2.42$).

Statement c8 belongs to astrobiology; water and compounds characteristic of life are sought on planets and moons.

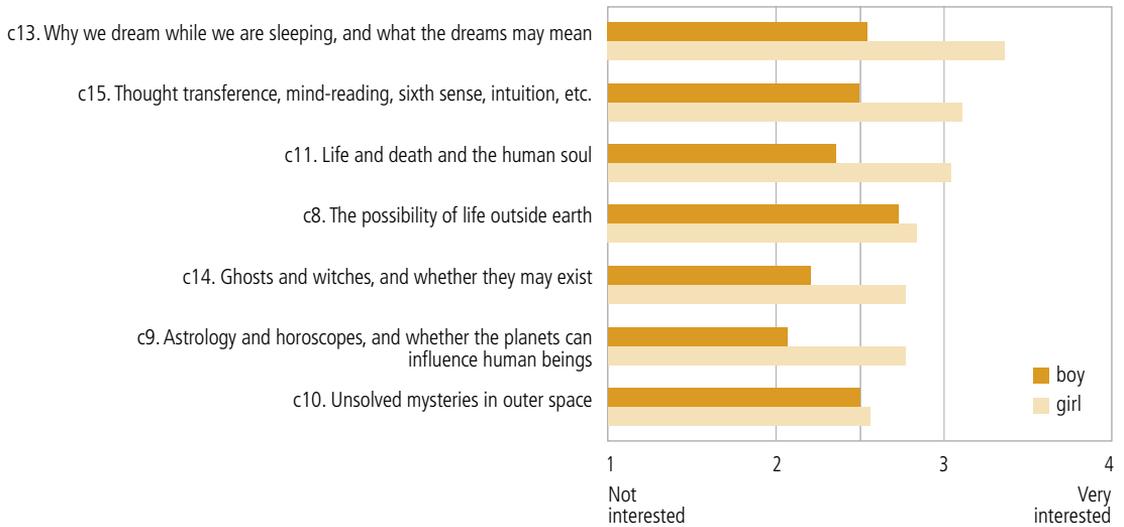


Figure 2. Students' interest in issues related to health science (health risks) ($M = 2.52$, $M_g = 2.62$, $M_b = 2.43$).

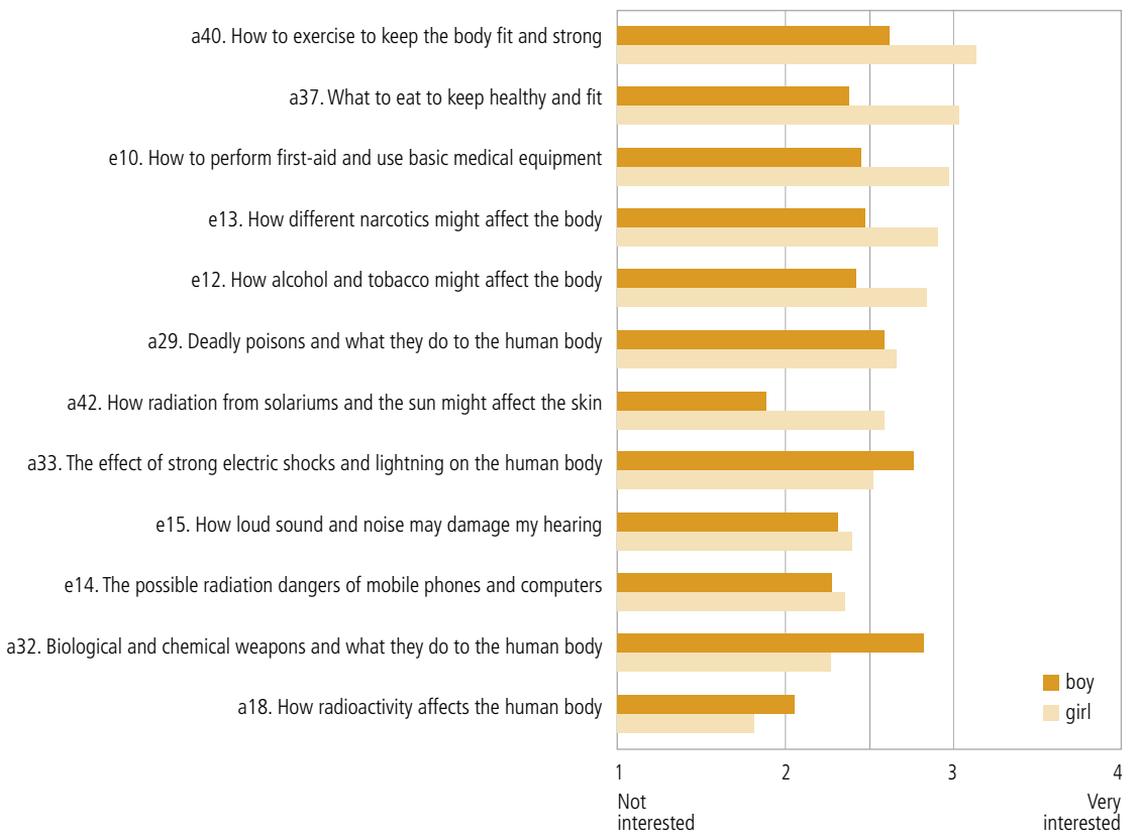


Figure 3. Students' interest in phenomena of the animal world ($M = 2.46$, $M_g = 2.57$, $M_b = 2.34$).

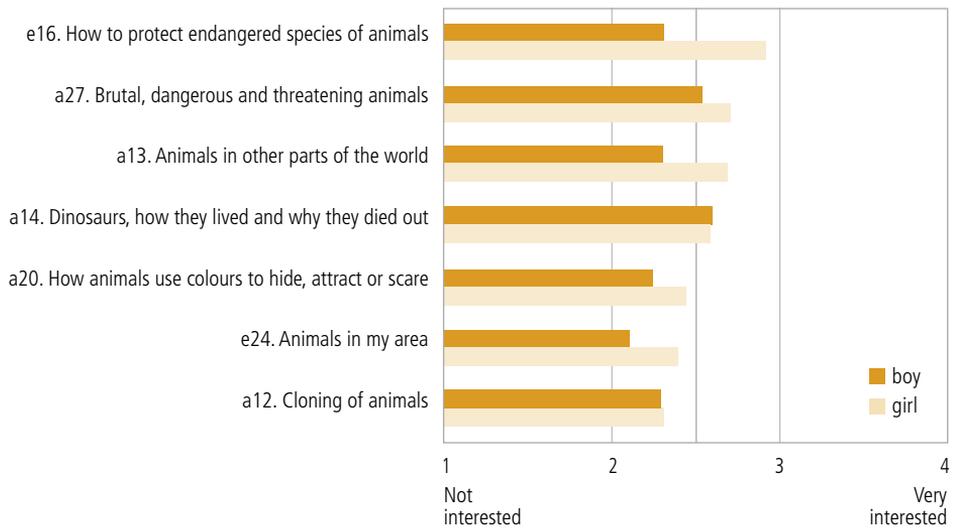


Figure 4. Students' interest in health science (included in health education) ($M = 2.46$, $M_g = 2.70$, $M_b = 2.22$).

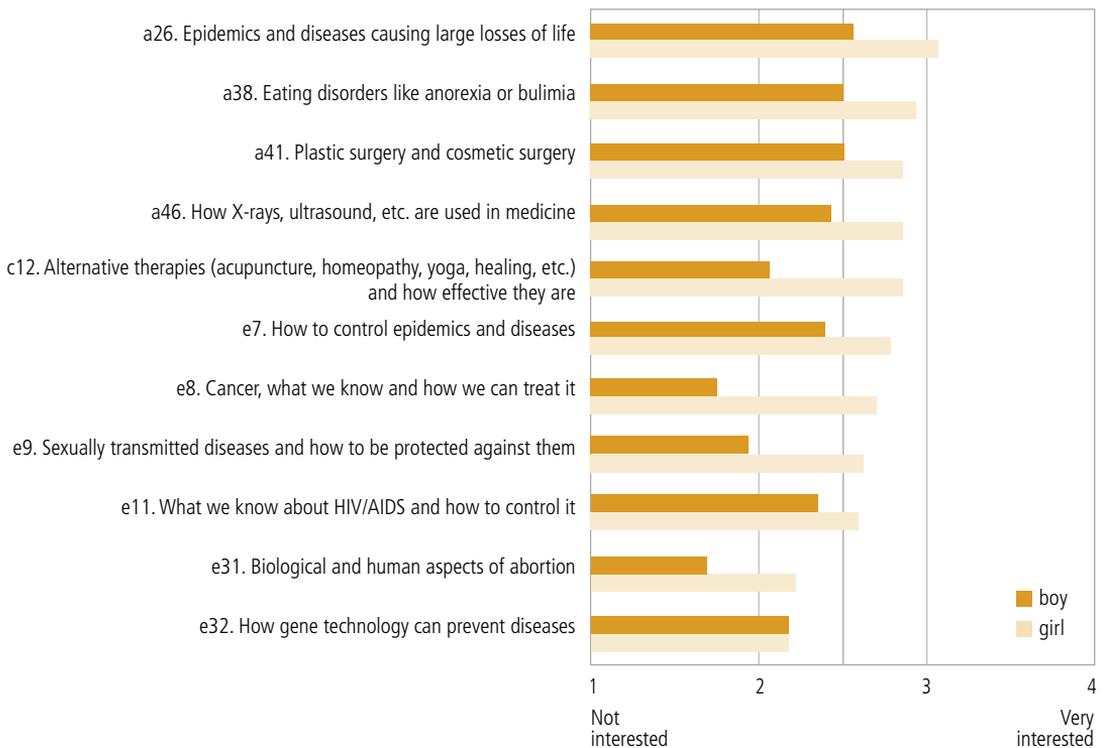


Figure 5. Students' interest in phenomena of astronomy and space research ($M = 2.44$, $M_g = 2.46$, $M_b = 2.52$).

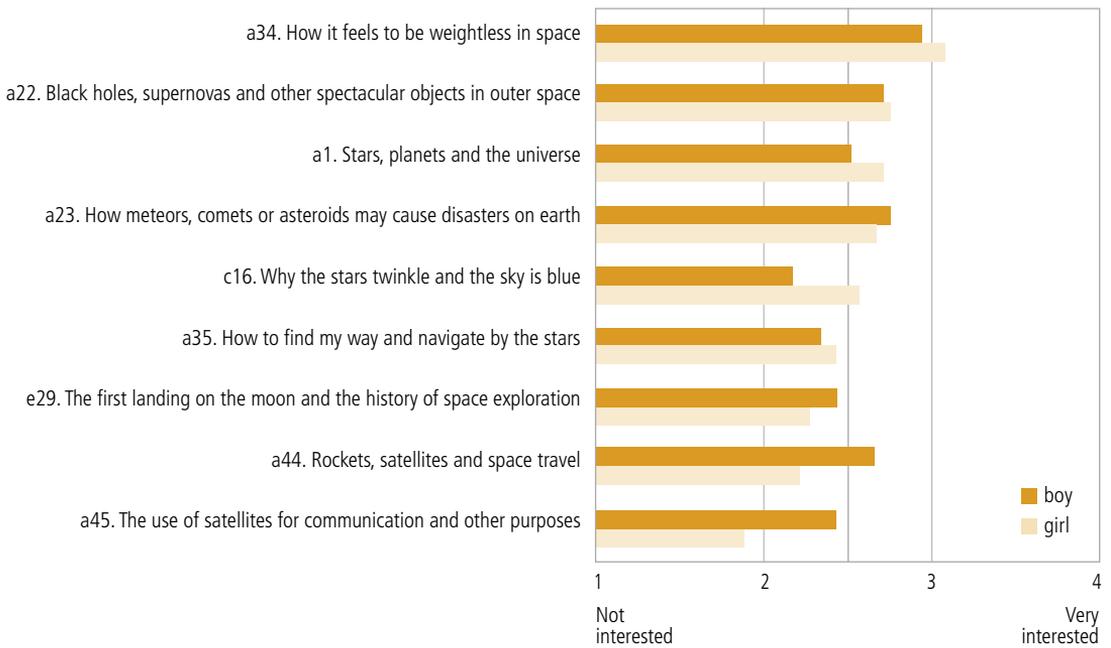


Figure 6. Students' interest in phenomena of human biology. ($M = 2.43$, $M_g = 2.62$, $M_b = 2.24$).

Questions a9, a11, e23, a7, a39 and a10 relate also to health science (Figures 2 and 4).

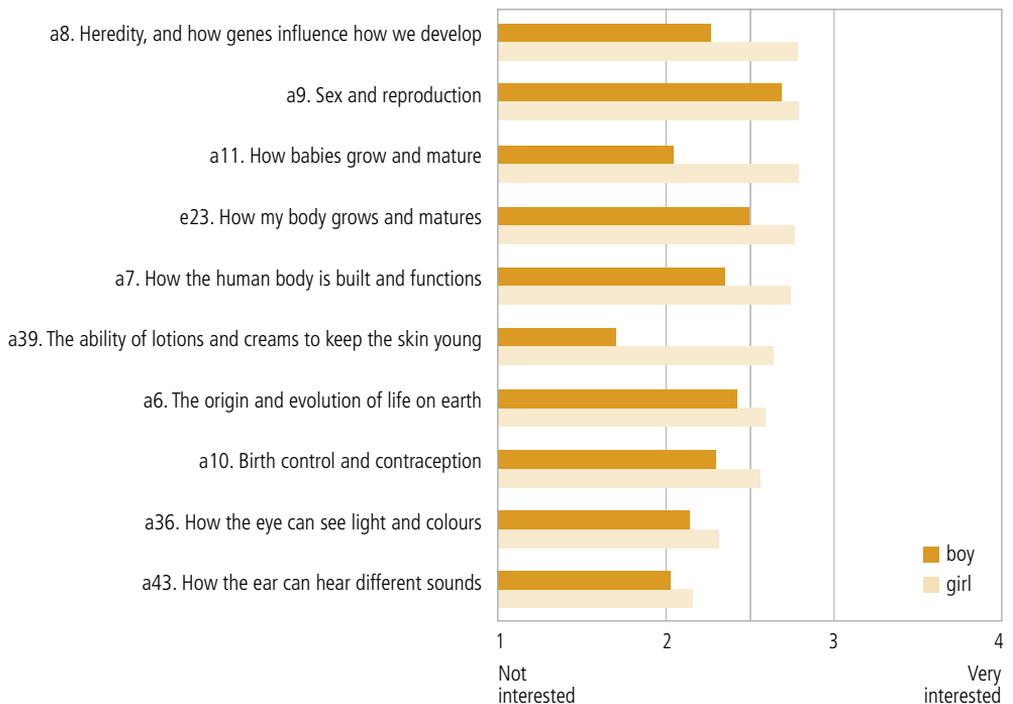


Figure 7. Students' interest in phenomena of earth science ($M = 2.34$, $M_g = 2.38$, $M_b = 2.30$).

