”I need advanced mathematics to pursue the career of my choice”

Norwegian students’ motivations for enrolling in mathematics and plans for post-secondary studies

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Participation in advanced science and mathematics courses in upper secondary school is a gateway to tertiary education and career opportunities in the STEM fields (Science, Technology, Engineering, and Mathematics). The purpose of this study is to investigate Norwegian final-year upper secondary school students’ motivations for choosing to enroll in the most advanced mathematics course offered (3MX), as well as to ascertain their plans for post-secondary education. Since females are underrepresented in mathematics and mathematics-related fields of study, special attention is paid to the gender perspective. The analyses are based on questionnaire data from the large-scale international achievement study TIMSS Advanced, and are framed by the expectancy-value model developed by Eccles and her colleagues (1985). Results show that the subject’s utility value was the primary reason for students’ enrollment in mathematics; that interest in mathematics as a school subject is somewhat more important to the girls than to the boys; and that there are some gender differences in students’ plans for post-secondary studies in the STEM fields.

In industrialized countries such as Norway, scientific and technological knowledge provides much of the basis for industry, value creation, and progress in public health and welfare. Projections from Statistics Norway indicate that the labor market’s demand for candidates with a higher education in the STEM fields (Science, Technology, Engineering and Mathematics) is likely to increase in the coming years (Bjørnstad, Fredriksen, Gjelsvik & Stølen, 2008). At the same time, the proportion of the Norwegian work force with a scientific or technological background is expected to decrease due to a combination of (1) too low recruitment for higher education and research in the STEM fields and (2) high average age among existing engineers (KD, 2010). The problem of low recruitment to STEM, in the face of increasing societal needs for such graduates, is a

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problem for a number of other countries as well; nevertheless, the focus of this article will be the situation in Norway.

Participation in advanced science and mathematics courses in upper secondary school is a gateway to tertiary education and career opportunities in the STEM fields. Hence, increasing the participation in upper secondary school mathematics and science is one approach to improve the recruitment to tertiary education in STEM. In the Norwegian context, research on this topic includes studies that have examined the effect of out-of-school mathematics projects on upper secondary school students' STEM motivation (Jensen & Sjaastad, 2013), and analyzed students' reasons for choosing (or not choosing) science-related subjects in upper secondary school (Bøe, 2012). The present study aims to contribute to the latter by examining Norwegian upper secondary school students' motivations for enrolling in advanced mathematics courses and their aspirations for post-secondary education. As research has shown that females are consistently underrepresented in mathematics and mathematics-related studies and careers, special attention is paid to the gender perspective throughout this article.

Motivation and mathematics enrollment

Motivation can be defined as "the process whereby goal-directed activity is instigated and sustained" (Pintrich & Schunk, 2002, p.5); hence, motivational theories concern what it is that moves people to act and why people think and behave as they do (Weiner, 1992). Current theory and research on motivation to a large extent focuses on students' beliefs, values, and goals as primary influences of motivation (Eccles & Wigfield, 2002; Wigfield, Eccles, Roeser & Schiefele, 2008); and central constructs include self-efficacy (e.g. Bandura, 1997), interest (e.g. Hidi & Renninger, 2006), intrinsic/extrinsic motivation and self-determination (e.g. Deci & Ryan, 1985; Ryan & Deci, 2000), task value (e.g. Eccles & Wigfield, 1995), and goal orientation (e.g. Ames, 1992).

Numerous studies have employed motivation constructs that refer to students' beliefs in their own ability and competence (e.g. self-efficacy, competence beliefs, and perceptions of ability) (Bandura, 1997; Deci & Ryan, 1985; Wigfield & Eccles, 2000). While there are conceptual differences among these constructs, they all refer to students' confidence in their own relevant abilities, and research has shown that students' competence beliefs relate strongly to their performance on different tasks or activities, as well as to academic choices such as course enrollment and career aspirations[1]. There is also very strong research evidence demonstrating that females have lower competence beliefs than males in mathematics[2], and there is some evidence that this difference holds even after all relevant skill-level differences are controlled for (Hannula et al., 2005; Wigfield, Battle, Keller & Eccles, 2002).

