Science Choices in Norwegian Upper Secondary School: What Matters?

Abstract

There is international concern about young people’s participation in science. This study investigated the relevant importance of various issues in 1,628 Norwegian upper secondary students’ choices of post-compulsory subject combinations: Natural science and mathematics (henceforth Science) or Languages, social science and economics (henceforth HumSoc). Questionnaire items based on the Eccles et al. model of achievement-related choices were grouped into six constructs by factor analysis: expectation of success, interest-enjoyment value, self-realisation value, fit to personal beliefs value, utility value for university admission, and relative cost. Interest-enjoyment and fit to personal beliefs were somewhat less important to Science students than to HumSoc students, especially to girls taking Science. Utility value for university admission was much more important to Science than to HumSoc students, and more important to Science girls than to Science boys. Costs in terms of time and effort were much more important to HumSoc than to Science students. The findings indicate that students choose Science both for identity reasons, such as interests, self-realisation and fit to personal beliefs, and for strategic utility reasons. Some of the students, especially the girls, appear to have placed more weight on utility than on their interests. Implications for participation in post-compulsory science are discussed.

Author Posting. © 2011 Wiley Periodicals, Inc.
Science Choice in Norwegian Upper Secondary School: What Matters?

Introduction

Throughout the developed world, government, industry, and educators have called for increased participation in science, technology, engineering and mathematics (STEM) fields. Public health and well-being rely increasingly on science and technology, and industry is ever more dependent on technology development. Moreover, science and technology play increasing roles in society and everyday life, both of which makes scientific literacy and participation in STEM fields more and more important to the general public. Bøe, Henriksen, Lyons and Schreiner (2011) previously stated that participation in STEM is important for five reasons: to fill demands for STEM professionals, to ensure a greater diversity of STEM professionals to increase the innovative potential, to improve empowerment of groups that are currently under-represented in STEM fields, to give everyone the chance to experience the wonders of science and technology; and to ensure that everyone has real free choice of education by reducing mental and cultural barriers arising from stereotypical views of scientists. Women are still underrepresented in STEM in most developed societies, and the imbalance is most severe in physical science and engineering (EU, 2009; National Science Foundation, 2006).

Many researchers have highlighted the prevalence of disenchantment with school science among students in developed countries (Osborne, Simon, & Tytler, 2009; Schreiner, 2006; Schreiner & Sjøberg, 2007; Tytler, Osborne, Williams, Tytler, & Clark, 2008). Young people’s increasing reluctance to participate in science in especially physical science and mathematics subjects has been most evident in highly developed and modernised regions such as Europe (European Round Table of Industrialists [ERT], 2009; OECD, 2008), the US (Stine & Matthews, 2009), Australia (Lyons & Quinn, 2010), New Zealand (Hipkins & Bolstad, 2005a), Canada (Government of Canada, 2007), Japan (OECD, 2007b; Ogura, 2005) and Korea (Anderson, Chiu, & Yore, 2010). Educators agree that enrolment patterns are difficult to investigate and compare over time and between countries, due to the absence of a precise and agreed classification system and complete statistics (OECD, 2008). Nevertheless, it appears clear that a decreasing proportion of the total student pool choose to study STEM in higher education. Young women opt out in particular of especially physics, engineering and technology.
Norwegian students generally spend 3 years in upper secondary school. Students who choose General Studies and Specialisation to general studies (FIGURE 1) all take the same compulsory subjects the first secondary year (Year 11), but choose one of three programme areas for the next two years. According to the Norwegian Directorate for Education and Training (NDET) (2009a), 40% of students in Year 12 in 2008 chose Science, 53% chose HumSoc, and 5% chose Arts, crafts and design (these students are outside the target group and not included in this study). Girls accounted for 46% of the Science students and as much as 60% of the HumSoc students (Statistics Norway, personal communication, June 29, 2009).

FIGURE 1: Norwegian upper secondary school system

Note. Possible paths from Year 11 General Studies (Vocational upper secondary training is not included in the figure). Students in paths illustrated by grey, dotted lines were outside the target group.

Many countries have reported that a decreasing proportion of upper secondary students choose science and mathematics, for example Australia (Lyons & Quinn, 2010), the UK (Institute of Physics, 2010), New Zealand (Hipkins & Bolstad, 2005b) and India (Garg & Gupta, 2003). In Norway, however, there has been a slight upturn in the number of Norwegian students finishing upper secondary school with a comprehensive grounding in science and mathematics (Hægeland, Kirkebøen, & Skogstrøm, 2007). In Year 12 in 2007–2008, Level one courses in physics, chemistry and mathematics for natural sciences
were the most popular among Science students. However, one third of the physics students and one quarter of the chemistry students did not continue with the subjects to Level 2 in Year 13. In contrast, 97% of biology Level 1 students took biology Level 2 in Year 13 in 2008–2009 (NDET, 2009a). The gender distribution in the science subjects follows traditional patterns: Level 2 biology, chemistry and physics had roughly equal numbers of students in 2008-2009 (NDET, 2009a), but girls made up 69%, 57% and 30% of students in biology, chemistry and physics, respectively (NDET, 2009b). Many researchers have suggested that females are reluctant to participate in the physical sciences and engineering due to a perceived lack of relevance and fit to personal values (Eccles, 2007; Kozoll & Osborne, 2004; Osborne, Simon, & Collins, 2003; Ramberg, 2006; Schreiner & Sjøberg, 2007; Taconis & Kessels, 2009). The “Lily” study draws on this important perspective where an expectancy-value model of educational choices is employed to study young people’s choices in secondary education.