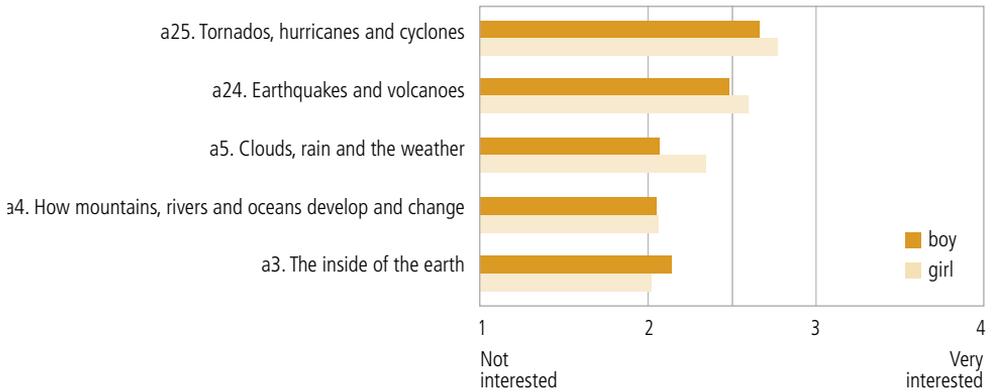


Figure 8. Students' interest in technological phenomena and the relationship between technology and society ($M = 2.33$, $M_g = 2.06$, $M_b = 2.64$).

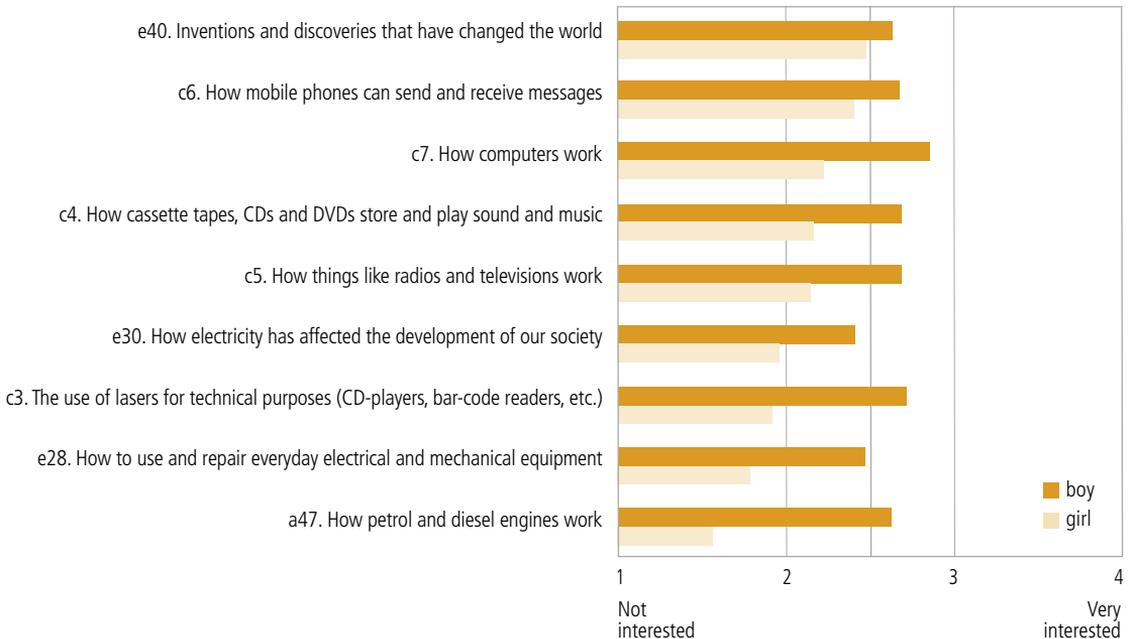


Figure 9. Students' interest in science in general (issues related to the philosophy of science) ($M = 2.28$, $M_g = 2.24$, $M_b = 2.32$).

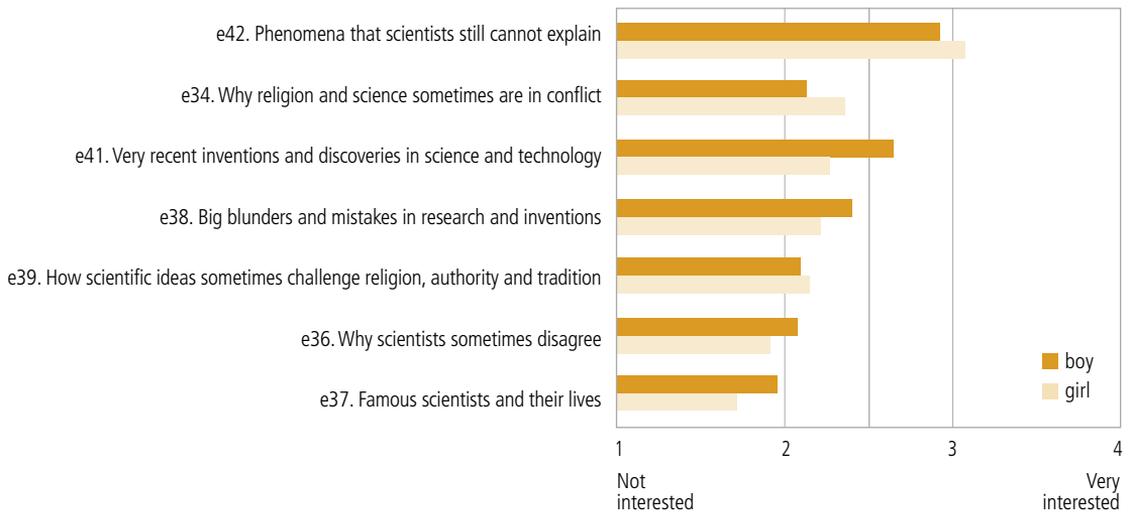


Figure 10. Students' interest in environmental issues and sustainable development ($M = 2.27$, $M_g = 2.32$, $M_b = 2.22$).

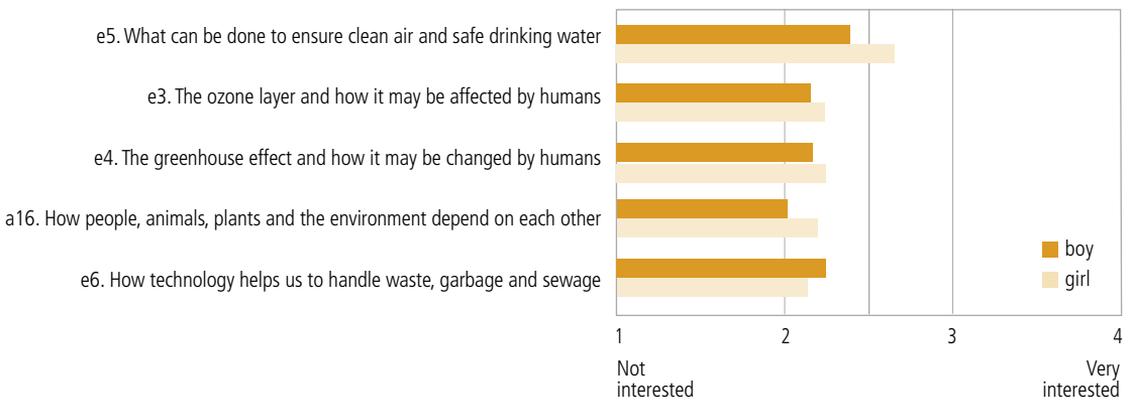


Figure 11. Students' interest in physics ($M = 2.20$, $M_g = 2.03$, $M_b = 2.32$).

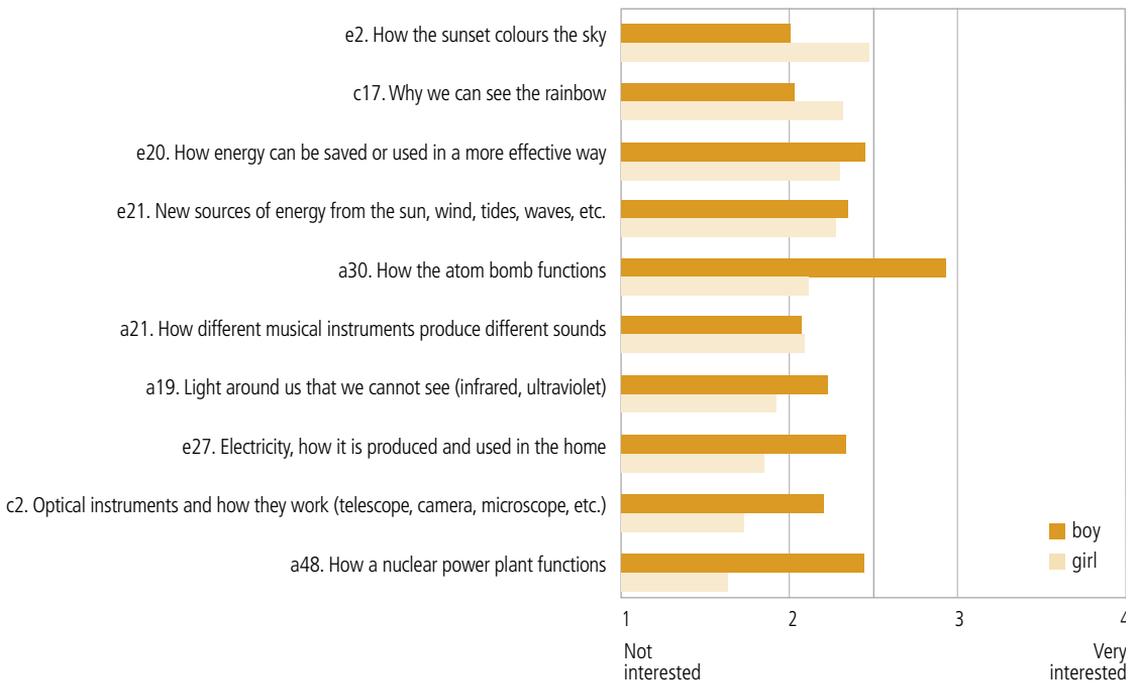


Figure 12. Students' interest in chemistry ($M = 2.12$, $M_g = 1.93$, $M_b = 2.16$).

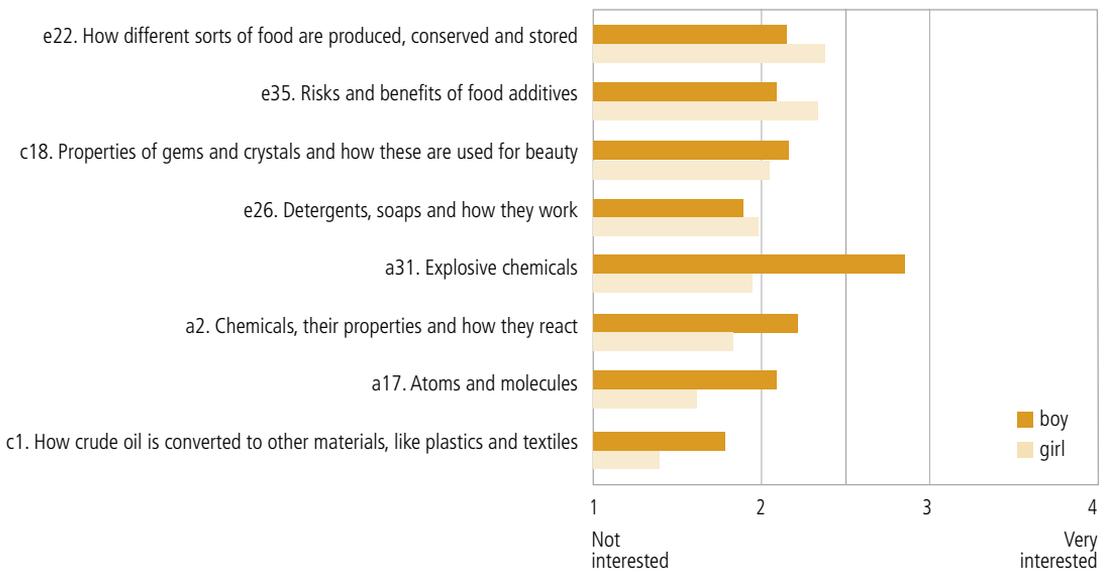
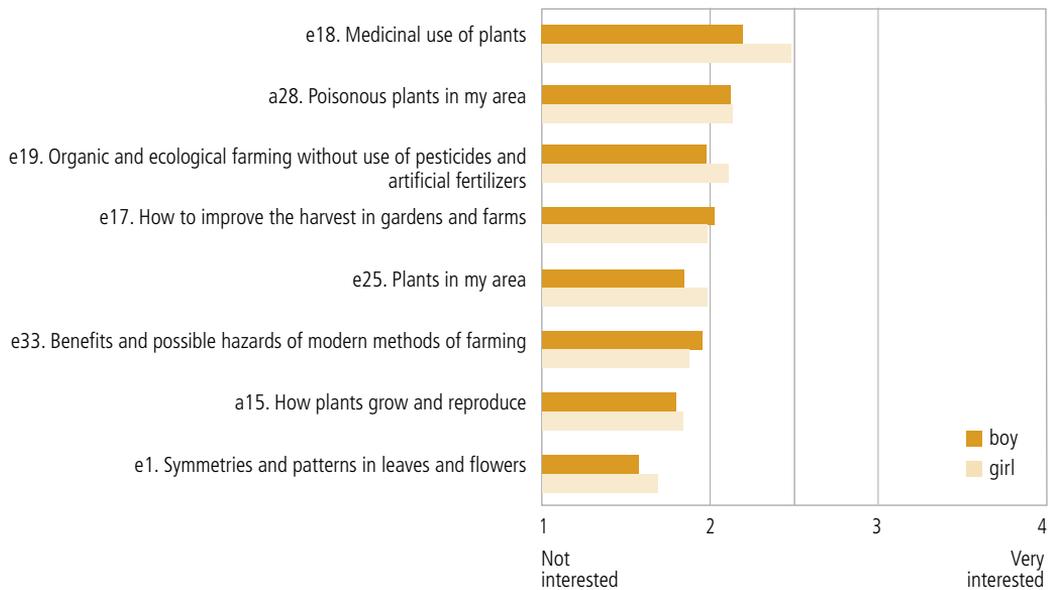


Figure 13. Students' interest in botany and applied biology ($M = 1.99$, $M_g = 2.04$, $M_b = 1.95$).