With respect to students' participation in mathematics, the most prominent current motivational theory is the expectancy-value theory of Eccles and colleagues (Eccles (Parsons) et al., 1983; Eccles, 1985, 2005). Expectancy-value theory was developed specifically to predict gender differences in mathematical achievement and enrollment choices, and it links educational choices to two sets of beliefs: (1) the student's expectations for success, and (2) the importance or value the student attaches to the different available options (Eccles, 1985, 2005; Updegraff, Eccles, Barber & O'Brien, 1996; Watt, Eccles & Durik, 2006). Expectations of success is defined as students' "beliefs about how well they will do on upcoming tasks" (Eccles & Wigfield, 2002, p. 119) and depend on the student's confidence in his or her intellectual abilities, as well as on the student's estimation of the difficulty of the courses in question (Eccles, 2005). The value of a course has four components (Eccles, 1985, 2005; Wigfield et al., 2002): intrinsic value, utility value, attainment value, and cost. *Intrinsic value* (also referred to as interest-enjoyment value) is related to the enjoyment the student experiences when participating in an activity or a course, while *utility value* relates to how a given course will be useful to the student, for instance with respect to his or her career goals. These constructs can be seen in relation to those of Self-Determination Theory, where intrinsic motivation refers to doing something because it is inherently interesting and/or enjoyable, while extrinsic motivation causes individuals to engage in activities or tasks to obtain a separate outcome (Ryan & Deci, 2000). Thus, intrinsic value captures aspects of intrinsic motivation, while utility value appears similar to extrinsic motivation. Finally, *attainment value* is linked to how participating in the course relates to the student's identity or self, while *cost* is conceptualized in terms of what the student has to sacrifice doing to participate in the course as well as the negative experiences (for instance performance anxiety and fear of failure) that may be associated with that choice (Eccles, 2005).

Research conducted by Eccles and her colleagues suggests that while both expectancies and values predict career choices, the value beliefs are stronger predictors of enrollment decisions in mathematics than expectancy beliefs (Eccles & Wigfield, 2002). In a study investigating the reasons underlying Norwegian upper secondary school students' choices of post-compulsory subject combinations (natural science, mathematics, languages, social science or economics), Bøe (2012) found similar results, in that value beliefs (particularly intrinsic value) were more influential factors for students' enrollment decisions than expectation of success. Other researchers have found that this may vary among countries; for instance, ability/success expectancy have been found to be a key predictor of mathematics participation in North American schools, while value beliefs (again, particularly intrinsic value) appears to be most important in Australian schools (Watt et al., 2012).

With respect to gender differences, the evidence for beliefs associated with the value students attach to different tasks or activities is less consistent than for the competence beliefs. Some studies find no significant gender differences in students' valuing of mathematics (e.g. Wang, 2012; Wigfield et al., 1997; Wolters & Pintrich, 1998), while other studies indicate that males report higher intrinsic value (e.g. Frenzel, Goetz, Pekrun & Watt, 2010; Nagy et al., 2006; Watt, 2006) and attainment, intrinsic and utility value (Feather, 1988) than females. When studying course enrollment in mathematics, Eccles and her colleagues have found some evidence that the gender differences in students' choices are primarily mediated by gender differences in the value that students' attach to mathematics, in that girls have been found to view mathematics as less important, less useful, and less enjoyable than the boys (Eccles, 1994).

The current study

The purpose of the present study is to investigate Norwegian final-year upper secondary school students' motivations for choosing to enroll in the most advanced mathematics course offered (3MX), as well as their plans for post-secondary education. Thus, the results of this study may complement those of Bøe (2012), who analyzed Norwegian students' reasons for choosing (or not choosing) science-related subjects in upper secondary school.