The Lily study is a quantitative survey about the educational choices of around 14,000 Norwegian students in secondary and tertiary education. It aims to contribute to increased participation in STEM by producing generalisable knowledge about why students do or do not choose science-related subjects and studies. The results presented in this article use data from a sample of Year 12 upper secondary students undertaking Specialisation in General Studies. The students responded to a questionnaire early in Year 12 and had recently chosen their programme area for the last 2 years of upper secondary school, Year 12 and 13 (FIGURE 1). This choice is critical as the Science programme area is a requirement for higher education STEM studies (Norwegian Ministry of Education and Research, 2010).

The questionnaire is based on Eccles at al.’s expectancy-value model of achievement-related choices (Eccles et al., 1983). The underlying premise of expectancy-value theory is that choice, persistence, and performance can be explained by beliefs about how well the individual will perform in a particular activity and the extent to which that individual values the activity (Wigfield & Eccles, 2000). The motivation for educational choice, thus, consists of two main factors: the students’ expectation of success, and the value the students place on this particular option. The model predicts that students are most likely to choose courses they think they can master, and that have high value for them (Eccles, Barber, & Jozefowicz, 1999). It is important to underline that educational decisions are made in a complex social context: Each individual is presented with a variety of options, all of which have various consequences for their lives (Eccles et al., 1999). Two constructs directly influence
achievement-related choices: Expectation of success and subjective task value. Eccles et al.
(1999) previously showed that both predict career choices. Their model predicts that the
expectation of success and subjective task value are the result of several psychological and
social/cultural parameters, for example, self-concept of abilities and personal goals, as well as
the cultural milieu and the socialisers’ behaviour (Eccles & Wigfield, 2002). The model has
been developed and tested over many years and in many studies (see Eccles et al., 1983;
Eccles et al., 1999; Meece, Wigfield, & Eccles, 1990; Nagy et al., 2008).

Expectation of success is defined as "individuals’ beliefs about how well they will do
on upcoming tasks” (Eccles & Wigfield, 2002, p. 119), and is similar to Bandura’s self-
efficacy beliefs (see e.g. Bandura, 1997, 2007; Bandura, Barbaranelli, Caprara, & Pastorelli,
2001). For example, what constitutes success in two courses – advanced mathematics and
economics – in upper secondary school depends on the students’ self-images in relation to
those courses. A just above-average mark in mathematics may be a success if the students
view themselves as average mathematics students but a failure if they view themselves as
very good mathematics students. Expectation of success also includes the students’
perception of the level of difficulty of the courses. If they regard advanced mathematics as
more difficult than economics, they may characterise a just above-average mark in advanced
mathematics a major success, whereas equal success in economics would require a top mark.

In the model, subjective (task) value\(^1\) is split into four components: Interest-enjoyment value,
attainment value, utility value, and relative cost. Interest-enjoyment value concerns how
interested students are in the subject in question and the enjoyment experienced when
engaging in it. It is similar to intrinsic motivation (Ryan & Deci, 2000), flow (Shernoff,
Csikszentmihalyi, Schneider, & Shernoff, 2003), and interest (Hidi & Renninger, 2006;
Krapp, 2002, 2005). Students who are, for example, political activists are possibly quite
interested in community economics. They may, therefore, enjoy economics and statistics
more than calculus, and an economics course will have higher interest-enjoyment value for
them than advanced mathematics.

Attainment value refers to how well a subject or career choice fits with a person’s
identity. People want to confirm central aspects of their identity and will attribute higher
value to options that enable them to establish this identity (Eccles, 2009). The importance of

---

\(^1\) Eccles and colleagues use the term subjective task value. As this article concerns the choice of school subjects
and educational programmes, rather than specific tasks, I use subjective value.
succeeding to fulfil personal needs is also part of attainment value (Eccles, 1994). An educational choice may have attainment value for students because it makes them feel happy and proud of themselves, or because it is stimulating to work creatively and overcome challenges. For instance, for someone who wants to confirm and express an identity as very intelligent, an advanced mathematics course may have higher attainment value than economics, because mathematics is generally considered to be more difficult than most other subjects. Similarly, it may be important not to choose subjects that appear to be in conflict with a desired identity. If physics is perceived to be for brainy and unpopular geeks, physics will have low attainment value for someone who rejects such an identity.

Utility value concerns how helpful a certain course is in reaching external goals, such as career objectives. A choice that has high utility value, therefore, leads to extrinsic motivation (Ryan & Deci, 2000). Universities also often award more credits for upper secondary advanced mathematics than economics, a factor that may give the former higher utility value for some students. Extrinsic motivation causes people to engage in activities to obtain a separate outcome. Physics may have high utility value for students who hope to gain entry to medical school, even if they have no personal interest in the subject.

Relative cost refers to negative aspects related to one activity or educational choice compared with other options. It could, for example, be the time and effort that is required to do well in advanced mathematics compared to economics. It could be fear of failing advanced mathematics, or fear of disappointing parents. Lost opportunities from choosing one course or study programme over another are also relative costs.

