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STUDENTS' MOTIVATIONAL ORIENTATIONS AND CAREER CHOICE IN SCIENCE AND TECHNOLOGY: A COMPARATIVE INVESTIGATION IN FINLAND AND LATVIA

Abstract. *This paper examines lower secondary school students' motivational orientations on the characteristics of science and technology occupations. The survey data of 9th grade students were collected in spring 2003, in Finland from 75 schools (3626 students) and in Latvia from 39 schools (1065 students). An exploratory factor analysis was used to describe the students' orientations towards the characteristics of or activities typical to occupations. The multi-group confirmatory factor analysis was used for the simultaneous analysis of Finnish and Latvian data and the factorial invariance across the two separate data was confirmed. The factors were named: Personally meaningful, Leadership, Craft, Nature, Innovation, and Social orientation. Characteristics related especially to Personally meaningful orientation, and also to Innovation and Social orientations appeared most important for choice of future occupations. Boys, on the average, were much more oriented towards conventional technology than girls, whereas girls had much stronger Personally meaningful, Nature, and Social orientations than boys reflecting traditional role models.*

Key words: *career choice, motivation, science and technology education, comparative study.*

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Introduction

Students' interest towards science and technology and interest in careers in those fields have been intensively researched since the 1960s. It is known that science in general is quite interesting for students, but most students, especially girls, do not find school science and technology or careers and occupations in those fields interesting (Woolnough, 1996; Boser, Palmer & Daugherty, 1998; Jones, Howe & Rua, 2000; Osborne, Simon & Collins, 2003; EU, 2004; EU, 2005).

According to international ROSE (Schreiner & Sjøberg, 2005) and SAS surveys (Sjøberg, 2000) the social position of scientists and engineers has weakened in developed countries and their lifestyle appears unattractive to students: working hard and alone in a laboratory. Science and technology occupations are perceived as being of too low in status in relation to the workload. Consequently, lack of interest in science and technology occupations has more to do with the perceived values and images of science and technology and careers in those fields than with lack of interest in general to science and technology. Scientists and engineers are no longer such strong symbols of social and economical progress in developed countries as they were before or as they are in undeveloped countries nowadays. Furthermore, several students had stereotypical views of science and technology occupations, like 'I want to work with people and scientists don't do that', 'I think engineering is a man's job', 'I want to be a nurse and so don't need science'. However, discovering new things and an ability to do something useful were recognised as being important reasons for studying science and choosing an occupation in science. Consequently, it seems that students are unaware of the range of career opportunities opened up by studying science and technology, neither are they familiar with the characteristics of science and technology careers (OECD Global Science Forum, 2005).

However, images of science and technology and careers in those fields do not completely explain all the reasons for not choosing science studies or science related careers. The required school studies, especially those in mathematics and physics which are typically preconditions for further studies in science and technology are perceived as being difficult. This lack or perceived lack of competence has an effect on interest as is described later in this paper.

Woolnough (1994) researched in the UK, via a questionnaire, 1180 18-year old students' opinions regarding factors affecting their choice of studies or occupations in science and engineering. The factors that were most influential on the future scientists were the quality of science teaching and the personal encouragement given to them by science teachers, the practical nature of science lessons and the intellectual satisfaction of performing science, the likely job satisfaction in science and engineering and scientific hobbies and extracurricular activities. Therefore, the role of science and technology education has an impact on young people's choices and teachers have to take this into account when they are planning science classes. Woolnough (1996) investigated also students' opinions as to why some of them choose a science and technology related occupation and others not. He used open questions and received the responses of 654 students in six UK comprehensive schools (11-16 year old students). According to the survey, a decision not to choose a science and technology related occupation was not a decision against them but due to the pursuit of an occupation in another field. A number of countries have replicated these studies and made similar conclusions (Young, Fraser, & Woolnough, 1997).

Research in science and technology career or occupation choice has focused on the relationships between career aspirations and the contextual factors, like student aptitude, quality of science teaching and learning, and socio-cultural environment (OIA, 1995; Koszalka, Grabowski, & Darling, 2005). This kind of research has provided insights into the development of career interests.

However, there is little research on students' interest in or motivational orientation on the characteristics of occupations or activities typical to science and technology related careers. In this paper we are especially interested in Finnish and Latvian boys' and girls' interests in or motivational orientation on the characteristics of future occupations or activities typical to them when finishing their comprehensive school education when they are 15 year old. The first research question is:

1. *What characteristics of and or activities typical to science and technology occupations do lower secondary school students see as being interesting in their future occupation in Finland and in Latvia?*

Secondly, we are interested in the correlations between previously mentioned characteristics and gender, nationality, interestingness of school science and interestingness of career in science and technology. These correlations are needed in any discussion regarding the characteristics of occupations or activities typical to them from the point of view of science and technology education. The second research question is:

2. *What correlations are there between interest in the characteristics and activities typical to occupations, and gender, nationality, interestingness of school science and interestingness of career in science and technology?*

Student interest in and motivational orientation on occupations

According to Krapp (2003) there have been two major points of view from which interest has been approached. One is interest as a characteristic of a person and the other is interest as a psychological state aroused by specific characteristics of the (learning) environment. The former approach has been termed *topic interest, individual interest* or *personal interest* and the latter has been called *situational interest*. Unlike personal interests, that are always specific to individuals, situational interest is assumed

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to be spontaneous, fleeting, and shared among individuals. At school it is aroused as a function of the *interestingness* of an object, like content, context or an activity or a career and is also changeable and partially under the control of teachers (Schraw, Flowerday, & Lehman, 2001). Thus, situational interest may vary depending on the pedagogical solutions a teacher has chosen. Personal interest is topic specific, persists over time and can be subdivided into *latent* and *actualized* interest (Schiefele, 1991; 1999). Latent personal interest guides student's cognitive engagement. Thus, a student who has personal interest in science enjoys learning about natural phenomena, experimenting and especially solving problems. These students also spontaneously continue their science and technology studies in universities or in engineering schools. Latent personal interest guides student's cognitive engagement because it is "a relatively stable positive evaluative orientation toward certain domains" (Naceur & Schiefele, 2005, p. 156). The *interest based motivation* refers to a motivational state that results either from situational interest or an individual interest (Hidi, Renninger, & Krapp, 2004).