As indicated by the literature review above, much research has been conducted on different aspects of students' motivations for enrollment choices and career plans, particularly in the context of STEM. Nevertheless, it appears that the results regarding the relative importance of constructs such as ability/success expectancy and value beliefs are somewhat inconclusive, perhaps because this may vary among countries. Acknowledging this, the present study aims to address the following research questions: *How much importance do Norwegian students attribute to their expectations of success and to the perceived value of mathematics when deciding whether to enroll in advanced mathematics courses?* and *Which value beliefs are the strongest predictors of course enrollment for this group of students?* The expectancy-value theory of Eccles et al. is chosen to frame the analyses, as this theory is based on empirical evidence and provides a comprehensive description of the expectations and values of individuals concerning their choices about participating in activities[3].

Students' expectations of success and their valuing of mathematics may in turn be influenced by the attitudes of social agents, such as their parents, teachers, and peers (Eccles, 1994). Furthermore, students' achievement levels have been shown to strongly affect their participation in advanced mathematics (Ma, 2001). With this in mind, the study includes the research questions: *What is the influence of the social milieu on students' enrollment decisions?* and *What characterizes the relation between students' different reasons for choosing mathematics and their mathematical performance level?*

As studying mathematics is a gateway to tertiary education and career opportunities in the STEM fields, these students' plans for post-secondary education are also investigated. Thus, the study also addresses the research questions: *To what extent are the 3MX students planning to pursue post-secondary studies in the STEM fields?* and *How do students' motivations for enrolling in mathematics and their mathematical achievement interact with their intentions to participate in STEM/non-STEM post-secondary studies?*

Finally, as research has shown that females are underrepresented in tertiary education and careers in the STEM fields in most industrialized countries around the world (Blickenstaff, 2005), the current study considers differences between male and female students in all analyses. With respect to studies of males' and females' beliefs and motivations, sex and gender are terms that are often—and inaccurately—being used interchangeably. To clarify the terminology, *sex* refers to biological differences whereas *gender* refers to sociological aspects and comprises a persons' identification with "feminine" or "masculine" values and the social and cultural influences of the gender role that influence attitudes, behavior, cognition, and choices (Darnall & Suarez, 2009; Wedege, 2007). Differences in males' and females' reasons for choosing mathematics and plans for post-secondary education are in this study assumed to relate to culture dependent traits attributed by society to men and women; hence, I consider this to be *gender* differences.

Methods

In 2008, Norway participated in the large-scale international achievement study TIMSS Advanced. This survey assessed the mathematics and physics achievement of final-year upper secondary school students enrolled in advanced mathematics and/or physics courses, and collected a wealth of data about school contexts, instructional factors, and student backgrounds and attitudes through school-, teacher-, and student questionnaires. The present study is based on the Norwegian data from the mathematics component of TIMSS Advanced.

The Norwegian students who participated in the TIMSS Advanced mathematics survey were enrolled in the 3MX course, which at the time was the most advanced mathematics course offered at upper secondary school[4]. TIMSS Advanced employed a two-stage cluster sampling design, where schools were sampled in the first stage and whole classes of students were subsequently sampled within the participating schools. The vast majority of the selected schools (89 %) participated in this study. Table 1 summarizes key features of this sample.

Table 1. *Description of sample*

Number of schools in sample	Number of students in sample	Average age of students in sample	Proportion of the entire age cohort enrolled in 3MX	Gender distribution in 3MX (Girls/Boys)
107	1932	18.8	11 %	38 % / 62 %

As indicated, about 11 % of the entire age cohort was enrolled in the final-year mathematics course 3MX, and the majority of these students (62 %) were male.

The TIMSS Advanced mathematics student questionnaire was comprised of 30 questions (counting A and B parts as separate questions). The present study is based on three of these questions relating to students' sex, motivation for studying advanced mathematics, and plans for post-secondary education, as well as on students' performance on the advanced mathematics achievement test.