Among the thirteen school subjects or disciplines, the students were most interested in non-scientific (mystical) phenomena, such as horoscopes and UFOs, as well as in things related to human health such as a healthy diet and substances detrimental to health. Among the sciences, the students, on average, were most interested in topics related to medicine and astronomy. The students were least interested in topics related to physics, chemistry and botany. Health education (Figure 2), medicine (Figure 4) and human biology (Figure 6) are, on average, the subjects or disciplines of most interest to girls and are clearly of less interest to boys. Physics (Figure 11) and technology (Figure 8) are the subjects or disciplines in which boys have at least some interest but in which the girls, as group, have little interest. Science and its fundamental nature in general (Figure 9), environmental science (Figure 10) and astronomy (Figure 5) are neutral subjects or disciplines, in other words they interest boys and girls to practically the same degree. We must take into account that in those subjects or disciplines, where there are differences in interest between

the genders, the differences are significant, and we should be conscious of them when designing instruction.

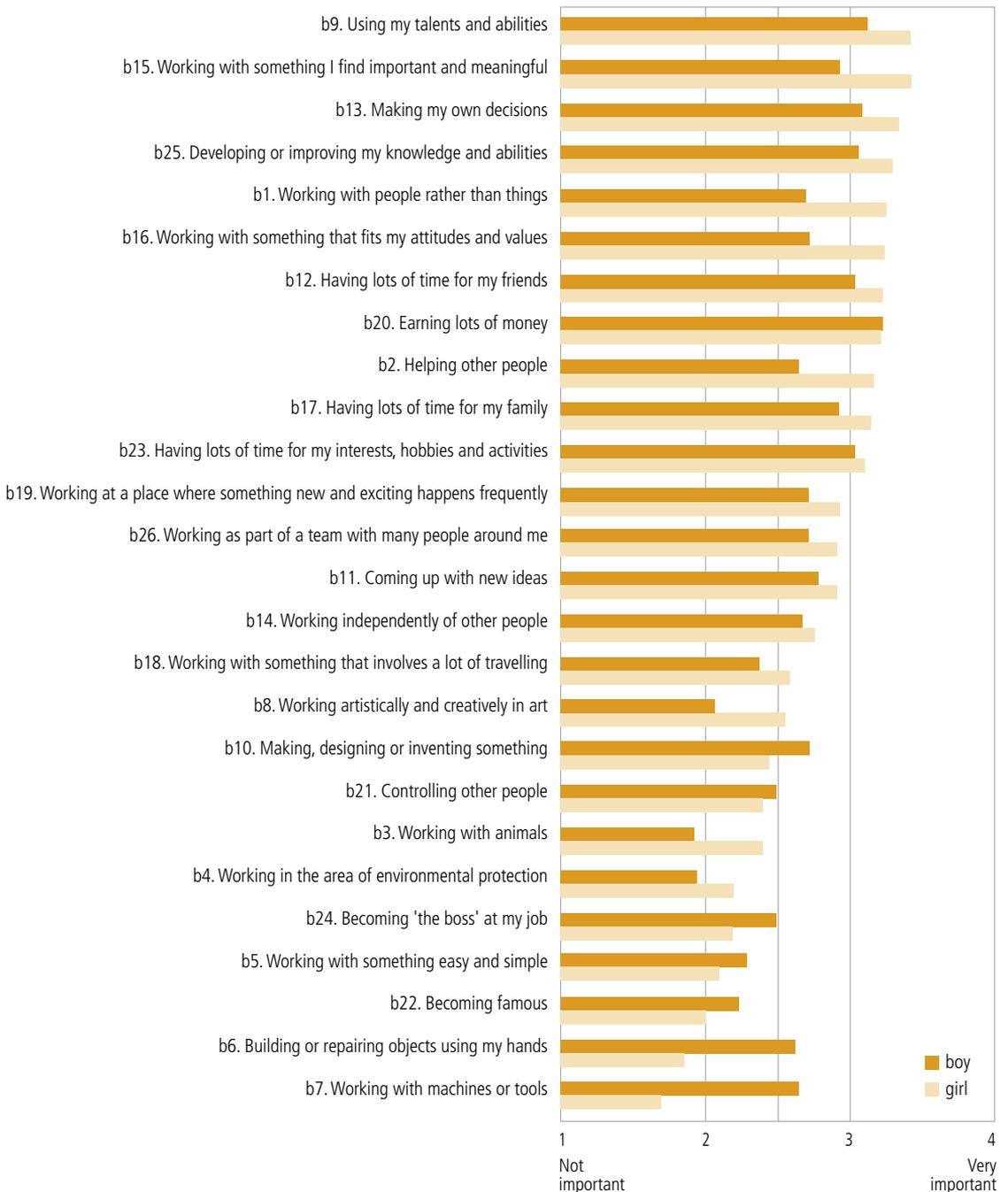
Spectacular events such as evidently or potentially dangerous situations are of interest to both genders but on average even more to girls. "Brutal, dangerous and threatening animals", "Epidemics and diseases causing large losses of life", and "Tornados, hurricanes and cyclones" and "How to perform first-aid and use basic medical equipment". The biggest difference between boys and girls – in the sense that something is of more interest to girls – lies in situations that relate to caring of ones own health, looks or beauty. "What to eat to keep healthy and fit", "Plastic surgery and cosmetic surgery" and "The ability of lotions and creams to keep the skin young". However, boys but not girls were interested in explosions, weapons and machines: "Explosive chemicals", "How the atom bomb functions", "Biological and chemical weapons and what they do to the human body", "How petrol and diesel engines work" and "The use of lasers for technical purposes (CD-players, bar-code readers, etc.)".

Future job and career

The ROSE questionnaire includes a section measuring students' general interest in the characteristics of jobs. Even though the questions do not actually measure interest in scientific and technological jobs, the findings allow for conclusions

to be drawn as to what extent scientific and technological jobs interest students. In Figure 14, the questions measuring students' general interest in the characteristics of jobs have been rated according to girls' preference.

Figure 14. Questions measuring students' general interest in features of job; arranged according to girls' interest



Girls and boys are interested in jobs or a career where one can use his/her abilities and talents. This is linked to desire to work with people, to do something one finds important and meaningful and to make one's own decisions. In particular, girls are not interested in working with machines, in building or in repairing objects. Studying those characteristics of jobs that are found to be interesting becomes easier if the statements relating to the jobs are grouped.

Statements measuring expectations connected to a future job or career were grouped utilising factor analysis. Factor analysis is a statistical method for grouping questions according to respondents' responses. The six-factor solution shown in Table 1 accounts for 46% of the total variance and it is easy to name the factors (comprehensible criteria). The factors describing future career expectations were named as follows: **Innovative orientation, Leisure-oriented orientation, Leader orientation, Social orientation, Technological orientation and Nature orientation.** Table 1 also includes a comparison of means for boys and girls performed with an analysis of variance as well as a presentation of means and standard deviations for both genders.

The findings indicate that girls are more interested in the qualities characteristics of their future career than boys. Girls, on average, appreciate more than boys the opportunity to use their abilities and talents in a job, to be creative and to work with other people. A managerial position is more important to boys than to girls, equally so a need to build objects and work with machines. Superficially, the findings can be interpreted so that boys, as group, are more interested in jobs within the technical and scientific area. It is noteworthy that the qualities girls expect from their careers and jobs are exactly what are required in technology development jobs, namely, creativity, the ability to work in teams and continuous personal development.

Good income is the only variable for which boys' and girls' expectations are not shown to be statistically significantly different from each other. Representatives of both genders expect their job to be well paid. In addition, girls appreciate leisure time and time for family more than boys. Boys, on average, are more technology-oriented than girls, whereas girls are more nature-oriented than boys.

Table 1. Six-factor solution (Maximum Likelihood, Promax and Kaiser Normalisation–Rotation) as calculated using variables measuring students' general interest in characteristics of jobs. Comparison of boys and girls using variation analysis.

| Item | Factor loading | Girl | | Boy | | F (1) |
|--|----------------|----------------|-------|----------------|------|-------------------|
| | | M _g | S.D. | M _b | S.D. | |
| Factor 1: Innovative orientation | | | | | | |
| b11 Coming up with new ideas | ,806 | 2,91 | ,896 | 2,78 | ,886 | 18*** |
| b10 Making, designing or inventing something | ,752 | 2,44 | ,956 | 2,72 | ,916 | 84*** |
| b9 Using my talents and abilities | ,615 | 3,43 | ,738 | 3,13 | ,875 | 122*** |
| b8 Working artistically and creatively in art | ,476 | 2,55 | 1,059 | 2,05 | ,990 | 208*** |
| b25 Developing or improving my knowledge and abilities | ,448 | 3,31 | ,733 | 3,06 | ,838 | 89*** |
| b13 Making my own decisions | ,356 | 3,35 | ,698 | 3,09 | ,815 | 106*** |
| b16 Working with something that fits my attitudes and values | ,319 | 3,24 | ,772 | 2,72 | ,853 | 353*** |
| Factor 2: Leisure orientation | | | | | | |
| b23 Having lots of time for my interests, hobbies and activities | ,698 | 3,10 | ,795 | 3,04 | ,850 | 6* |
| b12 Having lots of time for my friends | ,689 | 3,22 | ,834 | 3,03 | ,887 | 45*** |
| b17 Having lots of time for my family | ,490 | 3,15 | ,848 | 2,93 | ,901 | 56*** |
| b20 Earning lots of money | ,484 | 3,22 | ,745 | 3,23 | ,853 | 0,3 ^{NS} |
| b15 Working with something I find important and meaningful | ,381 | 3,42 | ,743 | 2,93 | ,871 | 333*** |
| b14 Working independently of other people | ,331 | 2,75 | ,874 | 2,66 | ,841 | 10*** |
| b5 Working with something easy and simple | ,302 | 2,11 | ,845 | 2,30 | ,904 | 41*** |
| Factor 3: Leader orientation | | | | | | |
| b24 Becoming 'the boss' at my job | ,807 | 2,19 | ,958 | 2,50 | ,940 | 96*** |
| b21 Controlling other people | ,694 | 2,41 | ,902 | 2,51 | ,903 | 10** |
| b22 Becoming famous | ,630 | 2,00 | ,948 | 2,22 | ,975 | 46*** |
| b18 Working with something that involves a lot of travelling | ,439 | 2,58 | ,959 | 2,36 | ,920 | 47*** |
| b19 Working at a place where something new and exciting happens frequently | ,309 | 2,93 | ,853 | 2,72 | ,867 | 50*** |
| Factor 4: Social orientation | | | | | | |
| b2 Helping other people | ,794 | 3,17 | ,837 | 2,65 | ,897 | 327** |
| b1 Working with people rather than things | ,603 | 3,26 | ,880 | 2,69 | ,930 | 354*** |
| b26 Working as part of a team with many people around me | ,465 | 2,91 | ,865 | 2,71 | ,886 | 48*** |
| Factor 5: Technological orientation | | | | | | |
| b7 Working with machines or tools | ,844 | 1,68 | ,845 | 2,65 | ,961 | 1001*** |
| b6 Building or repairing objects using my hands | ,834 | 1,84 | ,900 | 2,62 | ,974 | 619*** |
| Factor 6: Nature orientation | | | | | | |
| b4 Working in the area of environmental protection | ,720 | 2,19 | ,911 | 1,93 | ,879 | 73*** |
| b3 Working with animals | ,705 | 2,41 | 1,020 | 1,90 | ,877 | 250*** |