According to the model, identity influences both expectation of success and subjective values, and is influential when students make educational choices (Eccles, 2009). Eccles and colleagues distinguished between personal and social or collective identities. Students’ personal identity includes their self-image and their values and goals. It also includes what kind of person they think they may become in the future (possible future selves). Students’ social identities are how they see themselves in terms of social categories and how they express membership of these categories through symbols and activities. Students try to fit educational choices into their identities. When developing their identity, students use stereotypes related to jobs, subjects and activities, all of which are defined by culture and are often gender specific. Young people have their own perceptions of each stereotype; these perception are also influenced by those of parents, peers and other socialisers.
Much science education research has identified differences between girls and boys, and gender has been thoroughly addressed by Eccles and colleagues in the expectancy-value model of achievement-related choices (Eccles, 1994, 2007; Eccles et al., 1999; Nagy et al., 2008). The model suggests that culture, through gender and gender specific stereotypes, socialises boys and girls differently. Eccles and colleagues (2009; 1999) stated that these socialisation processes may lead to the genders developing different hierarchies of core personal values and cause boys and girls to place different values on activities due to stereotypical notions of gender-specific activities. To construct a desired identity, the same educational choice may have very different value for boys and girls. A girl who wishes to study medicine and a boy who wants to become an engineer both place high utility value on physics in upper secondary school, because it is required for university admission later on. However, although a physics student stereotype may be easily incorporated into a technically oriented engineer identity, it may be less compatible with a care-oriented medical practitioner identity.

Science educators have found that the Eccles et al. model is a suitable framework for studying young people’s choices of science (Author et al., 2011). Among the model’s strengths is its comprehensive and inclusive nature. It is comprehensive in that it incorporates social, psychological and cultural aspects that influence educational choices, and inclusive in the sense that many of its constructs overlap with concepts from other motivational theories (see Eccles & Wigfield, 2002), such as Bandura’s (1997) theory of self-efficacy, Ryan and Deci’s (2000) theory of intrinsic and extrinsic motivation, and Hidi and Renninger’s (2006) and Krapp’s (2002, 2005) theory of interest. Another strength is that it acknowledges identity as an important factor in educational choices (Eccles, 2009; Eccles & Wigfield, 2002). A few issues have been identified that require consideration when the model is used in science education research (ibid.). First, expectation of success and subjective values are affected by constantly changing society and cultural milieu. This makes measures of expectation of success and subjective values sensitive to cultural changes. Second, social background variables such as ethnicity and class could be stated more clearly in the model. Third, researchers should note that the expectancy-value structure of the model does not imply that choices are made through a fully informed calculation of all the available options. For example, interest-enjoyment value has major affective components and may be based on a “gut-feeling”.
Wigfield and Eccles (1992) stressed how social surroundings influence young people’s expectancies, their self-schema, their perception of stereotypes, and the subjective values they attach to educational options. I, therefore, include perspectives from sociology about late modernity and identity development, to understand better the social and cultural setting in which young Norwegians make their choices.

Young people in rich, developed nations such as the Nordic countries live in a society that the sociologist Giddens (1991) calls late modern society. The late modern period needs to be distinguished from the general modern age, which has characterised developed societies in the last centuries. The modern age was triggered by the industrial revolution, and values supporting economic growth were central (Inglehart, 1997). Characteristics of late modern societies include less emphasis on material values and more emphasis on personal ones, such as self-realisation and quality of life. Late modernity can be seen as a continuation of modernity into a late and accelerated stage, rather than an epochal shift into what some theorists call post-modernity. A post-modern society is described as highly pluralistic and diverse, with no universal principles, common ideas or grand narratives that can direct social development (Giddens, 1991). In contrast, late modernity is recognised by the radicalisation, amplification and intensification of modernity (Beck, Giddens, & Lash, 1994; Fornäs, 1995; Miles, 2000). A central mechanism in late modernity is detraditionalisation where authorities and tradition have lost much of their influence (Beck et al., 1994). Detraditionalisation results in a concept referred to as individualisation where each individual is more culturally liberated and can to a larger extent than in more traditional societies make specific choices in relation to factors such as lifestyle, place to live, education and jobs, political views, life partner and religious faith. Individualisation brings with it the freedom to take control of one’s own life and the task of making the best of it. In this task of self-realisation, the quality and meaning of life are central (Inglehart, 1997).

Identity construction plays a major role in individualisation. In a society less bound by tradition, identity is no longer inherited or given but must be constructed by the individual (Côté, 1996; Giddens, 1991). Adolescence, therefore, becomes a crucial period, with individuals seeking their own identity and trying to fit many choices into a consistent person. Young people see their interests, their favourite school subjects, their job plans, their friends and their views (on science and technology and everything else) as part of their identity, of who they are (Beck, 1999; Goffman, 1959). Large parts of their days are spent with other young people in a range of activities such as school, dance class, football practice, cinemas,

Manuscript accepted for publication in Science Education Maria Vetleseter Bøe
cafés and chat rooms. All of this gives rise to youth culture, a stage where identity construction takes place. Today’s social life offers multiple contexts of action, making lifestyle choices increasingly important in the establishment of self-identity (Giddens, 1991). Sociologists like Giddens, Beck and Inglehart described late modernity in the 1990s, and the period’s characteristic traits have also been recognised in more recent work (Bauman, 2008; Furlong & Cartmel, 2007). However, it is important to note that late modernity provides an idea of free choice. Class, gender and other constraints of social life continue to limit young people’s life chances, but have been obscured (Atkinson, 2008; Furlong & Cartmel, 2007). As a result, young people hold themselves responsible if they cannot resolve problems on their own, even if these problems are rooted in social constraints (Furlong & Cartmel, 2007).

Recently, science and mathematics educators have increased their focus on the societal changes taking place in most developed countries (Tytler, 2007) and on the role that identity plays in young people’s orientations to science and mathematics (Aikenhead, 2006; Osborne et al., 2009; Sfard & Prusak, 2005). Several contributions to science education research have related young people’s identity work to their orientations to science (Archer et al., 2010; Brickhouse, 2001; Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Hazari, Sonnert, Sadler, & Shanahan, 2010; Kozoll & Osborne, 2004; Schreiner, 2006; Taconis & Kessels, 2009).