Constructing measures

A set of constructs was formed by factor analysis of the question "Why are you studying advanced mathematics? Please indicate how important each reason was for you", which listed 13 statements to which the respondents gave their answers on a scale from "Very important" (coded with the value 4) to "Very unimportant" (coded with the value 1). Although the expectancy-value theory has been chosen to frame the analyses in this article, it should be noted that the TIMSS Advanced questionnaire has not been developed on this theoretical basis. Rather, the present study is an example of *secondary analysis* (analysis of data and documents by researchers who may be external to the project, for purposes that may not have been envisaged by those responsible for the data collection [Olsen, 2007]), and the theoretical basis was therefore deemed insufficient to pre-define measures (Fabrigar, Wegener, MacCallum & Strahan, 1999). Thus, the factor analysis was exploratory rather than confirmatory.

Principal axis factoring was chosen to extract factors, as this method does not assume normally distributed data (Costello & Osbourne, 2005; Fabrigar et al., 1999). Factors with eigenvalues greater than 1 were retained, and inspection of the scree plot supported this decision. Direct Oblimin rotation was used to simplify and clarify the data structure, as this method allows the factors to be correlated (Costello & Osbourne, 2005; Fabrigar et al., 1999). One item (”I enjoy solving mathematical problems”) was excluded due to unclear loading pattern. The analysis suggested four factors, which were deemed to represent theoretically meaningful constructs and tested for internal consistency using Cronbach’s alpha (see table 2).

Table 2. *Constructs resulting from the factor analysis*

Construct	Questionnaire items	α
Expectation of success	I usually do well in mathematics. I expect that I will easily pass the tests. Studying or doing mathematics homework does not take me a lot of time.	0.62
Interest in mathematics as a school subject	Advanced mathematics lessons are interesting. Advanced mathematics has good teachers. I like the way advanced mathematics is taught in my school.	0.72
Utility value for future studies	I need advanced mathematics to pursue the career of my choice. Studying advanced mathematics will give me more options after finishing upper secondary school.	0.66
Influence of social agents	My parents advised me to study advanced mathematics. A teacher advised me to study advanced mathematics. The study coordinator at my school advised me to study advanced mathematics. My friends also are studying advanced mathematics.	0.61

Note. The question was ”Why are you studying advanced mathematics? Please indicate how important each reason was for you”. The scale ranged from *Very important* (4) to *Very unimportant* (1).

As shown in table 2, the factors identified by the factor analysis formed four constructs: Students’ perceptions of own ability and expectations of performing well on the course (without doing too much work) constituted the construct *Expectation of success*, which relates to students’ confidence in their mathematical abilities. Students’ perceptions of mathematics as useful for post-secondary education and career opportunities constituted the construct *Utility value for further studies*, while students' valuing of advice from parents, teachers, and study coordinators, as well as influence from their peers, formed the construct *Influence of social agents*. Hence, these constructs correspond reasonably well to main components of the Eccles et al. model of expectancy-value theory.

The remaining construct comprises students' view of mathematics lessons as interesting and their valuing of how mathematics is taught (including their appreciation of mathematics teachers). According to Hoffmann (2002), interest in a school subject can be seen as a combination of interest in the topics themselves and interest produced by enjoyment of the instruction and the social climate in class. Thus, this construct is here named *Interest in mathematics as a school subject*. It should be noted that the concept of interest is conceptually very close to that of enjoyment, as interest-driven actions are characterized by the enjoyment experienced while engaging in them (Freznel et al., 2010). Hence, *Interest in mathematics as a school subject* has some relation to intrinsic value.

A Chronbach's alpha value of 0.7 is usually considered to be an appropriate lower boundary for the internal consistency of attitudinal measures. The alpha values in table 2 are, with one exception, somewhat lower than this generally accepted cutoff value. However, when a construct has other desirable properties, such as meaningful content coverage, a low reliability coefficient may not be a major obstacle to its use (Schmitt, 1996). As argued above, the constructs in table 2 represent main components of the expectancy-value theory of motivation. Therefore, they will be used in spite of their somewhat low values of Chronbach's alpha.