1) * p < 0.05, ** p < 0.01, *** p < 0.001

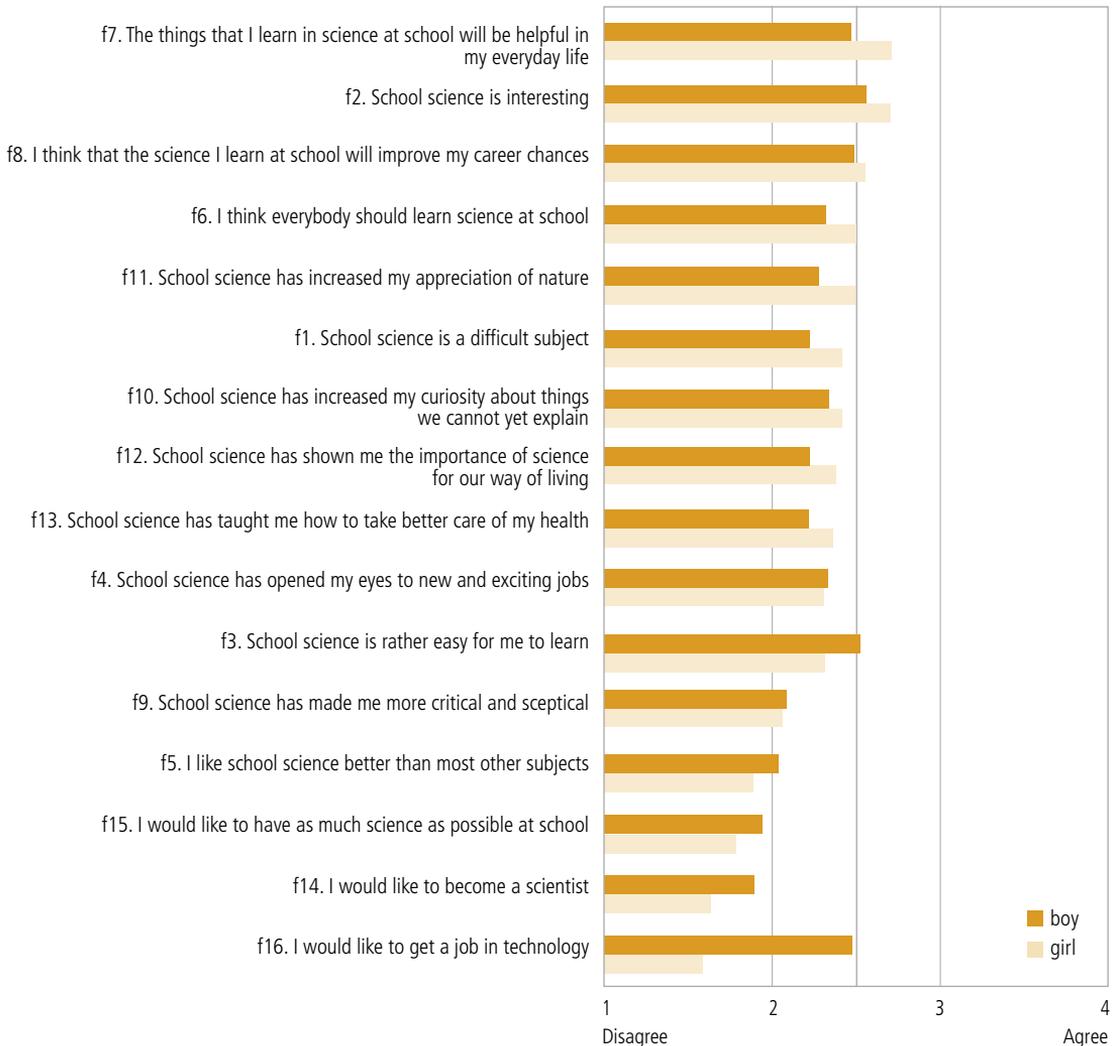
M = mean, S.D. = Standard Deviation

Science education

Students' perception of the general relevance of their science classes was measured using 16 questions. Boys' and girls' perceptions do not differ very much from each other except for the last question. Only three of the questions demonstrate

a mean greater than 2.5. On average, students consider the study of science to be of benefit for the future and it is perceived to offer a wider choice of career.

Figure 15. Students' perception of general relevance of science classes (physics, chemistry, biology and earth sciences).

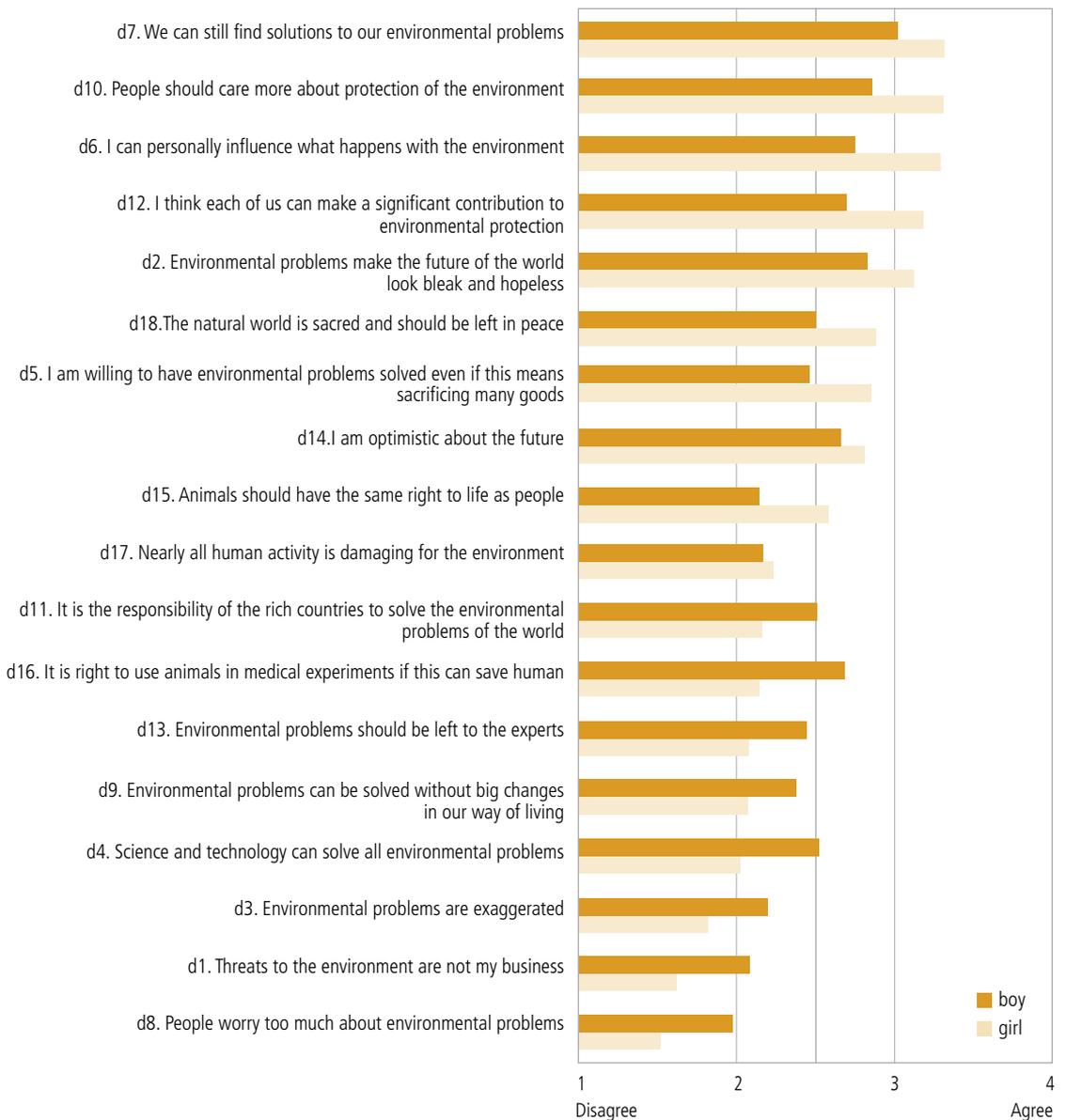


Relationships with the environment, science and technology

The questions in section D measure students' attitudes towards the environment and their sense of responsibility for environmental issues. The results indicate that, on

average, girls are more concerned with environmental issues and are have a greater sense of environmental responsibility than boys.

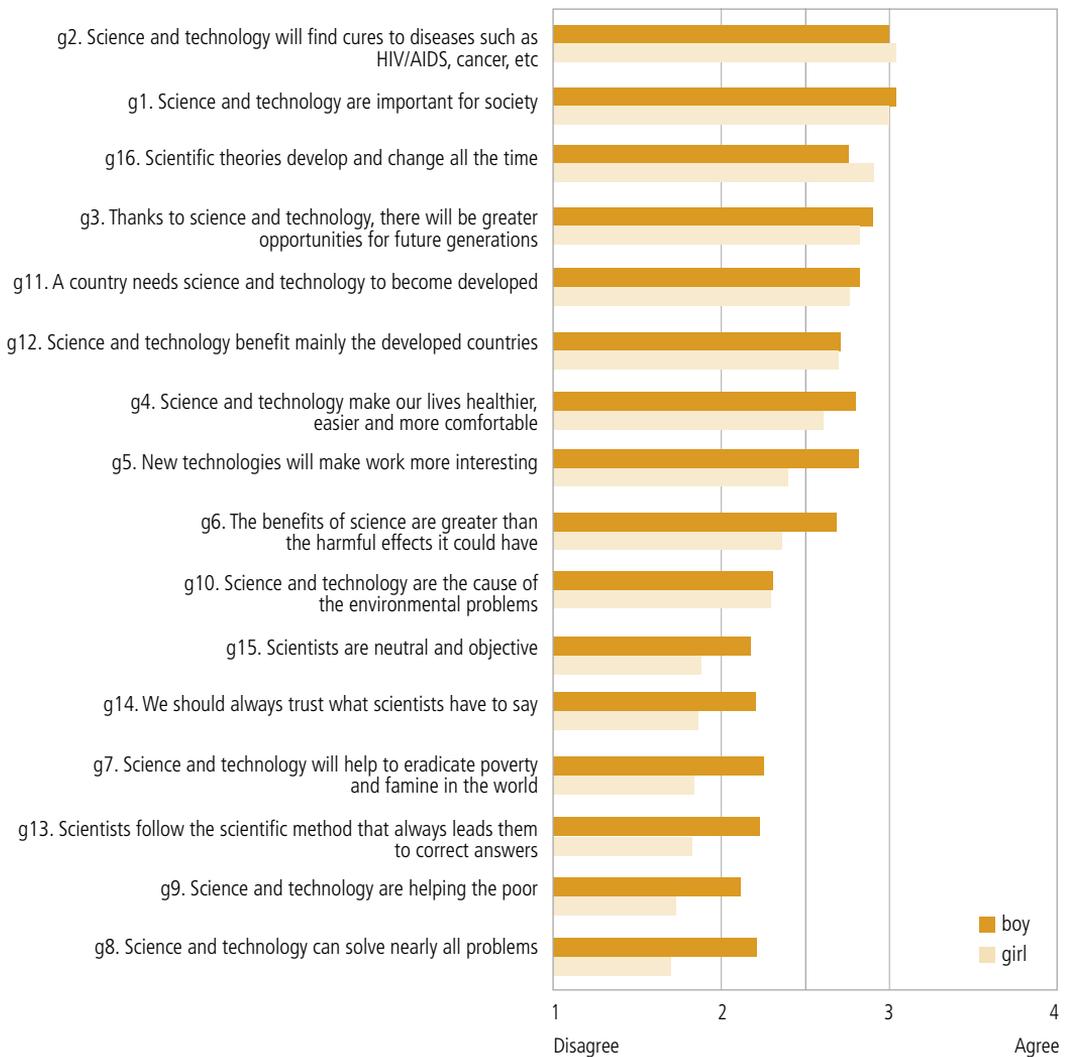
Figure 16. Students' attitude towards the environment and their sense of responsibility for environmental issues.



The questions in Section G measure students' attitudes towards science and technology, (as well as towards their eventual ability to solve problems relating to humankind such as environmental problems and how to eradicate famine and

disease from the world). The results indicate that both boys and girls believe in the potential of science and technology to some extent at least. Girls are, however, more critical.

Figure 17. Students' attitudes towards the possibility of science and technology to solve human and environmental problems.



Out-of-school experiences

Section H of the ROSE questionnaire includes questions measuring students' out-of-school experiences such as using tools, backpacking, homemaking and using different kinds of equipment. The questionnaire asks students: "How often have you done this outside school?" Students answered by ticking the appropriate box on a four-point scale, the extreme categories being Never and Often. The responses were scored 1, 2, 3 and 4. Even if the scale is an ordinal one, it is easier to discern the results when they are presented as means of the students' responses. A comparison of boys' and girls' responses gives the teacher valuable insight into what kind of earlier experiences exist that learning new concepts and skills in science classes can draw upon. The teacher should be wary of using too many examples of things in which, for instance girls have little experience when compared to boys. Likewise, the teacher could pay attention to encourage girls to use technical equipments.

Because there are 61 questions in section H, they have to be grouped for presentation of the findings. The questions were grouped using factor analysis but the resulting factor solutions did not group the students' experiences in different subject areas in an optimal manner. Yet the questions in Section H have been grouped based on the best factor solution because the factors could be named as follows: Experiences in using information and communication techno-

logy; Experiences in using household "tools" and everyday measurements; Experiences of nature through books, films and museums; Experiences of collecting, going outdoors, fishing and hunting; Experiences of being ill and getting medical treatment; Experiences of using "heavy" tools; Experiences of agriculture and gardening and experiences of building and investigating small objects.

Once again, it is worthwhile to stress that grouping can be done in other ways, too. Therefore, in this chapter we try to determine what kind of experiences relating to science education students have from outside school. The findings are presented so that the first subject matter introduced is where girls have had the most experiences, the last being the one where they have had least experiences. The caption shows the overall mean for the questions and the means for boys and girls separately. In each case the questions have been arranged so that girls have had more experiences of the topmost situation. Once again, it is noteworthy that the middle point of the scale is 2.5. On this basis, we can conclude that when the mean is less than 2.5, it means that most of the students have not had experiences either regarding the situation or the subject matter. In contrast, when the mean is more than 2.5, it means that most of the students have had experiences of either the situation or the subject matter.

Figure 18. Students' experiences in using information and communication technology ($M = 3.3$, $M_g = 3.3$, $M_b = 3.3$).