Schiefele (1991; 1999) suggested that interest consists of two kinds of valences: *feeling-related* and *value-related* valences. Value-related valences refer to the attribution of personal significance or importance to an object or activity, like interest in a certain characteristic of a career, e.g., possibility to help other people. Feeling-related valences are feelings that are associated with a topic, for instance, feelings of enjoyment and involvement. Especially, comprehensive school students could have these kinds of feeling-related valences to the characteristics of or activities typical to occupations, like the possibility to work as the boss or to earn a lot of money and use this money for leisure activities. Students can associate science and technology with high personal significance, for example, because success in related studies can help them in getting a prestigious career. Although feeling-related and value-related valences are highly correlated (Schiefele, 1999), it is useful to differentiate between them because likely some individual interests are based primarily on feelings, whereas other interests are probably based on personal significance. According to Krapp (2002), it is possible that situational interest develops into personal interest only if both feeling-related and value-related factors are experienced together in a positive way. Later, some characteristics of occupations are discussed from the point of view of feeling or value related point of views.

Lewalter and Krapp (2004) introduce a concept, *vocation-related interest*, which refers to a specific topic or area, a certain kind of activity or characteristic of an occupation. Furthermore, they equate individual's vocation-related interest with the *motivational orientation* and interpret it as a component of the (cognitive) motivational belief system in the framework of educational-psychological theories on goal orientation (e.g., Hidi & Harackiewicz, 2001; Pintrich, 2000). Consequently, motivational orientation in the framework of this research tells why a person is interested in certain characteristics of an occupation or a certain activity of that occupation. Finally, Lewalter, and Krapp (2004) differentiate extrinsic and intrinsic motivational orientation and call intrinsic motivational orientation *interest orientation*. This orientation is based on the joyfulness of the activity met in an occupation or on the subjective appreciation of the content of the activity.

We use here the term *motivational orientation* to refer to an importance or dispositional personal interest, including feeling-related and value-related valences and in addition a strong future emphasis towards a certain characteristic of an occupation or an activity typical to an occupation. A certain characteristic of an occupation or an activity typical to an occupation is later named a characteristic of an occupation. An orientation towards a certain action or field means also that personal importance is involved. This interpretation is related to the models of motivational orientations, but it also shows the need to widen these models. In accordance with Lewalter and Krapp (2004) we assume that it is possible for a young person to pursue both intrinsic and extrinsic goals simultaneously when weighing up occupational choices.

Science and technology related careers and occupations and their choice

To describe general characteristics of occupations in science and technology is difficult because the occupations are different in nature. For example, design engineering and engineering manager careers are different in nature. Moreover, in design engineering, depending on the design task, designing of a 'user friendly' system may need more collaboration, creativity, psychological knowledge and logical thinking instead of general science knowledge and skills. Therefore, an engineer needs in addition to mathematical, science and technical skills, for example, team working and creative skills (Cedefop, 2001). Scarpello and Whitten (1991) studied the personalities of research scientists, inventors and technical entrepreneurs and identified four personality types: creativity, entrepreneuriality, analytic mind and orientation to development. They conclude that most engineers have a high need for autonomy and technical challenge but tend to be only moderate risk takers. According to Hoyt and Gerloff (1999) a similar nature and personality are needed in science and technology careers. For example high-energy physics, astrophysics and cosmology are increasingly competitive environments where all areas of science, industry and commerce are seeking to capture the imagination of the most creative minds.

According to the literature review of Unwin, Fuller, Turbin, and Young (2004), young people's occupational choices, in general, reflect the nature of the education and training system and the youth labour market. They argue based on relevant research that school science and science teachers have an effect on students' occupational choice even if they do not always strive for it on purpose. However, the connection between science education and occupational choice is not simple and there are several other reasons, such as students' learner identity, which have an effect on occupational choice (Hodkinson, Sparkes, & Hodkinson, 1996, pp.7-8; Biggart, 2002).

The Office of International Affairs (OIA) (1995) has published a book *Careers in Science and Technology: An International Perspective* where there is a summary of factors contributing to students' decisions to pursue a career in science and technology (see also similar classifications by Furlong & Biggert, 1999; Sjøberg 2000; Koszalka, Grabowski, & Darling, 2005; Gedrovics, Lace, & Zemesarajs, 2006). The following factors contributing to the students' science and technology related career and occupation choice can be presented based on our literature review:

1. Sociocultural environment or students' own environment including the role models found among family, friends, the community, and media, like television, newspapers, movies and computer games and, moreover, value system of the whole society can have an influence on students' occupational choice. Especially, the role models in media and models met in environment or during visits can have an effect to career choice.
2. The quality of science teaching and learning in schools including students' achievements, the teachers as role models, the student-teacher relationship and the workload of science and technology programs. From the point of view of quality of teaching, for example visits to research institution, companies, science museums and centres, can have an influence to students interest and also on occupational choice. To this factor also the influence of career counsellors and activities organised by them can be included.
3. The gender gap of students created by different life experiences according to their gender and gender stereotypes. For example, role models easily provide support for traditional role models: men work in engineering and women in education or nursing. In many societies there is a social pressure according to which students coming from the labour class are supposed to go directly into labour-class occupations. Outside North European countries it is typical that career aspirations are strongly constrained by girls' expectations of becoming mothers and the subsequent social pressures, which would lead them to give up work.
4. The image of science created through the beneficial and harmful nature of its applications and its contribution to society and the conceived elitist discipline nature.
5. Science and technology curricula, including science textbooks and role models in textbooks (texts and pictures), are perceived as narrow, giving little information about science and technology related careers and thereby limiting career flexibility.