This article investigates the relevant importance of different issues for Norwegian upper secondary students who chose Science and HumSoc (short for Humanities (including languages and economics) and Social studies) and discusses implications for participation in post-compulsory science.

**Methods**

The survey data were collected during the autumn 2008 term from a sample of Norwegian Year 12 students undertaking General Studies Specialisation. Prior to the data collection, the students had chosen their programme area for Year 12 and 13 and decided whether or not to continue with science. For practicality reasons, the students were sampled in clusters. Seventy-three Norwegian upper secondary schools were randomly selected from a list of all schools that fit the target group: schools that offered the standard Science programme area as an option in Specialisation in General Studies. Forty-two (58 %) of the selected schools participated. The data collection was administered by teachers at each
school, and 1,628 students in the two programme areas Science and HumSoc participated. The filled out questionnaires were returned by post. Due to the low response rate, the representativity of the sample is addressed below by comparing the distribution on gender and programme area in the sample to that of the population (TABLE 1). The geographical distribution of respondents was also investigated and found to be representative.
TABLE 1: Distribution according to programme area and gender

<table>
<thead>
<tr>
<th>Group</th>
<th>Respondents (percentage)</th>
<th>Population(^a) (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>21.1</td>
<td>19.8</td>
</tr>
<tr>
<td>Boys</td>
<td>24.1</td>
<td>23.1</td>
</tr>
<tr>
<td>HumSoc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>33.8</td>
<td>34.2</td>
</tr>
<tr>
<td>Boys</td>
<td>20.9</td>
<td>22.9</td>
</tr>
</tbody>
</table>

\(^a\)(Statistics Norway, personal communication, June 29, 2009)

The questionnaires contained 120 closed Likert-type questions, in addition to two open-ended questions. A focus group interview was conducted prior to the administration of the questionnaires. The five participants filled out the questionnaire individually, followed by a group discussion about various aspects of the questionnaire such as interpretation, length and format, difficulty of answering and general impression. Their responses were used to revise the questionnaire. The questionnaire used a 4-point scale with no neutral mid-category to prevent respondents using a mid-category response as an “I don’t know”- or “does not apply”-response (Kulas, Stachowski, & Haynes, 2008), and force them to express an opinion. On the front page of the questionnaire, respondents were instructed to leave the space blank if they found that none of the alternatives fitted, or if they did not understand the question. The mid-categories 2 and 3 were not named, thereby encouraging respondents to interpret the distance between the boxes as equal (Cummins & Gullone, 2000). The constructs (TABLE 2) were formed by factor analysis of the question “How important were the following factors for you in your choice of programme area?” The question listed 20 items to which the respondents gave their answers on a scale from ”not important” (coded with the value 1) to ”very important” (coded with the value 4). Missing values on these items ranged from 1.4 to 2.4 %, and cases were excluded list wise in the factor analysis.

The factor analysis was exploratory. Although the questionnaire items are based on the Eccles et al. model, the retrospective nature of the study suggests that this theoretical
basis is not sufficient to pre-define constructs (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Principal axis factoring was used to extract factors which does not assume normally distributed data but assumes that the data are continuous (SPSS, 2009). If ordinal data do not have strong floor or ceiling effects, Likert-scales with four (B. Muthén, personal communication, September 16, 2009) and five (Finney & DiStefano, 2006) categories can be approximated as continuous. The factor solution was rotated by Direct Oblimin rotation. This oblique rotation allows the factors to be correlated (Fabrigar et al., 1999), as the factors are predicted by the Eccles et al. model to be. All analyses were performed using SPSS (SPSS, 2009).

To create constructs and ensure that the items in the construct measured something they have in common, the factors were tested for internal consistency using Cronbach’s alpha where .7 is an accepted cut-off point for attitudinal measures (Gable & Wolf, 1993). Test of unidimensionality were performed to determine whether items had more than one aspect in common. The inter-item correlations in a construct were between .3 and .8 (Hellevik, 2002), with low dispersion. For each factor, a new factor analysis was conducted on only the items in the factor to determine whether they returned only one factor even if the eigenvalue criterion was lowered to .75. With this eigenvalue criterion, any factor that explained more than
measured by Cohen’s $d^2$ (Cohen, 1992). A 99% confidence interval was consistently used to evaluate the statistical significance of differences of means. This quite conservative criterion was employed because the cluster sampling of schools, as opposed to randomly sampling students, implies that the true standard error is larger than what is observed in the data.

The questionnaire also included 37 items regarding priorities in a future job under the heading “How important are the following factors for your future occupation or job?” Although the entire question was not well suited for factor analysis, it included five items that correspond to items in the question about choice of programme area and that form two constructs that satisfy the criteria for internal consistency and unidimensionality. Scores on these constructs are reported in this article to inform the discussion about choice of programme area. Missing values on the items in these constructs ranged from 1.5 to 2.6 %.

Six constructs – based on the Eccles et al. model – were used to measure the importance of various issues for students’ choices of upper secondary programme area. Differences between girls and boys and Science and HumSoc students were examined, as well differences between subgroups of gender and programme area.

**Results**

Factor analysis identified four factors that yielded six constructs with satisfactory internal consistency and unidimensionality. Two factors were multidimensional in the second factor analysis test and were both split into two constructs. The typical mean inter-item correlation of all six constructs was .5, and the gaps between the weakest and the strongest correlations were all less than .2. The constructs with Cronbach’s alpha ($\alpha$), mean score ($M$), and standard deviation ($SD$) for the sample are given in TABLE 2.