Calculating student achievement

TIMSS Advanced constructs scales for measuring students' mathematical achievement by using Item Response Theory (IRT). Central to this approach is using a plausible value or multiple imputation methodology to obtain proficiency scores in mathematics for all the participating students. The plausible values are predictions based on limited information (because individual students' achievement is measured with only a subset of the total item pool developed for this study), and will therefore contain a substantial amount of measurement error. In order to minimize these errors, the TIMSS Advanced database provides five separate plausible values that should all be used in analyses of student achievement (Rønning, 2010; von Davier, Gonzalez & Mislevy, 2009). In this article, analyses including measures of student achievement are, therefore, based on all five plausible values.

Results

Table 3 summarizes the mean scores, standard deviations, and effect sizes of differences in mean scores (Cohen's *d*[5]) between girls and boys for the constructs in table 2 and for student's mathematics achievement. Value constructs are measured on a scale from 1 (Very unimportant) to 4 (Very important), while achievement is measured on a scale where the international scale average is set to 500, with a standard deviation of 100.

Table 3. *Descriptive statistics and effect sizes (Cohen's d) for differences in gender*

	Mean	Standard-deviation	Girls – Boys (*d*)
Expectation of success	2.49	0.59	0.05
Interest in mathematics as a school subject	2.63	0.68	0.22*
Utility value for future studies	3.46	0.66	-0.05
Influence of social agents	1.98	0.58	-0.05
Mathematical achievement	439	80.9	-0.10

Note. Coefficients marked with an asterisk (*) are significant at the 0.01 level. This rather conservative criterion is chosen due to the cluster sampling of classes, which means that the observed standard error is lower than what would be the case if individual students were randomly sampled.

The mean scores presented in table 3 show that to a large extent, students stated that the subject's *utility value for future studies* was important for their choice of mathematics. Furthermore, to some extent they agreed that *interest in mathematics as a school subject* played a role in this choice; while *expectation of success* was neither especially important nor unimportant (the neutral midpoint of the scale is 2.50). Finally, students mostly agreed that *influence of social agents* was not an important factor in their choice of mathematics.

With respect to gender, table 3 shows that *interest in mathematics as a school subject* was somewhat more important to girls than to boys. There were, however, no significant gender difference in these students' mathematical achievement, nor were there significant differences in the importance boys and girls attribute to the factors *expectation of success*, *utility value* and *influence of social agents*.

According to the Eccles et al. model, the constructs (e.g. expectancies, values, and social factors) are expected to be correlated (Eccles & Wigfield, 2002). Table 4 shows the correlation (Pearson's *r*) between the factors listed in table 3 and includes gender differences in these correlation coefficients.

Table 4. *Correlations between factors (The numbers in parentheses indicate correlation coefficients for the girls/boys in the sample.)*

	Expectation of success	Interest	Utility	Influence	Achievement
Expectation of success	1	0.33* (0.27*/0.36*)	0.08* (0.05/0.10*)	0.10* (0.15*/0.08*)	0.28* (0.26*/0.29*)
Interest		1	0.12* (0.10*/0.14*)	0.18* (0.18*/0.18*)	0.08* (0.07/0.09*)
Utility			1	0.12* (0.17*/0.09*)	0.11* (0.11*/0.11*)
Influence				1	-0.16* (-0.07/-0.21*)
Achievement					1

Note. Correlation coefficients have been calculated for all five plausible values, and the results have been averaged accordingly. Coefficients marked with an asterisk (*) are significant at the 0.01-level for all the plausible values.

As table 4 shows, the strongest correlation is that between expectation of success and interest in mathematics as a school subject, a relation that seems to be stronger for the boys than for the girls. This correlation is positive, which indicates that students who stated that expectation of success was instrumental for their choice of mathematics also (to some extent) agreed that interest in mathematics as a school subject played a role in this choice. There is also a moderate positive correlation between students' expectation of success and their achievement (with no gender difference). The remaining correlation coefficients are all below 0.20, indicating only a weak relation between these factors. It may, however,

Table 5. *Students' intentions for post-secondary education*

		Proportion of students		Proportion of girls		Proportion of boys	
STEM	Science	9 %	65 %	9 %	61 %	8 %	66 %
	Health sciences	17 %		30 %		9 %	
	Engineering	33 %		20 %		41 %	
	Computer and inform. sciences	5 %		1 %		7 %	
	Mathematics	1 %		1 %		1 %	
Non-STEM	Business	14 %	36 %	13 %	39 %	15 %	34 %
	Social sciences	9 %		11 %		7 %	
	Other field of study	13 %		14 %		12 %	

be worth noting that there is a negative correlation between student achievement and the extent to which influence of other people was important for their choice of mathematics, and that this relation was stronger for the boys than for the girls.