According to the literature review of VanLeuvan (2004) career counsellors may not encourage students, especially girls, to enrol in advanced mathematics and science courses because they view these courses as being difficult or unnecessary. She gave also evidence in her paper about mathematics and science teachers' operations, like emphasising competition, which drive students away from these fields.

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Finland and Latvia as nations

One possibility for comparing nations, in general, is to use the Human Development Index (HDR, 2006) which is a comparative measure of life expectancy, literacy, education, and standard of living for countries worldwide. Finland was number 11 in the world or number 7 in Europe (HDI = 0.947) and Latvia number 45 in the world or number 26 in Europe (HDI = 0.845) on the UN Development Programme's list of 177 ranked nations. It can be seen that Latvia has one of the lowest HDI in Europe and Finland one of the highest.

Finland has a rather homogeneous and distinctive culture of its own. Latvia has more marked differences in culture, which have their roots in Latvia's modern history. On the one hand, there are only about 59% Latvians (Basic indicators, 2006) with more or less Latvian culture as an identity for the Latvian nation. Although Latvia is officially known as a one-community state and all domestic policy is oriented to promote such a society, it can not be negated that such cultural differences influence education, too. It is likely that it has an influence on youngster's occupation choice as well as other expressions. For wider interpretation we refer to the international ROSE study (Schreiner & Sjøberg, 2004).

Methodology of Research

In order to answer the research questions, we use the Finnish and Latvian data which have been collected during the international comparative research project ROSE (The Relevance of Science Education, Schreiner & Sjøberg, 2004). The interest items in the ROSE questionnaire, measuring students' interest or motivational orientation towards characteristics of occupations or an activity typical to the occupation were similar to items used in the SAS research (Sjøberg, 2000) and in Jones, Howe and Rua (2000). In the questionnaire there were also questions evaluating the students' general interest in school science and its difficulty, interest in science and technological careers and, moreover, how school science has helped students to perceive career possibilities and increase career chances. Authors of the present paper translated the original English language items into Finnish and into Latvian in a process including several iteration cycles. The purpose was to maintain the meanings of the items as close to the original as possible.

In the questionnaire, students were asked to state *"How important are the following issues for your potential future occupation or job?"* Altogether there were 26 "issues" such as "*Making, designing or inventing something*" or "*Working with people rather than things*". In the same section the students were also asked about free-time type questions, like "*Having lots of time for my family*" and "*Having lots of time for my interests, hobbies and activities*". These questions were not taken to analysis. Moreover, the students were asked questions about their science classes and their motivational orientation to science and technology occupations. They were asked to what extent they agree with statements like: "*School science is interesting*"; "*I would like to become a scientist*" and "*School science has opened my eyes to new and exciting jobs*". Students answered by ticking the appropriate box on a four-point Likert type scale, the extreme categories being "*Not important*" and "*Very important*" or "*Disagree*" and "*Agree*". The responses were scored 1, 2, 3, or 4. The scale is interpreted as interval and, therefore, the findings can be presented as means (*M*) and standard deviations (S.D.) for each item.

In Finland, 75 lower-secondary schools were randomly selected from the list of comprehensive schools. In each of these schools, about 65 students were asked to answer the survey. Altogether, 4954 students were chosen to participate in the survey. The questionnaire was sent to the schools in spring 2003, and the school principals were asked to organise the survey. The survey was answered by 3626 students (1772 girls) in 61 schools. Because in Latvia there are two types of schools with different language of instruction, the questionnaire was translated into Latvian, but for respondents in schools with Russian as the language of instruction the Russian translation was done by a research group in Petrozavodsk (Russia, Karelia). In total 950 questionnaires in Latvian and 450 in Russian were sent to 40 schools. After receiving 1216 questionnaires, technical audit limited the number to 1061 (624 girls) and thereafter questionnaires from 39 schools, located in five regions, were used for analysis.

The teachers or headmasters in both countries reported no problems in organising the survey. It can be interpreted that the sample represents the population quite well and the internal and external validity of the present research could be evaluated to be quite high. The students' answers were read by optic scanners in Finland and data were subsequently saved to SPSS. In Latvia the data were written directly to SPSS. The data were cleaned in SPSS by looking carefully through all lines and for example frequency running tables for all variables to search for values outside the 'legal' range. SPSS was also used for factor analysis and for correlation analysis. In the Finnish data the skewness varies between -0.98 … 0.43 and kurtosis between -1.08 … 0.37 and in the Latvian data the skewness varies between -1.40 … 0.46 and kurtosis between -1.23 … 1.40. Therefore, skewness and kurtosis values were in a reasonable range and, thus, acceptable for the use of multivariate methods.

To compare Finnish and Latvian girls' and boys' opinions, the Independent-Samples *t*-tests (two-tailed) are used. The Independent-Samples *t*-test procedure compares means for two groups of cases. As an additional check the power of the difference using Cohen's *d* ($d = M_g - M_b / S.D._{pooled}$, where $S.D._{pooled} = \sqrt{[(S.D_g^2 + S.D_b^2) / 2]}$ (Cohen, 1988) is also tested. Cohen's *d* measures the effect size for the difference between boys and girls: no effect at $d < 0.2$, small effect at $0.2 \le d < 0.5$, moderate effect at $0.5 \le d < 0.8$, and large effect at $d \ge 0.8$.