”That I would have fun with the subjects” and ”That I would learn about something I am interested in” made up the construct interest-enjoyment value referred to in the Eccles et al. model. ”That I would be able to develop myself”, ”That I would be able to use my talents and abilities”, ”That I would be challenged” and ”That I would be able to work creatively” formed a construct I interpreted as self-realisation value, whereas ”That I would learn about
something I find important and meaningful”, ”That I would learn about something that fits my beliefs and values”, and ”That I would learn about something that is important for society” made up the construct fit to personal beliefs value.

### TABLE 2: Descriptives for constructs

<table>
<thead>
<tr>
<th>Factor</th>
<th>Construct</th>
<th>Questionnaire Items</th>
<th>α</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Interest-enjoyment value</em></td>
<td>That I would have fun with the subjects.</td>
<td>.69</td>
<td>3.29</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would learn about something I am interested in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><em>Self-realisation value</em></td>
<td>That I would be able to develop myself.</td>
<td>.74</td>
<td>2.97</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would be able to use my talents and abilities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would be challenged.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would be able to work creatively.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><em>Fit to personal beliefs value</em></td>
<td>That I would learn about something I find important and meaningful.</td>
<td>.72</td>
<td>2.89</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would learn about something that fits my beliefs and values.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would learn about something that is important for society.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><em>Utility value for university admission</em></td>
<td>To collect as many credits as possible.</td>
<td>.73</td>
<td>2.79</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entrance requirements for further studies.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>To keep many options for further studies open.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Expectation of success</em></td>
<td>My previous marks.</td>
<td>.64</td>
<td>2.79</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>My chances to get good marks.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* The question was “How important were the following factors for you in your choice of programme area?”, on a scale from *Not important* (1) to *Very important* (4).
TABLE 2 (continued): Descriptives for constructs

<table>
<thead>
<tr>
<th>Factor</th>
<th>Construct</th>
<th>Questionnaire Items</th>
<th>α</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Relative cost</td>
<td>That the programme area would not be too difficult.</td>
<td>.85</td>
<td>2.02</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>That the programme area would not demand too much work.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>That I would have time for things beside school work.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The question was “How important were the following factors for you in your choice of programme area?”, on a scale from Not important (1) to Very important (4).

"My previous marks" and "My chances to get good marks" formed the construct expectation of success. "To collect as many credits as possible", "Entrance requirements for further studies", and "To keep many options for further studies open" formed the construct utility value for university admission, whereas the items "That the programme area would not be too difficult", "That the programme area would not demand too much work" and "That I would have time for things beside school work" made up the construct relative cost, which corresponds to relative cost in the Eccles et al. model.

The effect sizes of differences in mean scores are expressed by Cohen’s d. TABLE 3 shows the differences between girls and boys and the differences between Science and HumSoc students, and TABLE 4 shows differences between subgroups of each gender in each programme area. Interaction effects between gender and programme area were identified for one of the six constructs: interest-enjoyment value. Nevertheless, as there are significant differences in mean scores between subgroups of gender and programme area also on other constructs, all differences are reported here.
### TABLE 3: Effect sizes\(^a\) for differences of gender and programme area

<table>
<thead>
<tr>
<th>Construct</th>
<th>Girls – Boys</th>
<th>Science – HumSoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest-enjoyment value</td>
<td>0.15**</td>
<td>–0.29**</td>
</tr>
<tr>
<td>Self-realisation value</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Fit to personal beliefs value</td>
<td>0.23**</td>
<td>–0.27**</td>
</tr>
<tr>
<td>Expectation of success</td>
<td>0.20**</td>
<td>–0.03</td>
</tr>
<tr>
<td>Utility value for university admission</td>
<td>0.04</td>
<td>0.90**</td>
</tr>
<tr>
<td>Relative cost</td>
<td>–0.12</td>
<td>–0.76**</td>
</tr>
</tbody>
</table>

\(^a\)Cohen’s \(d\)

\(^{**}p<.01\)
TABLE 4: Effect sizes\textsuperscript{a} for differences between combinations of gender and programme area

<table>
<thead>
<tr>
<th>Construct</th>
<th>ScG – ScB</th>
<th>HSG – HSB</th>
<th>ScG – HSG</th>
<th>ScB – HSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest-enjoyment value</td>
<td>−0.11</td>
<td>0.30**</td>
<td>−0.48**</td>
<td>−0.05</td>
</tr>
<tr>
<td>Self-realisation value</td>
<td>−0.08</td>
<td>0.11</td>
<td>−0.06</td>
<td>0.12</td>
</tr>
<tr>
<td>Fit to personal beliefs value</td>
<td>0.13</td>
<td>0.26**</td>
<td>−0.32**</td>
<td>−0.15</td>
</tr>
<tr>
<td>Expectation of success</td>
<td>0.25**</td>
<td>0.15</td>
<td>0.05</td>
<td>−0.05</td>
</tr>
<tr>
<td>Utility value for university admission</td>
<td>0.31**</td>
<td>0.10</td>
<td>1.02**</td>
<td>0.82**</td>
</tr>
<tr>
<td>Relative cost</td>
<td>−0.17</td>
<td>−0.31**</td>
<td>−0.76**</td>
<td>−0.86**</td>
</tr>
</tbody>
</table>