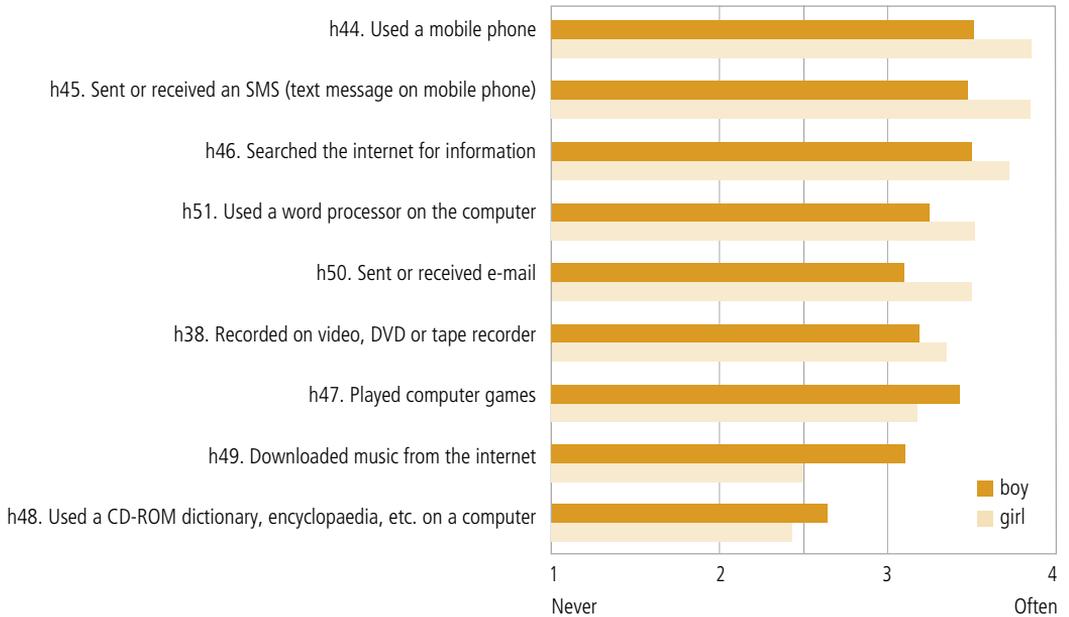


Figure 19. Students' experiences in using domestic "tools" and everyday measurements ($M = 2.98$, $M_g = 3.18$, $M_b = 2.80$).

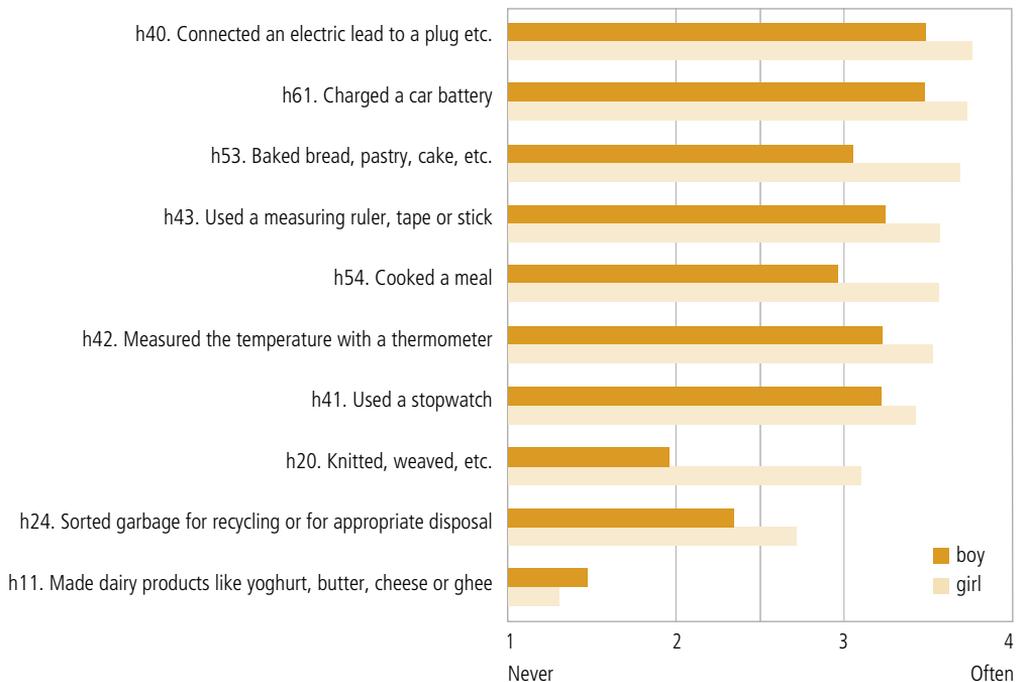


Figure 20. Students' experiences of nature through books, films and museums ($M = 2.65$, $M_g = 2.83$, $M_b = 2.47$).
Question h2 does not properly fit into any of the parts but is presented here based on factor analysis.

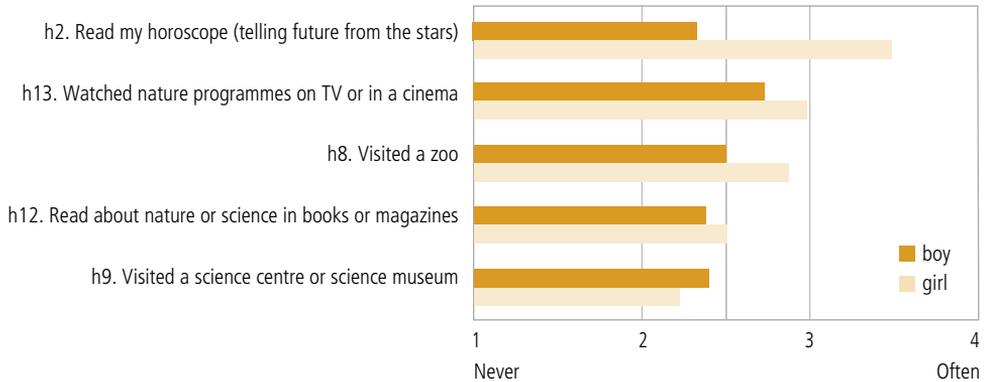


Figure 21. Students' experiences of backpacking, trekking, fishing and hunting ($M = 2.49$, $M_g = 2.43$, $M_b = 2.55$).

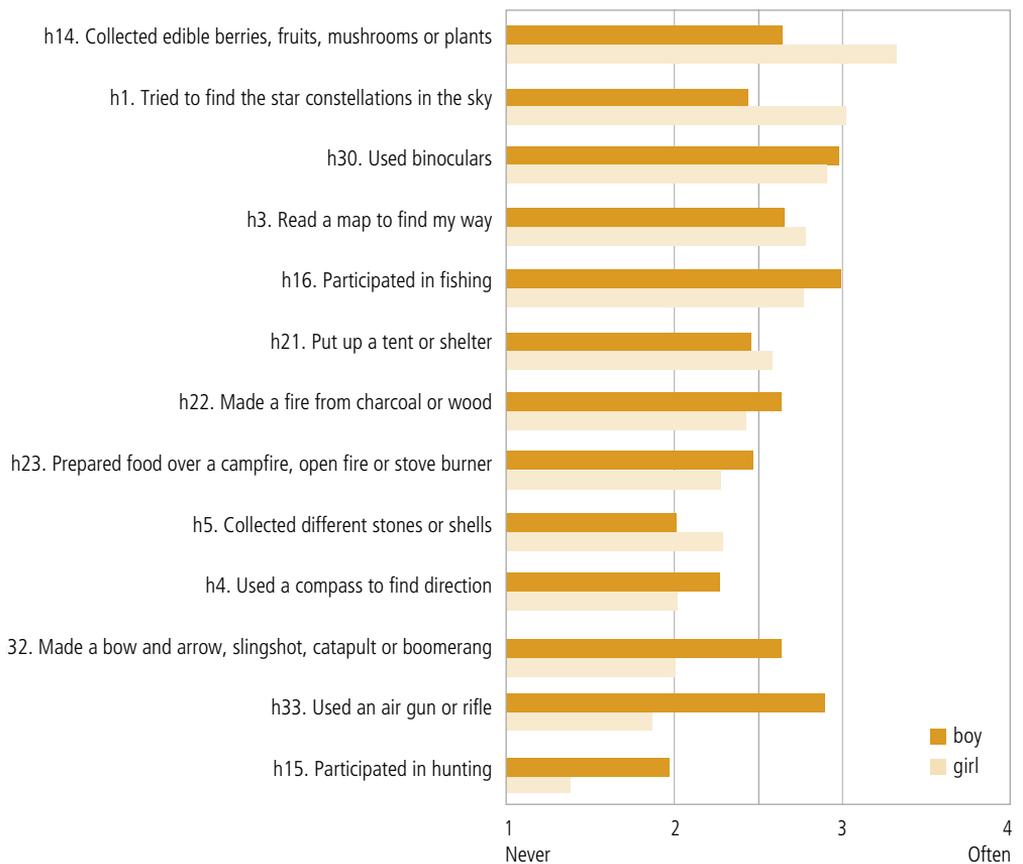


Figure 22. Students' experiences of being ill and being nursed ($M = 2.46$, $M_g = 2.52$, $M_b = 2.41$).

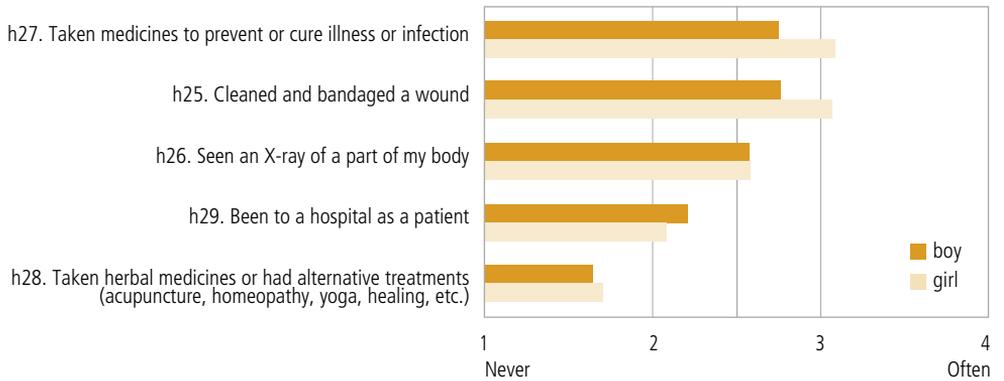


Figure 23. Students' experiences of using "heavy" tools ($M = 2.44$, $M_g = 2.17$, $M_b = 2.72$).

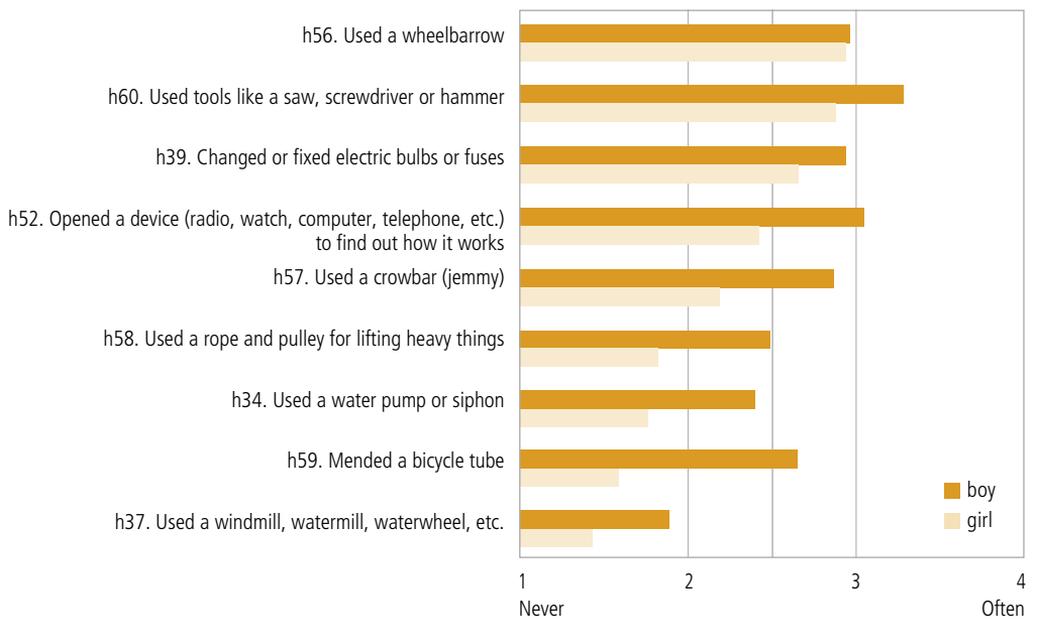


Figure 24. Students' experiences of agriculture and gardening ($M = 1.86$, $M_g = 1.94$, $M_b = 1.78$).

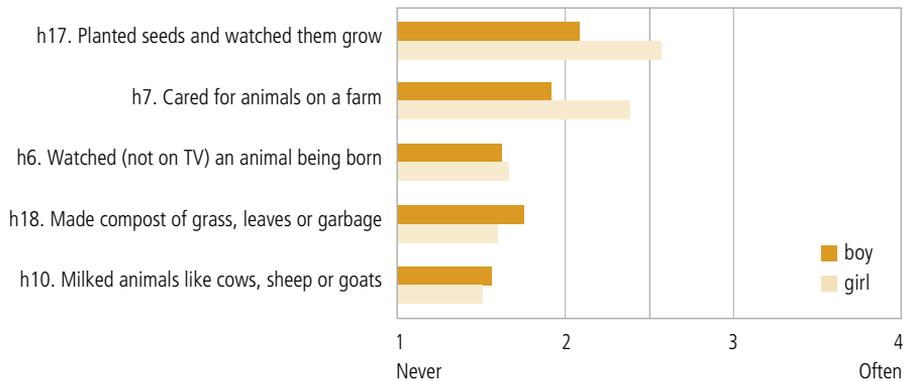
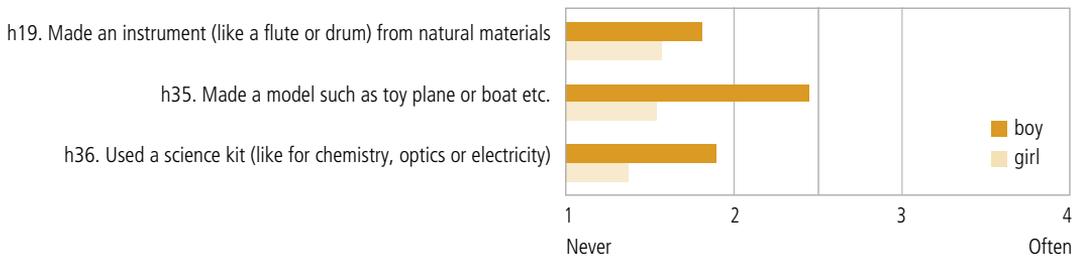


Figure 25. Students' experiences of building and of investigating small objects ($M = 1.77$, $M_g = 1.48$, $M_b = 2.06$).