Results of Research

In Tables 1 and 2 comparisons of Finnish and Latvian boys' and girls' opinions about interestingness and difficulty of school science and their interest in science and technological careers are presented. These variables are used in the correlation Table 5 (Research question no. 2). In the Tables 1 and 2 also comparisons of how school science has helped Finnish and Latvian boys and girls to perceive career possibilities and increase career chances are presented (Research question no. 1).

Table 1. Comparisons of boys and girls opinions about interestingness and difficulty of school science and their interest in science and technological careers and, moreover, comparisons of how school science has helped students to perceive career possibilities and improve career chances.

	Girls		Boys		t	d
	Mg	S.Dg.	Mb	S.Db.	1)	2)
X1. School science is a difficult subject	2.42	.91	2.24	.95	39.7***	0.16A
X2. School science is interesting	2.76	.90	2.60	.95	33.2***	0.14A
X14. I would like to become a scientist	1.66	.86	1.91	.95	89.5**	-0.23B
X16. I would like to get a job in technology	1.60	.81	2.52	1.02	1146.4**	-0.85D
X4. School science has opened my eyes to new and exciting jobs	2.40	.93	2.36	.92	1.6ns	0.04A
X8. I think that the science I learn at school will improve my career chances	2.58	.95	2.51	.95	5.2*	0.06A

1) ns $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) A no effect ($d < 0.2$), B small effect ($0.2 \le d < 0.5$), C moderate effect ($0.5 \le d < 0.8$), D large effect ($d \ge 0.8$).

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Table 2. Comparisons of Finnish and Latvian students' opinions about interestingness and difficulty of school science and their interest in science and technological careers and, moreover, comparisons of how school science has helped students to perceive career possibilities and improve career chances.

	Finnish		Latvian		t	d
	MF	S.DF.	ML	S.DL.	1)	2)
X1. School science is a difficult subject	2.33	.91	2.33	1.02	.002ns	0.00A
X2. School science is interesting	2.65	.92	2.80	.96	22.0***	-0.13A
X14. I would like to become a scientist	1.76	.89	1.86	1.01	8.5**	-0.09A
X16. I would like to get a job in technology	2.04	1.01	2.07	1.10	.9ns	-0.02A
X4. School science has opened my eyes to new and exciting jobs	2.33	.91	2.55	.97	45.8***	-0.19A
X8. I think that the science I learn at school will improve my career chances	2.53	.94	2.58	1.00	1.8ns	-0.04A

1) ns $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) A no effect ($d < 0.2$), B small effect ($0.2 \le d < 0.5$), C moderate effect ($0.5 \le d < 0.8$), D large effect ($d \ge 0.8$)

In addition, the General Linear Model (GLM) univariate procedure was used to determine the differences between the means of male and female students and of Finns and Latvians. The GLM procedure made it possible to investigate interaction between the variables (factors) as well as the effects of individual variables. In all analyses, factor variables were sex and nationality (random). The dependent variables were the items X1, X2, X14, X16, X4, and X8. One interesting interaction effect from the point of view of this research was found: for Latvian girls school science has opened their eyes to new and exciting jobs ($F = 14.0$, $p < .001$).

The students answering the questions about interestingness of (motivational orientation towards) characteristics of occupations stated how important certain issues were for the choice of their potential future occupation or job. Students' statements are interpreted to be articulations of motivational orientation towards the characteristics of occupations. Means for single items in the questionnaire lie between 1.60 … 3.73, and standard deviations between 0.71 … 1.11 (typically 0.9). The middle of the scale is 2.5 and, therefore, it can be considered as a neutral opinion. Consequently, it can be concluded that when the mean is below 2.5, the majority of the students do not value the certain characteristics of given occupations. In contrast, when the mean is above 2.5, the majority of the students appreciate the characteristics of a given occupation. To evaluate how much students' opinion differ from the neutral opinion in each item, we decided to calculate the power of the difference between the mean of item and middle of the scale using Cohen's *d* ($d = M_{item} - 2.5 / S.D._{item}$) (Cohen, 1988). This Cohen's *d* measures the effect size for the difference between a neutral opinion (2.5) and students' "measured opinion" at the scale: no effect at $d < 0.2$, small effect at $0.2 \le d < 0.5$, moderate effect at $0.5 \le d < 0.8$, and large effect at $d \ge 0.8$. For example, a mean and a standard deviation for the item "*I would like to become a scientist*" was $M_{item} = 1.66$ and $S.D._{item} = 0.86$. In this case Cohen's *d* is $d = 0.98$ and it indicates large effect size for the difference between a neutral opinion (2.5) and students' "average opinion". In this discussion section we refer to calculated *d* for each item based on item mean and standard deviation. The following directive guidelines can be followed with the data interpretations:

i) if the mean for a certain item lies between 2.3 … 2.7, the students' opinion was interpreted as neutral ($d < 0.2$),

ii) if the mean for a certain item lies between 2.0 … 2.3 or 2.7 … 3.0, there was a small effect in the difference between students' opinion and neutral opinion ($0.2 \leq d < 0.5$),

iii) if the mean for a certain item lies between 1.7 … 2.0 or 3.0 … 3.3, there was a moderate effect in the difference between students' opinion and neutral opinion ($0.5 \leq d < 0.8$),

iv) if the mean for a certain item lies under 1.7 or over 3.3, there was a large effect in the difference between students' opinion and neutral opinion ($d > 0.8$).