\textit{Note.} Sc=Science, HS=HumSoc, G=girls, B=boys

\textsuperscript{a}Cohen’s \textit{d}

\*\textit{p}<0.01

The mean scores presented in TABLE 2 show that the respondents found it easy to agree that interest-enjoyment (3.29), self-realisation (2.97) and fit to personal beliefs (2.89) were important in their choice of programme area. However, interest-enjoyment and fit to personal beliefs were somewhat less important to Science than HumSoc students (\textit{d}=−0.29 and \textit{d}=−0.27 respectively, TABLE 3). That gender interacted with programme area for interest-enjoyment value is illustrated by a difference of \textit{d}=−0.48 between girls in Science and HumSoc, whereas, in contrast, there was no significant differences between boys in the two programme areas. Science girls’ scores stood out in a way that can not be explained by the fact that they are Science students or by the fact that they are girls. In terms of the importance of utility value for university admission, Science students scored much higher than HumSoc students (to some extent, this is trivial because items in that construct describe formal admission qualifications that are only available to Science students (Norwegian Universities and Colleges Admission Service, 2010). Interestingly, the utility value for university admission was also more important to Science girls than to Science boys (\textit{d}=0.31). There was also a small difference between Science girls and boys in the importance of expectation of success (\textit{d}=0.25), though a corresponding difference between girls and boys in general (\textit{d}=0.20, TABLE 3) suggests that this was mainly a gender effect. Avoiding costs
in time and effort was much more important to HumSoc students than to Science students ($d = -0.76$).

Scores on two more constructs (TABLE 5) were included that consist of items from another question concerning priorities in future jobs.

**TABLE 5: Descriptives for constructs**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Questionnaire Items</th>
<th>α</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Interest and self-realisation in future job</em></td>
<td>Working with something I am interested in.</td>
<td>.73</td>
<td>3.59</td>
<td>.52</td>
</tr>
<tr>
<td></td>
<td>Using my talents and abilities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Developing myself.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fit to personal beliefs in future job</em></td>
<td>Working with something that fits my beliefs and values.</td>
<td>.72</td>
<td>3.36</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td>Working with something I find meaningful.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The question was “How important are the following factors for your future occupation or job?”, on a scale from Not important (1) to Very important (4).

Girls scored higher than boys on interest and self-realisation in future job and fit to personal beliefs in future job, with significant gender effects of $d = 0.40$ and $d = 0.45$ respectively. There was no significant difference between Science and HumSoc students or between Science and HumSoc girls specifically, which contrasts with the observed differences in the importance of interest-enjoyment value and fit to personal beliefs value in choice of programme area.

**Discussion and Implications for Post-Compulsory Participation**

High scores on interest-enjoyment value, self-realisation value and fit to personal beliefs value show that most students want their programme area to be interesting, meaningful and self-realising. This finding is not surprising in the light of sociological theories on late modernity, which stress that young people search for activities that they find interesting and meaningful (Inglehart, 1997), and that they can identify with (Beck, 1999; Giddens, 1991). These three constructs were closely related (all inter-construct correlations
were greater than 0.5), and I understand them to be related to the importance of identity and identity development. Both subjective value and expectation of success have been shown to be influenced by identity (Eccles, 1994, 2009), which is especially important to young people who are in the midst of forging their identity and who view interests, activities, world views, subject choices and job plans as part of who they are (Beck, 1999; Frønes, 1995; Goffman, 1959). Science educators have argued that to appreciate science, students need to make science part of their identity (Aikenhead, 2006; Kozoll & Osborne, 2004).

Even if Science students scored somewhat lower than HumSoc students on interest-enjoyment value and fit to personal beliefs value, the findings suggest that these were important issues to students who chose science. The finding also indicates that many Science students expect their programme area to be interesting and personally meaningful. The challenge is, therefore, to meet these expectations. Cleaves (2005) previously reported that some students experience disappointment with school science, and do not continue. Moreover, science interest has been shown to decrease throughout schooling, for girls in particular (Osborne et al., 2003). Popular characteristics of school science as having transmissive pedagogy, decontextualised content and being unnecessarily difficult (Lyons, 2006) suggest that some of the most enthusiastic students may not find the meaningful and important topics they expect in the Science programme area.

The results show clearly that utility value for university admission was very important for many Science students. These findings are in line with several studies that have found that instrumental reasons are important in the selection of upper secondary science and mathematics (Angell, Guttersrud, Henriksen, & Isnes, 2004; Hutchinson, Stagg, & Bentley, 2009; Lie, Angell, & Rohatgi, 2010; Lyons, 2006; Osborne & Collins, 2001). Among such instrumental reasons is the desire to keep as many options as possible open. In their study of Year 13 students in New Zealand, Hipkins and Bolstad (2006) found that many students stayed in science to keep their options open. This also appears to be an important motivation for Norwegian students, and can be seen as a sign that young people want to ensure that every path to a happy, fulfilled and self-realised life is available. In Beck’s (1999; 2002) individualised risk society, young people have the opportunity to create their own identity, but also assume the responsibility for making the most of it. They face the risk of failing their identity project, and need to keep as many doors open as possible, until the right choice becomes clear.
The fact that many students appear to have chosen science for strategic reasons points to both challenges and opportunities for upper secondary science. Firstly, the subjects must fulfil the needs of students with very different motives for choosing science. Students who chose physics because of a passionate interest in the subject will require something quite different from the teacher than those who chose it for the credits, in spite of their interests. Secondly, lessons provide an everyday arena where schools and text books can show the most strategic students that STEM education and careers can be interesting and self-realising. Hipkins and Bolstad (2006) asked how the science curriculum can become more relevant to students’ concerns, and help them learn more about the wide range of science-related research and careers. Cleaves (2005) argued that lack of knowledge about possible science careers keeps students from choosing science. In the light of the findings presented here, these questions are also appropriate for Norwegian science educators.