Among the topics dealt with in Section H, students have had most out-of-school experience in using information and communication technology, such as a mobile phone, the Internet and e-mail, as well as in using various household utensils such as a battery charger and a stove and everyday measuring devices such as a thermometer and a measuring tape. Students have had least experience in building scale models, jobs in agriculture and gardening as well as in using "heavy" tools such as those needed for repairing a bike.

On average, girls have had more experiences than boys in using domestic appliances, for instance for preparing meals and pastries, but also in using a thermometer, a clock and a

measuring tape. However, on average, boys have had more experiences than girls of using "heavy" tools. On average, both genders have had equal experiences in using information and communication technology, although the most frequently used objects are different: on average, girls use the mobile phone, e-mail and the Internet more than boys, who, for their part, on average, play more electronic games than girls. Both genders have had nearly equal experiences of backpacking and other outdoor activities, though the focuses of interest differ: on average, girls pick berries, mushrooms or flowers more than boys, and boys, on average, make bow and arrows and use air guns more often than girls.

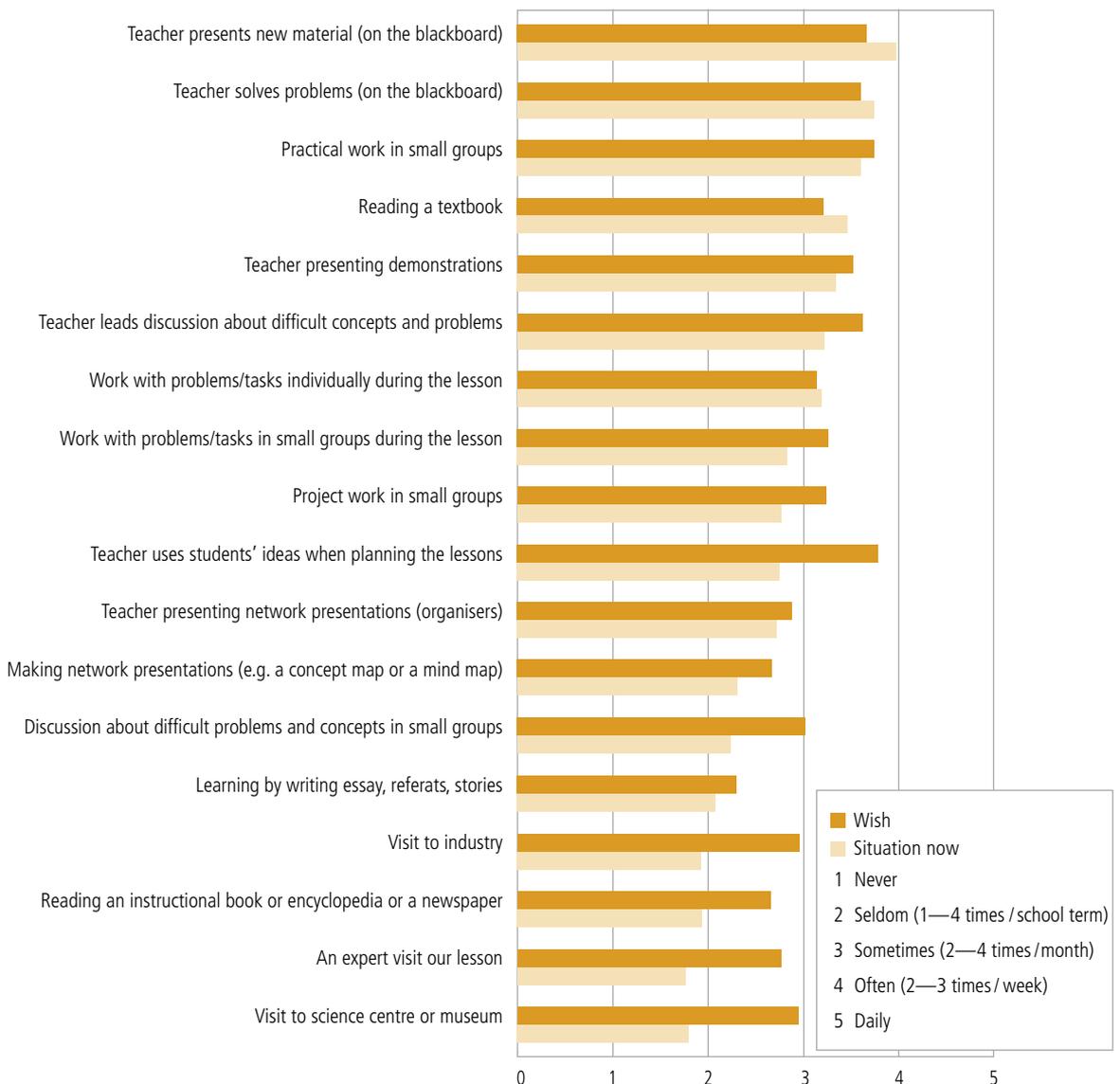
Students' interest in teaching methods used in science

The term “teaching method” is understood here as being synonymous with the concepts of learning method, instructional approach, the form of work or student activity the aim of which is to help the students adopt new concepts, skills, values or thinking patterns. Typical features of the teaching methods are target orientation and social interaction between the teacher and the student or between the students themselves.

Teaching methods used in the comprehensive school science

Figure 26 presents ninth-grade student evaluations of current and desired teaching methods used in the comprehensive school science (in practice physics and chemistry) classroom.

Figure 26. Mean of students' (n = 3626) perception of how often a particular approach is used in teaching science and how often they would like it to be used. The approach perceived by students to be the most frequent is topmost.



The desired degree of application of a teaching method or a wish for increase use of a teaching method also demonstrates how beneficial for learning the students think a particular method is and how interesting and motivating the application of a teaching method is felt to be.

The students feel that the teaching methods most commonly applied to science classes are instructor-centred studying or reading of the textbook and practical assignments. The students feel also that in science classes there are seldom small-group discussions, reading of reference books, essay writing or concept map design, or visits to places of interest.

Even if the students express a desire to follow the teacher's presentation in classes, 30% would like to reduce the amount of teacher-led studying. Nearly 40% of the students would like to have more practical work or small-group projects. About 30% of the students would like to have less studying of the textbook, and 47% of them would like to use more reference books or newspapers in classes. The students would like to see a greater variety of graphic presentation methods in teaching. Most of all, the students wish to increase the number of field trips and the use of experts in teaching (over 50%). It is consistent with the experience of many teachers that girls chose teacher-led approaches more often than boys.

The choice of teaching method has implications for interest

It is useful to know what kind of teaching and homework interests or motivates, or does not motivate, students to study because not all the learning content provided by the curriculum is bound to arouse all students' interest immediately. Learning is not just based on cognitive factors, but also the student's interest has an impact on what is learnt and how it is learnt.

The students do not want to reduce significantly the amount of teacher-centred work even if they would prefer to do more small-group work. The amount of independent work in science classes is considered adequate. In other words, the students perceive it as positive that new concepts are introduced by the teacher, an expert, who first presents new

information and then demonstrates how this information is used for solving problems or performing tasks. In particular, the students express a wish that there should be more teacher-led discussions in science classes. Apparently, they feel it to be appropriate that explanations of the discovered phenomena are presented and that conclusions are formulated, as well as relevance to everyday life is built on the concepts, under the guidance of an expert (Bransford et al. 2000, 31). This finding is well consistent with the findings of Bahar (2003), suggesting that discussion seems to be the main motivator of students to study science.

It appears from the findings presented in Figure 26 that students find the amount of experimental work in classes to be appropriate. However, they would like to see an increase in those teaching methods supporting the development of information processing skills, where the Internet, books and other written documents would serve as a source for information. In class, students would like reduced use of textbooks as information sources and more use of reference books and newspapers. They would also like to see an increase in the use of other teaching methods that support information processing being made available in written form, work methods such as using and writing concept maps and advance organisers. In addition to learning concepts, these teaching methods would develop skills for information acquisition, processing and evaluation. It is essential for understanding concepts that the interrelationships between the concepts are clear. Students would further like to increase the use of teaching methods that develop skills for both critical (e.g. debate) and creative (brainstorming) thinking.

Students wish most of all to increase the number of visits to places of interest and the use of experts in teaching. Guest speakers and educational visits provide a starting point that is more natural than traditional learning materials for becoming acquainted with the applications of scientific information, e.g. in technology and medicine. The visits promote students' interest in science. We can also interpret this desire for more frequent visits as a means for a student to see the application of science beyond school. According to Stokking (2000) this has a direct impact on interest in science.

The present study is concerned with teaching methods and their implications. The findings indicate that there is a need for a larger variety of methods to teach science. Therefore, when planning lessons the teacher should weigh up carefully what kind of teaching methods to use. Only the use of a variety of methods can motivate students to study or arouse their interest to study. Even if students do not want to reduce the amount of teacher-centred studying, it is quite evident that a reduction would occur in order to increase the use of such teaching methods that guide students to work in

small groups and to process information. No single teaching method provides a solution for increasing students' interest. Through employing a large variety of teaching methods, it is also possible to achieve, in a variety of ways, the objectives set for education. All this must be taken into account in formulating both the national core curriculum and individual school-specific curricula. There are also many options in learning material development and especially in teachers' further training for which these findings have implications.

Conclusions

As already stated in the introduction, the student's interest has many implications for studying and learning. When a student is interested she/he develops a close relationship with the subject matter and studying leads to deep learning, which in turn allows application of the achieved skills and knowledge in new situations (transfer). It would be important for the teacher to know what contents and contexts interest young people and to try to stimulate their interest by starting schoolwork from matters that interest them. Also, things in which students have experience are fruitful starting points for studies. Thirdly, we can influence interest by choosing teaching methods skilfully, in a way described in the previous chapter.

Students' focuses of interest inside subjects differ quite largely. For example, in biology and in related sub-disciplines the most interesting things from the student's perspective are connected to man, such as human biology, medicine, health science and personal well-being. Environmental challenges attract less interest and botany and applied biology are the least interesting of all disciplines. These findings are challenging, taking into account the objectives set forth in the criteria document of the national core curriculum, according to which students should be educated to become environmentally aware citizens that are engaged to sustainable way of living. In addition, students should for instance be able to make simple field studies, identify organisms of the surrounding living nature and make a small herbario.

Experience gained by a student outside school and situations in which studying takes place in classes are also

important for learning. Scientific knowledge, concepts and models are built by constructing on the basis of personal experiences, perceptions and their interpretations and deductions. Perception and interpretation of perceptions is adaptable and depends on the environment in which the perceptions are made. That's why perceptions must be made in different environments. Interpretation of perceptions depends also on the earlier experiences of the individual. That's why it is important for the teacher to know what kind of experiences students have outside school.

According to the findings, it is worthwhile being aware of the fact that boys and girls, on average, have different interests and everyday experiences in various school subjects or disciplines. Basing on these findings one can plan teaching in such a way that different interests – also between the genders – can be taken into account better, e.g. in planning teaching for different sub disciplines of physics and chemistry. On the other hand, we must bear in mind that there are always boys and girls whose interests differ from the profile of a 'mean value' student. Even if the findings indicate that there are differences between the genders in objects of interest, perceptions and attitudes and out-of-school experiences relating to various subjects or disciplines, we must beware of making broad generalisations on the basis of the above-mentioned findings. It is also important to understand that the findings are not absolute; on the contrary, they reflect present-day general trends among young people's perceptions and experiences, what the objects of interest are for Finnish boys

and girls and the world they experience in relation to science and science applications in various contexts as measured with the international ROSE Tool.

However, the study provides topical information about the attitudes of the generation on the verge of leaving comprehensive school towards science and science education. A deeper analysis of the material gathered is

ongoing. Furthermore, international cooperation is being carried out on the basis of the information gathered.

More information:

www.helsinki.fi/sokla/malu_gisel.htm

www.helsinki.fi/sokla/malu_julk_esit.htm

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Competition information and rules

The competition ran from 1 September to 6 December 2003. A preliminary information poster was sent to school principals.

There were three categories in the competition: essay (essay on given titles and essay on reference material), poster design and multimedia.

Instructions for techno competition essay



Read the assignments and study the reference material. Pick one of the assignments and write an essay drawing on your own experience and the reference material. The reference materials shall be used only for topics 1 and 2. The text shall form a consistent work so that a reader understands it without requiring knowledge of the reference materials. The title is an important part of the essay. Don't forget to put the number of the assignment before the title. The essays shall be written on large-squared paper with a ballpoint pen or **preferably on a computer** using 1.5 spacing and font size 12. In this way, it will be easier for researchers to study and the panel of adjudicators to analyse the entries. Write your name, the name of your school and of your teacher on the top right corner of the sheet.

1. Read the column written by Satu Hassi. Write an essay expressing your opinions on Hassi's views and on those of Heli Laaksonen quoted in the column. Discuss also the needs that have led to the emergence of information technology. How does it, in your opinion, serve these needs today? Opinions on the usefulness and usability of information technology can differ. What kind of information technology would you like to use? Would you like to be involved in designing new technology? What issues would you like to have an input in? Choose a title yourself.
2. Attached is a column by Jyrki Lehtola called **War Technology**. Read the column and comment on Lehtola's views. Discuss also how technology could improve the quality of life. How could it be used to better promote people's health and well-being? Write an essay expressing your views, choose our own title.
3. Information processing science students take courses in digital media, programming as well as in information system design. In addition some of them orientate themselves towards software business, others towards developing future mobile services. Those social skills that are important also in the workplace receive a special emphasis in the studies. Both team-work and communication skills are stressed in instruction. Only about 25% of the potential students applying for studies in the Department of Information Processing Sciences at the University of Oulu are girls notwithstanding the good employment prospects in the industry. Discuss possible reasons for girls' lack of interest. What changes need to be made to attract girls? What kind of images do you have about occupations in the industry? How should the image change to be interesting to more people? Choose your own title or use the given title **Girls, why don't you join us**.
4. What is your perception of persons working in the IT sector? Discuss what the stereotyped image of the sector and its occupations and people is like. How can these stereotypes be abolished? Why do stereotypes emerge? You can find job profiles at www.career-space.com and www.tol oulu.fi/abi/tyollistyminen.html. Choose your own title.