An exploratory factor analysis (EFA) was used to reduce the number of original 18 variables (importance of certain characteristics of occupations) to a smaller number of factors describing the students' motivational orientations towards the characteristics of occupations. The factor analysis was done separately to Finnish and Latvian data. Both the Kaiser-Mayer-Olkin Measure (Finland: KMO = .80) and Barlett's test of sphericity (Finland: $\chi^2(153) = 18331$, $p < 0.001$) supported the use of the factor analytic approach. Several Maximum Likelihood (ML) solutions with Promax rotation (Kappa = 4) were conducted. The ML method was chosen for the analysis because it yields most clearly differentiated factors (Gorsuch, 1983, p. 117). The number of factors chosen was six, since the meaning of the factors was then readily comprehensible (Dunteman, 1989, pp. 22–23) and their initial eigenvalues before rotating were higher than 1. Missing values were replaced with means.

The six-factor solution of Finnish data is shown in Table 3 and it accounts for 67.0% of the total variance in these data. Factors describing students' motivational orientations to the characteristics of occupations were named as follows: *Personally meaningful orientation, Leadership orientation, Craft orientation, Nature orientation, Innovation orientation, and Social orientation.* The similarity in factor structure in Latvian data (Table 4) was examined using the Confirmatory Factor Analysis (CFA) approach (see Byrne, 1991; Jöreskog, 1979). Thus, according to the results of the Finnish data (see Table 3), a corresponding confirmatory factor model was constructed for the Latvian data. In this base model the no-salient loadings ($\lambda < .25$) were fixed to value zero, and salient loadings were estimated freely (Jöreskog, 1993). Item B9 was estimated freely both for factors 1 and 5 because in the Finnish data this item had a secondary loading ($\lambda = .34$) on Factor 5. Item B20 was also estimated freely on Factors 1 and 2. The Robust Maximum Likelihood Method was used in the estimation procedure (see Jöreskog & Sörbom, 2004). The statistical fit of resulting six-factor model was acceptable, S-B$\chi^2(119) = 541$, CFI = .93, IFI = .93. However, the detailed analysis of the results revealed that Item B20 had statistically significant loading only on Factor 2 in the Latvian data. This result suggested that Latvian students interpreted this item differently from Finnish students. Finnish students connect earning of money to meaningful orientation and Latvian students to Leadership orientation. Thus, in the final model for the Latvian data this Item B20 was estimated freely only on Factor 2. The fit of this post hoc model was excellent, S-B$\chi^2(119) = 430$, CFI = .95, IFI = .95. Moreover, RMSEA was .05 and its 90 percent confidence interval from .045 to .055, thus supporting the conclusion that this final model was also a good population model. According to Steiger (1995), a RMSEA index value below .05 indicates a good fit. However, Browne and Cudeck (1993) have noted that in practice RMSEA values of about .08 or less indicate a reasonable error of approximation.

The multi-group confirmatory factor analysis (MGCFA) approach also allows for the simultaneous analysis of several groups and the testing of factorial invariance across groups (see Byrne, 1998; Jöreskog, 1979). A factor structure is said to be invariant when the factor loadings are equivalent across groups and at least the correlations among latent variables are invariant. Essentially, factorial invariance indicates that an instrument measures the same phenomenon in the same way in different populations. An instrument that demonstrates factorial invariance allows confidence to be placed in comparisons between groups. Thus, in the next phase a similar baseline model was constructed for both Finnish and Latvian data. However, this similarity had one exception, namely Item B20 was allowed to have a secondary loading on Factor 2 only in the Finnish model. As expected, the fit of this Model H_{form} was very good. Next, Model H_{Λ} was constructed by constraining all factor loadings to be equal. This model was compared to Model H_{form} with the chi-square difference test. The difference in χ^2 was statistically significant (S-B$\Delta\chi^2(18) = 180$, $p < .001$), thereby supporting rejection of the hypothesis of invariant factor loadings. The examination of modification indices (MI) suggested that the factor loadings of Item 21 were not invariant across gender ($MI_{Finland} = 38$ and $MI_{Latvia} = 37$). However, both the type-2 and type-3 fit indices of Model H_{Λ} were on an acceptable level, CFI = .93 and IFI = .93. Moreover, the RMSEA estimate was .067

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and its 90 percent confidence interval from .064 to .069, thus supporting the conclusion that H_{Λ} was a good population model. Moreover, a well-known problem with the χ^2 test is that its power is strongly linked to the sample size. If the sample size is sufficiently large, the χ^2 test will even reject models that approximate the covariance or correlation matrix very closely. Thus, the hypothesis of invariant factor loadings was accepted with caution (cf. Steenkamp & Baumgartner, 1998).

The next step was to test the invariance of the factor variances and covariances ($H_{\Lambda\phi}$). The result of the omnibus test (S-B$\Delta\chi^2(15) = 72$, $p < .001$) again supported the hypothesis of non-invariant factor variances and covariances. However, the goodness-of-fit measures remained quite high (e.g., CFI = .93 and IFI = .93). Moreover, the RMSEA estimate was .065 and its 90 percent confidence interval from .064 to .069, thus supporting the conclusion that $H_{\Lambda\phi}$ was a good population model. Examination of MIs suggested that the factor variance of Factor 2 (MI = 22) and the covariance between Factors 5 and 6 were not invariant across samples. However, because of the relatively small MIs and to avoid capitalisation on chance, the hypothesis of invariant factor covariances and variances was accepted with caution (cf. Steenkamp & Baumgartner, 1998).

Table 3. Six-factor solution (Maximum Likelihood, Promax and Kaiser Normalisation–Rotation) as calculated using variables measuring Finnish students' motivational orientation towards characteristics of occupations. Means (*M*) and Standard Deviation (S.D.) for all items are presented.