Students were also asked whether they were planning a post-secondary education (99.5 % did) and to indicate their intended area of study from a list of eight broad categories. These categories can be roughly grouped into STEM (science, technology, engineering, and mathematics) fields and non-STEM fields. Table 5 shows how the students were distributed over the proposed areas of study.

The majority of the 3MX students (65 %) were planning to enroll in post-secondary studies within the STEM fields, with the most popular areas being health sciences and engineering. Looking at the STEM fields as a whole, there were no substantial gender differences in students' plans for participation (61 % of the girls and 66 % of the boys intended to study in STEM-related areas). There were, however, marked gender differences in students' plans for participating in the areas of health sciences (30 % of the girls and 9 % of the boys) and engineering (20 % of the girls and 41 % of the boys).

Table 6. *Students' motivations for enrolling in mathematics and their mathematical achievement. Effect sizes for differences in intended area of study (STEM/non-STEM)*

	STEM – Non-STEM (*d*)
Expectation of success	0.29*
Interest in mathematics as a school subject	0.25*
Utility value for future studies	0.75*
Influence of social agents	-0.05
Mathematical achievement	0.50*

Note. Coefficients marked with an asterisk (*) are significant at the 0.01 level.

Table 6 indicates how students' motivations for enrolling in mathematics and their mathematical achievement interact with their intentions to participate in STEM/non-STEM post-secondary studies. We observe that students who plan further studies in the STEM fields place a greater importance on the utility value of mathematics, on their expectation of success, and on their interest in mathematics as a school subject than students planning to go into non-STEM fields. Students intending to study in STEM areas also have a higher mathematical achievement than students wishing to participate in other fields of study.

Discussion

The results clearly show that the subject's utility value for future studies was very important for many of the mathematics students; this was especially the case for students planning to pursue post-secondary studies in STEM fields. These findings are consistent with the results of other studies, where the usefulness of mathematics and science for students' future goals has been shown to be important for their enrollment choices (e.g. Bøe, 2012; Crombie et al., 2005; Ramberg, 2006).

As previously noted, utility value is related to the extrinsic aspects of motivation. In the classic literature, extrinsic motivation has a rather low status compared to intrinsic motivation, as intrinsically motivated students have been shown to exhibit more pedagogically desirable behaviors such as greater engagement and task persistence, elaborative processing and monitoring of comprehension, and greater creativity and risk taking (Middleton & Spanias, 1999; Ryan & Deci, 2000). From this perspective, the high degree of importance students ascribed to the utility value of mathematics may seem like a cause for concern. However, extrinsic motivation may be viewed as a multi-faceted concept, which can vary greatly in terms of student autonomy or self-determination. For example, a student who participates in mathematics because of parental pressure and a student who participates because she thinks mathematics is valuable for her chosen career are both extrinsically motivated. But while the former case merely involves satisfying an external demand, the latter case entails an active personal commitment to mathematics participation and, thus, a greater degree of student autonomy (Ryan & Deci, 2000). The more autonomous type of extrinsic motivation has been shown to relate to better task persistence, greater engagement, and higher performance (Ryan & Deci, 2000) and, thus, shares many qualities with intrinsic motivation. As indicated in table 4, the correlation between utility value and mathematical achievement was on the same level as the correlation between interest value and achievement. Hence, autonomous types of extrinsic motivations, such as the usefulness or utility value of mathematics and science for students' future goals, do not necessarily deserve a lower status than intrinsic motivation.