Instructions for the poster design category



You can **design your poster** on a computer or draw it by hand. The entries should be submitted as proofs but you can attach a diskette or a CD-ROM with your poster(s). The name of the author/s, the education institution and the teacher should be indicated on the back of the poster. Each member of the team should sign and return an entry confirmation and a consent form, which is also a raffle ticket.

1. Design and make a poster advertising a better and more innovative control device (e.g. a mouse). The poster format should be A3.
2. Design and make a future technology device and a presentation poster for it. Feel free to use your own creativity. The poster should make it clear what the device is to be used for. Therefore take into account people and their environment. The poster should express the lifestyle of the period that you have in mind and the device's usability. What needs does it satisfy? What will the future be like, say in 2020? The poster size should be A3.
3. Design and make a recruitment advertisement for one of the companies participating in the competition. Find the links to the companies on the competition web site (www.tol oulu.fi/kisa). Find out what the main business of the company is. There are no restrictions as to the size of the advertisement.

Instructions for the multimedia category



Entries in the multimedia category should be submitted on a CD-ROM. The name of the author/s, the education institution and the teacher should be indicated on the CD. Each member of the team should sign and return an entry confirmation and a consent form, which is also a raffle ticket.

1. The assignment is to design and make a presentation CD for your school making ample use of its technical facilities. In addition to technical implementation, artistic execution is of equal importance. Be innovative.
2. Design and make a demo incorporating both image and sound. The demo can be a presentation of a product, an event, a game or an issue. Don't restrict yourself, let your imagination fly!

Students were also asked to confirm their participation and to grant permission for using their work for research purposes. The questionnaire also included some background questions.

The competition assignments were sent to the schools' mother tongue, art and computing teachers before 1 September 2003. The teachers delivered them to their students.

In the essay assessment, attention was paid to the language, content, familiarity with the area and innovative-

ness. Poster design assessment stressed visual creativity, inventiveness (innovativeness) and technical skills. In the multimedia category, attention was paid to the merit of the idea and its functional execution. The importance of good documentation and the use of an appropriate manner of execution were stressed. Naturally, technical execution was expected to be functioning but not necessarily a complete product.

Rules

The competition was targeted at all the students in upper secondary education institutions in the provinces of Oulu and Lappi and in the Ylä-Savo region. All persons enrolled in these institutions were eligible for entry in the competition. There was no age limit. Both individuals and groups were eligible in the poster design and multimedia categories. Groups were not eligible in the essay category.

The competition was planned, taking into account that doing the competition assignment could be incorporated into normal instruction. It was, of course, also allowed to do the assignments outside school hours. Teachers could deliver the essays and materials to the students in advance so that they could familiarise themselves with them. Teachers were not expected to discard or comment on the participating works. Teachers collected the works from their students and sent them to the competition organisers. A number of researchers used the competition entries as research material. Permission for this was requested in advance. In the light of earlier experiences there were high hopes for the materials. It was requested that competition entries would be submitted in an electronic form in order to facilitate the pre-selection process and research.

It was possible to submit essays on a diskette or CD-ROM. Essays did not have to be typed. It was required, though, that handwritten essays should be written with a ballpoint pen and with the same page set-up as in the matriculation examination. Full contact information of the author as well as the name of the education institution and that of the teacher were to be indicated in the header of the essay.

An A3 printout was accepted as a poster. In addition a CD-ROM with the poster or posters could also be submitted. The posters had to carry the name of the author or authors, the contact information and the name of the teacher and that of the education institution.

Multimedia works had to be delivered on a CD-ROM. The CD-ROM had to include, in addition to the work, the name of the author or authors, the contact information and the name of the teacher and that of the education institution.

The competition participants had to be aware of and to accept that their work would be used as research material. The competition organisers filed all the entries and removed

the names before showing them to researchers or to anybody else. The competition participants also gave their consent to the awarded works being exposed on the Techno Competition

web site without separate compensation or request. In other respects, the author or the authors retain the copyrights and rights of use.

Submitted entries

The breakdown of the entries was as follows: 84 essays, 22 posters and 12 multimedia works.

Forty-one essays were submitted by girls to the essay competition: 24 essays on topic 1, 7 essays on topic 2, 5

essays on topic 3, and 4 essays on topic 5. They were used as research material for the study. Girls participated actively also in the poster competition and were members of the multimedia groups.

Competition panel of adjudicators

The panel of adjudicators consisted of persons broadly representing various actors of the IT industry, from business and education alike.

The panel of adjudicators met in January 2004 and picked the three best prequalifying entries in each category and also

decided on the honourable mentions. Nuku Literary Art School was consulted for expertise in essay prequalification. In the other categories, prequalification was performed by digital media professionals, who were employees of the Department of Information Processing Sciences.

Prizes

The prizes were made as attractive as possible in order to attract a large number of entries.

Cash prizes were awarded to the three best participants in each category. Additionally a raffle was conducted among the participating students, teachers and education institutions, awarding product prizes donated by companies and book packages for the admission test into the Department of Information Processing Sciences. The total value of the prizes was over 6,000 euro.

The Techno Competition prizes were awarded at the TIENI Seminar organised by the Department of Information Processing Sciences on January 31, 2004. The seminar was targeted at teachers from comprehensive and secondary schools. It discussed information technology and presented examples of integrating computing and information technology education with other teaching activities in school as well as integrating additional university courses with upper secondary school curricula.

Experiences

Why was it important to organise the competition? There are a number of reasons. Secondary school students are future university students and employees of companies. Youngsters currently studying in secondary school have already had experiences of using information technology and they have attitudes and perceptions relating to the subject as well as skills to utilise information technology. The views of these

youngsters are of primary importance when we consider our own activities ranging from student recruitment to teaching. Competitions like this can also be the only comprehensive link with secondary school students.

The competition entries convey a good variety of youngsters' perceptions of information technology and its use.

Stories, perceptions and attitudes from boys and girls

Two Master's theses emerged summarising the competition findings. They deal with young people's attitudes towards information processing and information processing education. The material was provided by essays that were grouped according to the subject area. The subject areas were information technology profession stereotypes, attracting girls' interest in information processing education and professions, and defence vs welfare technology. The total number of the essays was 84, submitted from secondary education institutions in northern Finland. In order to ensure sufficient qualitative material, the material was combined with that of a previous essay competition in 2002.

Perceptions of upper secondary school-girls relating to the field of information processing science

The first Master's thesis, written by Katja Leiviskä, deals with young girls' attitudes towards the information processing sci-

ence sector. It is based on qualitative research principles. The age range of the essay writers is 16–19 years, and, according to literature, this period is prone to ideological and identity crises. Girls are searching for their place in society, forming long-lasting human relationships and actively considering study and career prospects. Various perceptions relating to different fields of industry also take form at this stage. The essay sample for this thesis is 64 pieces. They were analysed using qualitative material-centred content analysis.

Perceptions of the sector

The author has analysed positive and negative perceptions in Table 1. The positive and negative perceptions of information technology found in the material form the main divisions. The subdivisions of the main divisions have been divided to form divisions relating to professions, employees, studies and information technology.

Table 1. Positive and negative perceptions of the information technology sector, occupations, workers and education.

| Positive images | | Negative images | |
|-------------------------------|---------------------------|-----------------------------------|---------------------------|
| Branch | Samples in amount (of 64) | Branch | Samples in amount (of 64) |
| Appreciation | 21 | Competition | 3 |
| Developing and growing | 12 | Urbanization | 2 |
| Future s branch | 9 | | |
| Challenging | 2 | | |
| Profession | | Profession | |
| Profits | 34 | Dullness | 8 |
| Employment | 19 | Monotonousness | 9 |
| | | Professional diseases | 3 |
| | | Un-social | 9 |
| | | Hurry | 13 |
| | | Stress | 3 |
| Employee | | Employee | |
| Men in suits , representative | 7 | Nerds | 22 |
| Capable | 7 | Un-social | 8 |
| Talented | 8 | | |
| High education | 8 | | |
| Education | | Education | |
| Necessary | 2 | Physics and mathematics important | 4 |

Positive perceptions

The benefits of information and communication technology are seen clearly. According to Leiviskä, girls have positive perceptions of information technology even if they are not willing themselves to opt for it as a career. The sector is mainly seen as evolving, growing, respected and as a sector for the future.

“Information technology is an ever-expanding sector. Development is continual; better and better equipment is being invented.”

Good employment prospects and benefits were seen as attractive. In addition, information technology is seen as being useful and acceptable and applicable to everyday life. The common perception of a ‘nerd’ has changed from that of a man in a suit to even that of an ordinary person.

“The employees I know are quite ordinary people who have to wear a suit because they represent a company but who wear a track suit at home like anybody else.”

To quote one author: “...Information technology has always been a male-dominated industry even if some women have explored it in the last few years.” Some girls seem to think that only a genius can cope with it. “Special talents are needed to succeed in this sector, geniuses seem to dominate it”, writes one of the girls.

Negative perceptions

Negative factors emerged, too. The work was seen as being boring, unsocial and stressing.

“My view of the information technology sector is that this work is boring and I wouldn’t like to work in this sector myself.”

“When I think of different jobs, it is hard to think of a more boring job than jobs in information processing.”

Health problems relating to work such as headaches and eye problems are seen as important negative factors.

“Information technology provides well-paid jobs but also an aching back and neck.”

Some of the girls know people working in the sector, and their perceptions were not negatively stereotyped to such a high degree. Girls with negative perceptions have in mind the old stereotype perception of a nerd.

Why look for work in information technology?

Reasons for girls to wish or not to wish to work in information technology have been compiled in Table 2.

Table 2. To work or not to work in information technology?

| ICT as a career | Samples in amount (of 64) | ICT not as a career | Samples in amount (of 64) |
|------------------------------------|---------------------------|------------------------------------|---------------------------|
| Physics and mathematics emphasized | 1 | Not human oriented (social) work | 15 |
| Challenging | 1 | Working with computers | 11 |
| Employment | 6 | Lack of understanding ICT | 9 |
| Interesting | 2 | Physics and mathematics emphasized | 4 |
| | | Nervousness | 1 |
| | | Fashion phenomenon | 1 |
| | | Computer readiness | 8 |

The positive perceptions of tens of girls either wanting to work in the sector or considering it were very evident from the material. The positive perceptions of the sector and jobs in it that were presented earlier are dominant in the girls' thoughts.

"I'd love a job where one can learn something new all the time and where one can enhance and develop one's skills. I think information technology provides great and versatile opportunities for this."

Lack of interest seems to arise from the old familiar reasons: unsocial work that is done only on a computer, physics or mathematics-centredness or lack of skills ("I'm useless with machines!").

Young people's attitudes towards information technology and the information technology sector

The second Master's thesis, written by Sauli Kukkonen, deals with young people's attitudes towards information technology and the information technology sector. The research utilises both qualitative and quantitative research methods. The main focus of the summary is on qualitative material.

Boys find technology important. They think that technology helps people to gain a better standard of living. They regard as negative the accelerating speed of development and the dependence on computers. Girls regard information technology as important, too, but they saw more negative factors than boys. Yet the attitudes of both genders were relatively similar.

Girls put special emphasis on the development of communication technology and the Internet as positive things. Boys emphasised more entertainment services and games. Boys' reaction to using and learning to use computers and software

Girls also reflected on how to attract more girls to study the subject. The following were suggested: 1) female role models, 2) information and advertising, 3) encouragement by parents to use information technology, and 4) positive user experiences in information technology gained at school. These research findings are similar to those found in earlier research, and the comments from girls strengthen views presented earlier.

was more positive, whereas girls thought computers are difficult to use and the manuals are not easily understood.

Boys find the sector's image more positive. Girls' perception of the sector was more negative, more stereotyped. Girls think the sector is male-dominated and that the physical or psychological conditions are unsuitable for girls. Boys' attitude towards military technology was a little more positive than that of girls' who were outright in their condemnation of it. All of the authors' opined that making use of information technology in welfare services is very important. Girls criticised the harmful material distributed over the Internet whereas boys did not even mention it. Girls also paid attention to the fact that there is an inequality between the western and developing countries and an imbalance in technological development and people's opportunities to make use of information technology.

Upper Secondary School Students' Perceptions of Technology, Studies at HUT and Working in the Technology Sector

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Research indicates that gender influences perceptions of different disciplines. The objective of the present study was to explore among boys and girls in upper secondary school their perceptions relating to technology and technical studies. It was noticed that the perceptions had improved after the course "Human Factors in Telecommunication".

Background information

A university course called "Human Factors in Telecommunication" targeted at upper secondary school students was delivered in autumn 2003 and 2004 by the Mirror-ITU Project carried out by the Communications Laboratory of the Department of Electrical and Communications Engineering at Helsinki University of Technology (HUT). The course is one of the basic courses provided by the Department of Electrical and Communications Engineering and it is obligatory for all the undergraduate students in the communication technology study programme. Annually, about 200 students take this course.

Four upper secondary schools participated in the project, two of them are situated in Espoo (Haukilahti and Olari Upper Secondary Schools) and two in Helsinki (Lauttasaari and Herttoniemi Upper Secondary Schools). Students from Espoo took the course on the premises of HUT in Otaniemi, together with university students. In Lauttasaari and Herttoniemi, the course was run separately in each school. The course consisted of lectures and practical assignments. Upper secondary school students' credits were entered both into the register of their own school and in the register of HUT Open University.

The objective was to explore upper secondary school students' attitudes to and perceptions of technology and studies. For this purpose, a preliminary survey was carried out among the upper secondary school students taking the course. The survey took place in autumn 2003 prior to the course and it queried perceptions of technology, studies at HUT and working in the sector. The survey was carried out both quantitatively and qualitatively. The preliminary survey had a cohort of 55 persons

of whom 51% were girls and 49% boys. Most of the students had taken a basic course in mathematics (78%). Nineteen per cent of the students had taken an extended course in physics, 46% a basic course in physics, and 35% had not taken any course in physics. Thirteen per cent had taken an extended course in chemistry, 51% a basic course and 36% had not taken any course in chemistry.