			Factor					
	M	S.D.	F1	F2	F3	F4	F5	F6
F1F: Personally meaningful orientation								
B15. Working with something I find important and meaningful	3.17	0.85	.833					
B16. Working with something that fits my attitudes and values	2.98	0.85	.599					
B13. Making my own decisions	3.22	0.77	.564					
B25. Developing or improving my knowledge and abilities	3.18	0.80	.524					
B14. Working independently of other people	2.71	0.86	.480					
B9. Using my talents and abilities	3.28	0.83	.457				.336	
B20. Earning lots of money	3.22	0.80	.439	.281				
F2F: Leadership orientation								
B24. Becoming 'the boss' at my job	2.34	0.96		.870				
B21. Controlling other people	2.46	0.90		.683				
B22. Becoming famous	2.11	0.97		.587				
F3F: Craft orientation								
B7. Working with machines or tools	2.17	1.03			.898			
B6. Building or repairing objects using my hands	2.23	1.02			.780			
F4F: Nature orientation								
B4. Working in the area of environmental protection	2.06	0.90				.861		
B3. Working with animals	2.15	0.98				.669		
F5F: Innovation orientation								
B11. Coming up with new ideas	2.84	0.89					.771	
B10. Making, designing or inventing something	2.58	0.95					.736	
F6F: Social orientation								
B2. Helping other people	2.91	0.91						.876
B1. Working with people rather than things	2.97	0.95						.531
Eigenvalue			4.38	2.39	1.83	1.51	.99	.94
% of total variance			24.37	13.30	10.17	8.39	5.53	5.26

Factor Correlation Matrix

Factor	1	2	3	4	5	6
1	1.000	.256	-.037	.157	.517	.506
2	.256	1.000	.246	-.061	.302	.073
3	-.037	.246	1.000	.125	.324	-.168
4	.157	-.061	.125	1.000	.185	.364
5	.517	.302	.324	.185	1.000	.204
	.506	.073	-.168	.364	.204	1.000

Table 4. Means (*M*) and Standard Deviation (S.D.) for items measuring Latvian students' motivational orientation towards characteristics of occupations.

	M	S.D.
F1L: Personally meaningful orientation		
B15. Working with something I find important and meaningful	3.46	0.75
B16. Working with something that fits my attitudes and values	3.39	0.79
B13. Making my own decisions	3.46	0.71
B25. Developing or improving my knowledge and abilities	3.56	0.68
B14. Working independently of other people	3.31	0.83
B9. Using my talents and abilities	3.43	0.81
B20. Earning lots of money	3.73	0.56
F2L: Leadership orientation		
B24. Becoming 'the boss' at my job	3.20	0.91
B21. Controlling other people	2.70	0.93
B22. Becoming famous	2.96	0.98
F3L: Craft orientation		
B7. Working with machines or tools	2.31	1.09
B6. Building or repairing objects using my hands	2.14	1.11
F4L: Nature orientation		
B4. Working in the area of environmental protection	2.23	1.02
B3. Working with animals	2.29	1.05
F5L: Innovation orientation		
B11. Coming up with new ideas	3.20	0.90
B10. Making, designing or inventing something	2.96	1.00
F6L: Social orientation		
B2. Helping other people	3.01	0.88
B1. Working with people rather than things	2.98	0.98

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Because the structures of the separate factor solutions to Finnish and Latvian data were very similar, the two data were put together for the rest of analyses. Correlation coefficients were calculated to find possible correlations between student motivational orientation towards the characteristics of occupations (Factors 1…6) and their gender, nationality, interestingness in school science, and interestingness of a career in science and technology. To evaluate how strong or week a correlation coefficient is, we have followed in the discussion Cohen's (1988) rules for effect size of the correlation coefficient. There is no effect at $r < 0.1$, small effect at $r = 0.1$ and medium effect at $r = 0.3$. In our data there were no correlations bigger than 0.5, which means a large effect. Correlations and their significances are presented in Table 5.

Table 5. Correlation coefficients between the students' occupational orientations (Factors 1…6) and their gender, nationality, and their interest in school science, and interest in career in science and technology. Correlations with a medium effect have grey background.

	Personally meaningful orientation	Leadership orientation	Craft orientation	Nature orientation	Innovation orientation	Social orientation
Gender	-.31***	.09***	.48***	-.19***	-.01	-.43***
Nationality	.27***	.39***	.04**	.06***	.20***	.05**
School science is interesting	.20***	.05***	.02	.19***	.19***	.15***
School science is a difficult subject	.03*	.02	-.05**	-.02	-.05**	.08***
I would like to become a scientist	.01	.11***	.16***	.21***	.15***	-.04*
I would like to get a job in technology	-.04*	.18***	.41***	-.03	.20***	-.21***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (Correlation is significant at the 0.001 level, 2-tailed test) Gender (1=girl, 2=boy); Nationality (1=Finland, 2=Latvia); School science is interesting (1=*disagree*; 4=*agree*); School science is a difficult subject (1=*disagree*; 4=*agree*); I would like to become a scientist (1=*disagree*; 4=*agree*); I would like to get a job in technology (1=*disagree*; 4=*agree*).

Correlation coefficients presented in Table 5 show how background variables correlate with occupational orientation factors, i.e. characteristics of occupations. Most powerful predictors for explaining student motivational orientation towards characteristics of occupations were students' gender and nationality. There was no correlation effect for the conceived difficulty of science. It is important to note that regardless of their statistical significance, correlations of school science interestingness or motivational orientation towards occupation in science and technology with any characteristics of occupations were relatively low. However, there is a high correlation between students' motivational orientation towards science and technology related job and Craft orientation.