Science girls scored higher than Science boys on the importance of utility value for university admission. Although the difference was not large, it suggests that Science girls chose programme areas more strategically than Science boys. Other studies have also found that girls choose science more strategically than boys: Miller and colleagues (2006) reported that young women often planned science majors mainly because they needed it to enter health professions such as medicine. In a UK study, Benneth and Hogarth (2009) found that among students who viewed chemistry positively, more young women than men did so for career reasons. In addition, in many countries, more women than men attend higher performing, academically oriented tracks and schools (OECD, 2007a). The fact that Science girls stood out from HumSoc girls with smaller scores on interest-enjoyment and fit to personal beliefs suggests that some Science girls placed more weight on the utility argument than on their interests and personal beliefs. When asked about their priorities in relation to a future job, however, there was no significant difference between Science and HumSoc girls on the importance of interests and fit to personal beliefs. Moreover, in both programme areas, girls scored higher on these constructs than boys. This finding indicates that Science girls are just as focused as HumSoc girls on finding interesting and meaningful jobs, but that some of them let the utility argument weigh more than interests and personal beliefs in their choice of programme area.

Girls tend to put more emphasis than boys on idealistic values, such as helping other people (Schreiner, Henriksen, Sjaastad, Jensen, & Løken, 2010; Schreiner & Sjøberg, 2007). Alarminglly, Eccles (2009) reported that placing a high value on helping other people is
predictive of not choosing careers related to physical science. A decontextualised, value-free notion of science will be especially alienating to girls (Osborne et al., 2009), and many girls may opt out of subjects if they do not offer extra credits or required qualifications, especially if the subjects do not appear personally meaningful to them. This may partly explain why the proportion of girls in Norwegian physics classrooms dropped from 40% in Year 12 to 30% in Year 13 (NDET, 2009b). Very few Norwegian universities have Year 13 physics as an entrance requirement.

The results clearly show that HumSoc students placed more importance than Science students on avoiding costs associated with difficult and demanding subjects. Given that these attributes typify physical science and mathematics (Angell et al., 2004; Carlone, 2003; Osborne & Collins, 2001; Tytler et al., 2008), this result is not surprising. It indicates, however, that some HumSoc students chose not to study science due to these costs. To persuade some of these students to choose science downplaying the difficulty or time needed to master these subjects is not necessarily the correct approach. The subjects’ reputation as being more difficult than most subjects is possibly rightfully earned. Therefore, rather than misleading students to choose a programme area they are not prepared for, recruitment initiatives should emphasise how interesting and meaningful topics can make the effort worthwhile. Subjects that appear both difficult, time consuming and uninteresting and irrelevant are poorly matched to late modern ideals such as self-fulfilment (Beck & Beck-Gernsheim, 2002) and meaningfulness (Frønes & Brusdal, 2001; Giddens, 1991).

Science subjects’ reputation as particularly difficult is also likely to affect students’ expectation of success in these subjects. This study found that girls placed somewhat more weight than boys on expectation of success in their choice of programme area. As girls have been found to have lower self-efficacy in science and mathematics than boys (Barnes, McInerney, & Marsh, 2005; Cavallo, Rozman, & Potter, 2004; Lloyd, Walsh, & Yailagh, 2005; Lyons, 2006; Preckel, Goetz, Pekrun, & Kleine, 2008; Simpkins, Davis-Kean, & Eccles, 2006), this finding indicates that increasing girls’ expectation of success may be a useful approach to make more girls to choose science.

Several studies have found that young people make up their minds about whether or not to study science at an early age (Tytler et al., 2008). Results from a recent Australian study, however, have challenged this claim with more than 80% of 15-year-olds stating that their experiences in the lower secondary years were most influential for their choice (Lyons
The results presented in this article indicate that many students have not made up their minds at age 16-17 years. However, identity and self-realisation are central in every choice modern young people make (Illeris, Katznelson, Simonsen, & Ulriksen, 2002), and students can only be persuaded to pursue STEM further if they are introduced to opportunities where their interests and identity can be met. To encourage more students to continue with STEM, the subjects in the Science programme area could present to them a wide range of further studies and careers. It may be fruitful to present careers in both pure and applied sciences. Sjaastad (2010) found that more Norwegian students in pure science than applied science higher education reported that their teacher had inspired and motivated them in their educational choice. It appears that school science is more able to advertise careers related directly to pure science subjects per se, than the wide range of applied science careers available.

This article has shown how the Eccles et al. expectancy-value model of achievement-related choices can be used in a retrospective approach to study young people’s educational choices. The model predicts a causal link between students’ expectation of success and subjective values and an achievement-related choice. To investigate such a causal relationship, a longitudinal design is required. For example, students’ expectations and values related to the Science programme area could be measured at a time prior to their decision making and whether these students chose science would be assessed at a later date. Such an approach was not feasible in the Lily study as the data were collected retrospectively after the choice in question had been made. By using respondents’ self-reports, the items measured the importance that the respondents placed on various factors when they made their choice of programme area. The six constructs interest-enjoyment value, self-realisation value, fit to personal beliefs value, utility value for university admission, expectation of success and relative cost form a valid instrument that can be used and developed further in future research. It is important to note that a factor solution is a product of the responses and may be unfit for another data set. The representativity of the sample was, therefore, needed for the factor analysis is to be generalised or used to generate theory. The large sample size (1,628) was another strength of the study, as the factor analysis procedure used assumes continuous data, and bias caused by non-normality or the categorical nature of data decreases with sample size (Finney & DiStefano, 2006).