Only 7% of the girls had taken an extended course in mathematics. Forty-eight per cent of the girls had taken a basic course in physics and chemistry, the rest had not taken any course. The number of respondents in the preliminary survey is not very large when considering statistical methods but yet it is able to provide an overview of what kind of choices boys and girls traditionally make in upper secondary school – girls choose a basic course in mathematical subjects more often than boys do. The survey was also carried out at the beginning and at the end of the course delivered in autumn 2004. Because the participating cohort in 2004 had, among other things, a more mathematically oriented background, it requires a deeper analysis to combine and compare the findings. These findings are not included in this report.

Research indicates that gender influences perceptions of different disciplines. For example, it has been found that boys estimate their mathematical abilities higher than girls do at the same level (Niemi 2001). Many stereotyped perceptions also direct young people towards particular careers. The objective of the present study is first to explore among boys and girls in upper secondary school their perceptions of technology and technical studies.

Perceptions of technology before the course

Quantitative findings

Upper secondary school students' perceptions of technology, technical studies and working in the technical sector were mapped with the following pairs of adjectives having opposite meanings:

Table 1.

| I find technology: | | |
|--------------------------------------|-------|--------------------------|
| 1. Interesting | ----- | Boring |
| 2. Reliable | ----- | Unreliable |
| 3. Useful | ----- | Useless |
| 4. Menacing | ----- | Safe |
| 5. Simple | ----- | Complicated |
| 6. Manual | ----- | Computer driven |
| 7. Unimportant | ----- | Important |
| 8. Polluting | ----- | Environmentally friendly |
| 9. Dynamic | ----- | Stagnant |
| 10. Significant | ----- | Insignificant |
| I find studying technology: | | |
| 1. Interesting | ----- | Boring |
| 2. Difficult | ----- | Easy |
| 3. Laborious | ----- | Not laborious |
| 4. Versatile | ----- | Monotonous |
| 5. Creative | ----- | Formulaic |
| 6. Working alone | ----- | Working in teams |
| 7. Theoretical | ----- | Practical |
| 8. Useful | ----- | Useless |
| Working in the technology sector is: | | |
| 1. Interesting | ----- | Boring |
| 2. Versatile | ----- | Monotonous |
| 3. Creative | ----- | Formulaic |
| 4. Social | ----- | Lonely |
| 5. Challenging | ----- | Routine |
| 6. Masculine | ----- | Feminine |
| 7. Controlled | ----- | Independent |
| 8. Varying | ----- | Constant |
| 9. Demanding | ----- | Easy |
| 10. Theoretical | ----- | Practical |

Using these pairs of adjectives, students expressed their opinions on technology, studying technology and working in the technology sector. The findings were encoded from 1 to 6 from left to right. Mean values and deviations of choices for each point are given in Table 2.

Table 2. Upper secondary school students' perceptions of technology, studying technology and working in the technology sector. The ordinal numbers on the left-hand side refers to the pairs of adjectives listed above, (MV) expresses the mean value and (SD) the standard deviation for each choice.

| I find technology: | MV | SD |
|--------------------------------------|------|------|
| 1. Interesting | 2,72 | 1,37 |
| 2. Reliable | 4,33 | 1,03 |
| 3. Useful | 1,76 | 1,10 |
| 4. Safe | 4,00 | 1,13 |
| 5. Simple | 4,64 | 1,35 |
| 6. Manual | 4,35 | 1,23 |
| 7. Important | 5,00 | 0,85 |
| 8. Environmental | 3,46 | 1,13 |
| 9. Dynamic | 1,74 | 0,99 |
| 10. Significant | 1,76 | 0,78 |
| Studying technology is: | | |
| 1. Interesting | 3,32 | 1,49 |
| 2. Difficult | 2,60 | 1,26 |
| 3. Laborious | 2,24 | 0,92 |
| 4. Versatile | 2,60 | 1,17 |
| 5. Creative | 3,29 | 1,33 |
| 6. Lonely | 3,37 | 1,14 |
| 7. Theoretical | 2,85 | 1,12 |
| 8. Useful | 4,87 | 0,91 |
| Working in the technology sector is: | | |
| 1. Interesting | 3,26 | 1,44 |
| 2. Versatile | 2,71 | 1,15 |
| 3. Creative | 3,38 | 1,47 |
| 4. Sociable | 3,56 | 1,28 |
| 5. Challenging | 2,22 | 1,19 |
| 6. Masculine | 2,48 | 0,90 |
| 7. Independent | 3,20 | 1,12 |
| 8. Varied | 3,26 | 1,23 |
| 9. Demanding | 2,22 | 0,95 |
| 10. Theoretical | 3,02 | 1,17 |

Table 3 includes those adjective pairs for which at least half of the students chose one of the extremes or the point next to it when considering their perceptions of technology, studying technology and working in the technology sector.

Upper secondary school students find technology useful (81%), complicated (62%), important (72%), innovative

(83%) and significant (83%). Students find studying technology laborious (58%), versatile (54%) and useful (74%). Working in the technology sector could, in students' opinion, be challenging (65%) but demanding (65%).

Table 3. Frequency distributions expressed in percentages for those adjective pairs which students use to describe best their perceptions of technology, studying technology and working in the technology sector. The ordinal numbers denote the order of the questions in the questionnaire.

| I find technology: | | | | | | | |
|--------------------------------------|----|----|----|----|----|----|---------------|
| 3. Useful | 54 | 27 | 11 | 4 | 2 | 2 | Useless |
| 5. Simple | 0 | 11 | 11 | 16 | 27 | 35 | Complicated |
| 7. Unimportant | 0 | 0 | 4 | 24 | 41 | 31 | Important |
| 9. Innovative | 52 | 31 | 11 | 2 | 4 | 0 | Stagnant |
| 10. Significant | 42 | 41 | 15 | 2 | 0 | 0 | Insignificant |
| Studying technology is: | | | | | | | |
| 3. Laborious | 25 | 33 | 35 | 7 | 0 | 0 | Not laborious |
| 4. Versatile | 11 | 43 | 32 | 4 | 6 | 4 | Monotonous |
| 8. Useless | 0 | 4 | 2 | 20 | 52 | 22 | Useful |
| Working in the technology sector is: | | | | | | | |
| 5. Challenging | 33 | 32 | 20 | 11 | 2 | 2 | Routine |
| 9. Demanding | 24 | 41 | 24 | 11 | 0 | 0 | Easy |

The profile of perceptions of technology based on mean values and deviations for all adjective pairs is presented in Table 2. The largest dispersion of the students' opinions relate to adjective pairs 1 and 5; in other words, it was most difficult to decide whether technology is interesting or boring, simple or complicated. As for studying technology, the opinions differed most on whether studying is interesting or boring, creative or formulaic. Concerning work in the technology sector, the most difficult thing to decide for the students was whether it is interesting and creative.

The smallest dispersion related to the dimensions 'technology is unimportant–important', 'studying technology is useful–useless' and 'work in the technology sector is masculine–feminine'. Therefore, there was a strong agreement among the students that technology is important and studying it is useful. They also agreed unanimously that work

in the technology sector is relatively gender-neutral, that is neither very feminine nor masculine. From the survey's point of view this kind of an initial perception already gives a positive finding because at least this cohort does not seem to have traditional perceptions of either men's or women's suitability for the technology sector.

Findings from the qualitative survey

In the preliminary survey, students were asked using open-ended, qualitative questions to express what 'technology' brings to their minds, what do they think studying technology is like and, the third open-ended question, whether they could be engineers.

The first question brought to most students' minds various machines and equipment, especially mobile phones

and computers. Many respondents associated the concept of technology with larger wholes such as industry, its products and, generally, with everyday living and the world relating to it:

“Opportunities, without technology life would be more difficult”

“Work, life, leisure”

Most of the respondents associated technology with positive images; things and concepts that make life easier. Only a few respondents related the concepts to their own skills and knowledge (“Mobiles, computers and things like that.... things I can’t figure out much”).

The second question, “What is it like to study technology?” inspired rather varying answers from interesting to boring. Most students had an image that it is difficult or laborious but at the same time challenging to study technology. Studying was associated with images of working with machines, reading formulae, mathematics and physics.

Most of the answers to the third open-format question “Could I be an engineer?” were negative. Most of the students argued that their competence in mathematical subjects was not sufficient to aim at a career in technology. Additionally, many students stated that they were not interested in technology. There were very few gender-related images; only one of the respondents said that she could not be an engineer because “an engineer brings to my mind only men and men only”. Some respondents evidently had no clear idea of what an engineer’s work is about. One student said that he “can’t really piece together an engineer’s job description”. Many respondents thought that an engineer’s job is very theoretical and that they do not work much with people. The following samples illustrate these images:

“There are more interesting occupations and things if you want to work with people.”

“Of course I could but at the moment I don’t believe or can’t imagine it”. “More interested in practical things.”

“I prefer something more practical.”

Change of image after the course

Quantitative findings

The objective of the survey was to explore the possible change of the perceptions relating to technology and studying technology after the students had taken the course “Human Factors in Telecommunication”. Therefore, the upper secondary school students answered the same questionnaire once again after completing the course. Thirty students participated in the final survey, 14 (47%) were girls, 16 (53%) were boys.

The changes in perception have been explored through the changes in the frequency distributions (Table 4). A slight increase in interest in technology had taken place during the course. Before the course 48% of the students stated that technology is interesting, and after the course 52% of the students held this opinion. After the course, the usefulness of technology was understood by 82% of the students. This assessment had gone up one percentage unit. After the course only 53% of the students perceived technology as

being complicated, whereas earlier 62% of them thought so. Seventy-five per cent of the students considered technology important. Before the course 72% held this opinion. The percentage of those perceiving technology as being significant had gone up from 83% to 85%.

After the course, 57% of the students considered studying technology difficult, whereas before the course less than half (47%) of the students thought so. The number of the students regarding studying technology as laborious had also increased a little during the course. Before the course 58% of the students considered studying technology to be laborious, whereas after the course 61% of the students thought so. The number of students that considered studying technology to be useful decreased slightly during the course, from 74% to 71%.

By analysing with cross-tabulation the impact of gender on the perception of technology as masculine it was found that after the course technology was perceived even more as gender-neutral than in the preliminary survey.

Before the course, 65% of the students found work in the technology sector challenging, after the course only 43% shared this opinion. The percentage of those finding work in the technology sector demanding rose from 65% to 72%.

Table 4. Frequency distributions in percentages for those adjective pairs which students use to describe best their perceptions of technology, studying technology and working in the technology sector. The ordinal numbers denote the order of the questions in the questionnaire.

| I find technology: | | | | | | | |
|--------------------------------------|----|----|----|----|----|----|---------------|
| 1. Interesting | 21 | 31 | 17 | 21 | 3 | 7 | Boring |
| 3. Useful | 46 | 36 | 4 | 7 | 3 | 4 | Useless |
| 5. Simple | 0 | 11 | 11 | 25 | 21 | 32 | Complicated |
| 7. Unimportant | 0 | 0 | 7 | 18 | 46 | 29 | Important |
| 10. Significant | 39 | 46 | 11 | 4 | 0 | 0 | Insignificant |
| Studying technology is: | | | | | | | |
| 2. Difficult | 25 | 32 | 25 | 7 | 7 | 4 | Easy |
| 3. Laborious | 29 | 32 | 18 | 14 | 4 | 3 | Not laborious |
| 8. Useless | 4 | 4 | 7 | 14 | 46 | 25 | Useful |
| Working in the technology sector is: | | | | | | | |
| 5. Challenging | 18 | 25 | 39 | 7 | 4 | 7 | Routine |
| 9. Demanding | 36 | 36 | 18 | 10 | 0 | 0 | Easy |

Qualitative findings

The students' perceptions of what technology is have broadened slightly. The course changed students', especially girls', perceptions of what comprises technology. Even if most of them already had some thoughts about what they would like to study in the future their perceptions of technology and studying it became slightly more positive.

On the course, the students did written lecture assignments based on newspaper articles about communication services or communication technology. In these assignments, the upper secondary school students (together with university students) were asked to think of ideas about new services or products relating to each topic. In the articles, they explored new perspectives such as: the use of communication services on farms or new ways of using camera phones. Samples of students' new ideas:

"If a cow had just calved, a camera could be installed in the stall taking pictures at regular intervals and sending them to the farmer's mobile phone so that he could see if everything was all right. This service could be developed further by installing a video camera in the stall sending video pictures to the farmer's mobile phone. Another service could be monitoring a sick animal with some sort of a sensor sending data to a mobile phone."

– a female student from upper secondary school

"The widespread use of camera phones can bring its own problems, too. Anybody can snap other people. There have already been incidents with men taking sneaky pictures of women in different situations. As with all new technologies it is important that society sets rules for their use."

– a male student from upper secondary school

In this way, the students could approach each assignment from another perspective and, at the same time, broaden their view on technology.

Conclusions

In conclusion, we can state that, having completed the course, the upper secondary school students considered technology even more important, significant and interesting than before the course. Also, technology was not seen as complicated as perceived earlier. Attitudes towards studying technology also changed slightly. The image of the studies being demanding strengthened, but at the same time perception of the studies as being difficult decreased. After the course, working in the technology sector was more often perceived as being more demanding than before but not seen so often as being as challenging as it was earlier. We can also state based on our findings and measurements that it is possible that a change

of image towards a more technology-favouring direction can take place at a later stage – for instance when the students have proceeded from upper secondary school to the next education institution.

The course “Human Factors in Telecommunication” dealt with issues related to communication technology and services, providing the upper secondary school students with an opportunity to broaden their view of technology to one that sees it as being not just restricted to traditional machines and equipment. Yet we must take into account that attitudes and perceptions change slowly and in a complicated way. Our target group consisted of upper secondary school students who had already made their choices concerning mathematical subjects, too. A stronger impact, especially among girls, can be achieved at the upper level of comprehensive school. Furthermore, perceptions are influenced by a combination of many factors – teachers, parents, learning materials, etc. – and not least of all, friends.

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Research Findings on Young People's Perceptions of Technology and Science Education



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