Discussion

School science and its role in helping students to perceive their future career

The means of both boys' and girls' opinions about difficulty and interestingness of science are near the middle of the scale. Boys perceive science as being a little easier than girls. Both have no interest in careers in science (the difference between both boys' and girls' opinions and neutral opinion is large, *d* > 0.8). Boys' interest in a technological career was neutral while girls had no interest in a career in technology. Both boys and girls had a neutral opinion about the role of school science in improving their career chances and in helping them to become familiar with new and exciting jobs.

There was no effect size for the difference between Finnish and Latvian students opinion about interestingness and difficulty of school science, neither their interest in science and technological careers, nor comparisons of how school science has helped students to perceive career possibilities and improve career chances. Students in both countries were not interested in becoming a scientist or getting a technology-oriented job. However, Latvian girls felt that school science has opened their eyes to new and exciting jobs. This result may reflect Latvia's current social phase of development in becoming a Western society. It is an interesting outcome, which is worth investigating further.

Our results are in general similar to the results introduced in the theoretical part of this paper: Most students find school science and technology difficult and uninteresting and, moreover, careers in science and technology unattractive. Consequently, there are challenges for science teachers in Finland and in Latvia to help their students, especially girls, to perceive career possibilities in science and technology as positive. However, there are no simple solutions because perceived difficulty (lack of competence) of a subject has a causal relation to the uninterestingness of the subject according to the review of interest research at the beginning.

Students' motivational orientation towards the characteristics of occupations in Finland and in Latvia

Young people in Finland and in Latvia feel that characteristics related especially to *Personally meaningful orientation*, and also to *Innovation orientation* and *Social orientation* are most important for their choice of future occupations (the effect size of the difference between students' opinions and neutral opinion is large, $d > 0.8$). Especially, the possibilities to improve knowledge and abilities and use them in decision making were the most important characteristics of future occupations. Moreover, the possibility to do something the students find important and meaningful and which fit their attitudes and values were also important.

Innovation orientation is linked especially to the desire to come up with new ideas and the possibility to design, make or investigate something. These characteristics of occupations were interesting for students, especially in Latvia (the difference between students' opinions and neutral opinion is moderate, $d > 0.5$, in Latvia). However Finnish students had a more neutral opinion to this orientation. *Social orientation* is linked with the desire to work in teams or with a possibility to help people. Students both in Finland and in Latvia had some interest in these characteristics of occupations (the effect size of the difference between students' opinions and neutral opinion is small, $d > 0.2$).

Craft orientation and *Nature orientation* were not so interesting for students in both countries (the effect size of the difference between students' opinions and neutral opinion is small, $d > 0.2$). Especially in Finland students were not interested in working with machines or tools. Especially the protection of the environment or working with one's hands belongs to the area of value related valences of interest. However, these values are not so important for young people in Finland and in Latvia.

Several characteristics of occupations, like *Working with something that fits my attitudes and values*, *Working with something I find important and meaningful*, and *Helping other people*, can be assigned to the area of value related valences of interest. These characteristics refer to the attribution of personal significance or importance to an activity. Therefore, the students should be helped to recognise these features of science learning activities and also in science and technology occupations.

There were the largest differences between Finnish and Latvian students' interest in items having high loading to *Leadership orientation*. Students in Latvia were very interested in becoming a boss at their job (the effect size of the difference between students' opinions and neutral opinion is large, $d > 0.8$, in Latvia and Finnish students had a neutral opinion.). However, students in Latvia were very interested in working independently (the difference between students' opinions and neutral opinion is large, $d > 0.8$). Therefore, they do not probably recognise all typical characteristics which belong to leadership and perhaps their interest towards leadership deals only with feelings.

The students in both countries highly value the possibility to earn lots of money in their future oc-

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cupation (the difference between students' opinions and neutral opinion is large, $d > 0.8$). However the item "*Earning lots of money*" was the only item which makes problems with confirmatory factor analysis: Finnish students connect this characteristic with *Personally meaningful orientation* and in Latvia with *Leadership orientation.*

Some characteristics of occupations, like *A possibility to work as a boss,* or *To earn a lot of money,* can be assigned to the area of feeling related valences of interest. These are associated with feelings of enjoyment and involvement. It is obvious that these characteristics are not enough to increase personal interest in science and technology or related careers, because situational interest develops typically into personal interest only if both feeling-related and value-related factors are experienced together in a positive way (Krapp, 2002).

The characteristics of occupations which are interesting for students are also characteristics of modern science and technology related occupations. For example, according to the *Career Space Consortium* ICT graduates need in addition to technical and programming skills, team working skills, problem-solving abilities and awareness of the need for lifelong learning (Cedefop, 2001). Therefore, these interesting characteristics should be introduced to students in science and technology education, during career counselling sessions and during site visits. Latvian youngsters have high interest in *Developing or improving my knowledge and abilities,* which is positive as it relates to lifelong education. However, they have highest priorities as *Earning lots of money,* and *Working with something I find important and meaningful,* which are more related with a desire for personal benefits than with concrete professions. It indicates perhaps that Latvian youngsters have not fully recognized their facilities, interests, or possibilities for future education. Therefore, there are challenges for science teachers and career counsellors.

As a summary, students' had strong motivational orientation towards several characteristics of occupations which load on the *Personally meaningful orientation* factor and also a relatively high motivational orientation towards the characteristics of occupations which load on factors *Innovation orientation* and *Social orientation*. Loadings on factors *Craft orientation* and *Nature orientation* were lower. We interpret that all kinds of interaction with surroundings where students are engaged with activities which are interesting for them could arouse their interest. If these activities are met during science and technology studies, students' interest in science can be aroused. Therefore, it is challenging for a teacher to develop activities where students can make their own decisions, use their talents and abilities, come up with new ideas and work with other students. When a teacher is planning projects, problem-solving sessions, practical work or other similar activities he or she should somehow combine interesting features of occupations with the activities. And also point out that these features of activities are also met in science and technology careers. There should be new emphasis on team work, formation of virtual study communities and worldwide networking with Internet resources.