---

4 Particle physics or biochemistry research are examples of what is here considered pure science, whereas engineering in construction or the oil industry are examples of applied science.
The constructs are not identical to the concepts in the Eccles et al. model. "That I would be able to develop myself", "That I would be able to use my talents and abilities", "That I would be challenged" and "That I would be able to work creatively" formed the construct self-realisation value. In a sense, these four items tap into attainment value in the Eccles et al. model because they can be understood as part of identity development. However, they concern development towards a future self more than confirmation of a current identity. The two latter items address the importance of reaching cognitive goals such as creativity and overcoming challenges. Eccles and Wigfield (2002) placed this in attainment value, and I suggest it can also be seen as part of self-realisation and identity development. As the fit to personal beliefs value can be seen as measuring the importance of the subjects’ fit to central parts of one’s identity (Giddens, 1991; Goffman, 1959) both self-realisation value and fit to personal beliefs value may be understood in the light of attainment value in the Eccles et al. model. The expectation of success construct had an alpha of .64. Although this is weak for a construct, the construct consisted of only two items, and alpha increases with the number of items. Moreover, as the inter-item correlation was .47 and the meaning of the items is easily interpretable, I used it as a construct. However, the construct only concerned outcome expectations in terms of marks, not a broader sense of self-concept or feeling of mastery. Eccles and Wigfield (2002) reported that young people cannot distinguish between their general abilities and outcome expectations on specific tasks. It is, therefore, likely that the respondents’ expectations of marks reflect their self-concepts in the subjects they chose. However, it may have been preferable to include more items concerning expectation of success in this study. One possibility would have been to include students’ own experiences of success or efficacy. For example, "That I felt confident about my abilities in the subjects” and "That I felt I would master the subject matter”. The inclusion of such experiences may have improved the construct, and future research would benefit from adding them. In the light of the terminology in the Eccles et al. model, it is also important to note that the items in the utility for university admission construct only ask about the programme area’s utility for admission to universities. The question could have asked about the importance of a broader utility or outcome expectations (Hazari et al., 2010), such as the possibility for high salaries or a secure job. The focus on the utility for university admission is based on the suspicion that the choice of upper secondary science and mathematics is often motivated by the credits and formal qualifications students are awarded in many educational systems.
The fact that self-realisation value and fit to personal beliefs value emerged instead of attainment value is partly due to the questions that were asked. The questionnaire included items about the importance of choosing subjects that are self-developing and personally important and meaningful because these appear to be central determinants in young people’s science-related choices. Science education research has indicated that many students view school science as irrelevant to them personally (Sjøberg, 2003; Tytler et al., 2008) and that more attention should be given to the role that identity development plays in young people’s orientations to school science (Aikenhead, 2006; Osborne et al., 2009; Schreiner, 2006). Including such items in the Lily study enabled the investigation of an interesting trait in modern youth culture, namely that young people constantly contemplate how well educational choices can serve their self-realisation (Illeris et al., 2002).

I selected the Eccles et al. model partly because it is comprehensive and inclusive. The comprehensive and inclusive nature of the model also illustrates the undoubtedly complex process involved in making educational choices. A science-related choice can take many potential pathways (Cleaves, 2005), include both unconscious and conscious decision making (OECD, 2008), and not least be made over time (Vaughan, 2005). Consequently, there are many possible approaches to studying these choices, and no single study can provide a comprehensive picture. Instead of the 25 items used in this article, the questionnaire could have listed 200 or 15 entirely different items. Other theoretical perspectives could also have been applied when developing the questionnaire that may have led to other interpretations and implications. For example, questions developed solely under the guidance of Bandura’s self-efficacy framework would be quite different: Fewer items would ask about the importance of subjective value and development, and more items would ask about self-efficacy-beliefs.

To broaden our understanding of the science choices of Norwegian upper secondary students, it would be valuable to investigate the choice process more qualitatively through, for example, in-depth interviews. A qualitative approach could, for example, yield insight into how concepts such as interest-enjoyment value are evaluated by students deciding whether to continue with science. It could also identify some of the complex pathways educational choices may follow. Longitudinal studies, both quantitative and qualitative, could help investigate how choices about participation in science develop over time.
Conclusions

This study assessed Norwegian Year 12 students’ choices of Science or HumSoc as their upper secondary programme area. Six constructs based on the Eccles et al. model of achievement-related choices were created that measured the importance of interest-enjoyment value, self-realisation value, fit to personal beliefs value, utility value for university admission, expectation of success and relative cost for the students’ choices. Scores on these constructs indicated that most students, in both Science and HumSoc, want their programme area to be interesting, meaningful and self-realising. This finding is not surprising in late modern societies where young people search for interesting and meaningful activities that fit their identities. It is important that the Science subjects enthuse students and meet their expectations in terms of exciting and meaningful subject matter.

Science students also had high scores on the importance of utility value for university admission, suggesting that many students chose science for strategic reasons. In particular, utility value was somewhat more important to Science girls than to Science boys. At the same time, Science girls scored lower than girls in HumSoc on the importance of interest-enjoyment and fit to personal beliefs. It appears that some girls chose Science not only strategically, but also in spite of their interests. It may be particularly challenging to keep such students engaged and motivated in the classroom. However, the subjects in the Science programme area have the opportunity to give them more than instrumental reasons to continue by introducing them to interesting and self-realising subject matter and career opportunities.

Very few Science students stated that it was important to avoid costs in time and effort, but this was much more important to HumSoc students. This reflects the general view that science and mathematics subjects are more difficult and time consuming than most other subjects, and implies that some students selected HumSoc to avoid difficult and demanding subject matter.
References


Atkinson, W. (2008). Not all that was solid has melted into air (or liquid): A critique of Bauman on individualization and class in liquid modernity. The Sociological Review, 56(1), 1-17.


SPSS. (2009). SPSS (Version 17.0). Chicago, IL: IBM.