Correlations between *motivational orientation towards* characteristics of occupations and *gender, nationality, interestingness of school science and interestingness of career in science and technology*

Boys, on the average, are more oriented towards conventional technology than girls, whereas girls have stronger *Personally meaningful, Nature,* and *Social orientations* than boys. It seems that the important 'orientation factors' reflect traditional role models and views about what is suitable for men and women. These stereotypical views can be seen especially in Craft orientation. Stereotypical views are also met in Social orientation: altruism, nursing and helping other people are traditional characteristics of the female role. Working with something that fits well personal interests, as well as working with animals and taking care of them belongs also to the characteristics of this role (cf., Jones, Howe, & Rua, 2000). The influence of traditional role models can be seen in male and female students' selection on the one hand of occupations in science and technology, and on the other in nursing and teaching. In accordance with Boser, Palmer, and Daugherty (1998) science and technology education programs do not meet the needs of female students. Therefore, the profession should develop new types of curriculum materials and activities that meet the interests and needs of all students.

Latvian students have much stronger *Personally meaningful, Leadership* and *Innovation orientations* than Finnish students. The orientations in Latvia can reflect radical changes in the society. Young people in Latvia are looking for high societal status (leadership) and at the same time looking for a personally important and meaningful occupation where they can make their own decisions. Perhaps models of how simultaneous needs of leadership and personally relevant perspectives can be satisfied and how the idea of entrepreneurship can be connected to all kinds of occupations are not yet recognised by youth in Latvia. In Finland these ideas have been mentioned for a long time in national school curricula.

According to the literature review, the quality of science teaching and the personal encouragement given to students by science teachers, the practical nature of school science, and the intellectual satisfaction of success in science influence student career choices. This survey suggests that there is a relatively small correlation between school science interestingness and the *Personally meaningful, Nature, Innovation* and *Social orientations*. Consequently, we may interpret that the way in which science is taught and learned now at school does not give students an insight into how scientists and engineers work, how new knowledge is created, and how knowledge is applied at work. Therefore, teaching methods should be developed so that they better demonstrate how one's own knowledge and skills are used in both science and technology studies and in related occupations. Furthermore, activities should be organised in small groups where creativity is allowed and required. The intrinsic satisfaction of "finding out new things", creating new things and the more altruistic "ability to do something useful" are important feelings which belong to science and technology activities. Within these activities, appropriate new types of role models can also be introduced. These ideas of diversifying teaching and learning methods fit well with previous research outcomes (see Lavonen, Byman, Juuti, Meisalo, & Uitto, 2005): Finnish lower secondary school students wish to have more discussions and working in small groups (cf. Baker & Leary, 1995). Moreover, students want most of all to have more frequent site visits and to meet more often specialists and experts during their science studies. Guest speakers and educational visits provide a starting point that is more natural than traditional learning materials for becoming acquainted with applications of science and meeting role models (Woolnough, 1996). We have followed these guidelines in our Material Science project.

According to Table 5, there is a relatively small correlation with the *wish to become scientists* and *Leadership, Craft, Nature,* and *Innovation orientations* – not at all with *Personally meaningful* and *Social orientation*. There are also very small correlations with the student orientation to technological careers (I would like to get a job in technology) and with different occupational orientations except *Craft orientation*. These results can be interpreted as showing that young people do not have a clear image regarding occupations in science and technology. If they are interested in such careers they are not looking for leadership, innovative work and social interaction. Moreover, technological career choice has a very high correlation with *Craft orientation* although modern work in technology is not similar to handicraft. Therefore, more career counselling is needed and teachers should help students to recognise *Leadership, Innovation* and *Social* orientations in students themselves and their relation to occupations in science and technology. In practice, more information should also be given regarding the content and features of occupations and typical activities and tasks employees face in their jobs on a daily basis, namely creativity, ability to work in teams, and continuous personal development. It is obvious that official career counsellors are not encouraging students to choose science and technology through explaining the possibilities of further studies or of related careers.

Conclusions

It is known that an individual makes choices based on life experiences, including experiences in school, and the perceptions of the consequences of those choices. Typically, decisions are based on a series of events with various intertwined factors exerting their influence along the decision path (OIA, 1995). We have presented above some implications to school science education and to the role of a science teacher. On the other hand, our data very clearly demonstrate a strong correlation between perceived difficulty (feeling a lack of competence) of a subject and the uninterestingness of the subject. Therefore, something should be done also with the content of the curriculum and how difficult content areas are approached in teaching. Simply, when the content is perceived too difficult, any site visit or role model

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can not help in recruiting more students to science. Curriculum designers, textbook authors and science teachers should have more courage in designing and implementing a curriculum. Consequently, more research is needed to find how to best intervene in the process to maximise influencing the educational and career choices of individuals to face the challenges of today and bring us into the future.

We have discussed the possibilities science teachers have in helping their students to acquire situational interest through demonstrating the characteristics of science and technology related occupations. This interest has an effect on the learning of science and technology and on whether students choose an occupation in science and technology. The gaining of situational interest can happen through teaching and learning methods and through choosing appropriate contents and contexts, as well as through giving high quality career advice. Moreover, previous interest research (see e.g., Krapp, 2002; 2003) suggests that in favourable situations, where both feeling and value related factors are experienced in a positive way, situational interest can transform into personal interest also under the control of teachers. Unfortunately, there are no clear recipes of how to proceed and it is obvious that new innovative design research projects are needed in this field.

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