Students also reported that their interest in mathematics as a school subject was rather important for their choice to enroll in advanced mathematics, and this factor was somewhat more important to the girls than to the boys. Similar gender differences have been found in other studies (e.g. Watt et al, 2006). This does not, however, mean that girls are more interested in mathematics than boys; on the contrary, research has shown that boys tend to report a higher intrinsic value of mathematics than girls do (e.g. Feather, 1988; Nagy et al., 2006; Watt, 2006). Hence, efforts to heighten the interest in mathematics as a school subject among adolescents in general, and girls in particular, should have considerable potential for promoting girls' participation in mathematics.

Research conducted by Eccles and her colleagues suggests that expectations of success are weaker predictors of mathematics participation than the value beliefs (Eccles & Wigfield, 2002), while Watt and her colleagues have found that the relative importance of expectancy beliefs and value beliefs may vary across educational systems (Watt et at., 2012). In the case of Norwegian upper secondary school students' enrollment decisions, Bøe (2012) found results similar to Eccles and Wigfield, in that value beliefs were more influential factors than expectation of success. The results of the present study support the findings listed in Bøe (2012) and Eccles and Wigfield (2002), as Norwegian 3MX students ranked expectation of success as less important for their choice of mathematics than utility value and interest value.

With respect to expectancy beliefs, it should be noted that this may exert an indirect influence on students' choices. For instance, Watt and her colleagues showed that in the case of Australian students, expectancy beliefs influenced their intrinsic valuing of a course, which in turn was the strongest predictor of enrollment decisions (Watt, 2012). The results of the present study show that the importance Norwegian students ascribed to expectation of success was positively correlated with the importance they ascribed to interest in mathematics as a subject, which was an important factor for their enrollment choices. In the research literature, one may find some evidence that although the relationship between students' mathematical self-concept and their interest (intrinsic) valuing of the subject is reciprocal, the effect of self-concept on interest/intrinsic value is stronger than vice versa (Marsh et al., 2005). In this respect, efforts to heighten students' confidence in their mathematical abilities – and thus their expectations of succeeding – will have a potential for enhancing their interest in, as well as their participation in, mathematics. This may be especially important for the girls, as numerous studies have shown that girls have lower competence beliefs in mathematics than boys (Jacobs & Eccles, 1992; Nagy et al., 2006; Perez-Felkner et al., 2012; Simpkins et al., 2006; Watt, 2006), even after relevant skill-level differences are controlled for (Wigfield et al., 2002).

As indicated in table 3, most of the Norwegian 3MX students reported that the influence of others (parents, teachers, peers, study advisors) was unimportant for their choice to enroll in advanced mathematics. This is in line with previous research indicating that Norwegian STEM students' educational choices appears to be made based primarily on personal interests and individual qualities (Schreiner et al., 2010). In contrast, Sjaastad (2012) found that interpersonal relationships are also key factors in order to inspire and motivate choices of STEM education, and thus, suggests that initiatives to increase recruitment to STEM may be aimed at teachers, parents, and other persons in interpersonal relationships with young people (Sjaastad, 2012). The research base on the influence of socializers (e.g. parents, teachers, peers, study advisors) on Norwegian students' enrollment decisions is thus somewhat inconclusive, and more research on the ways in which significant persons may inspire students to choose STEM would be welcome.

One reason for investigating students' motivations for enrolling in mathematics courses in upper secondary school is the expressed need to increase recruitment to studies and careers in science, technology, engineering, and mathematics (STEM) at the college and university levels (KD, 2010). After all, participating in advanced mathematics courses such as 3MX is a gateway to tertiary education and career opportunities in mathematics and the natural sciences. Almost two-thirds of the participants in the present study intended to pursue post-secondary studies within the STEM fields, which incidentally means that more than one-third of these specialized students opted away from STEM. Not surprisingly, students planning further studies in the STEM fields place a greater importance on the utility value of mathematics. Furthermore, future STEM students have higher mathematical achievement and ascribe more importance to their expectations for success in mathematics and their interest in mathematics as a school subject than students planning to go into non-STEM fields. This is in line with earlier research summarized in Eccles and Wigfield (2002), which indicated that both expectancies and values predict career choices. Hence, efforts to heighten adolescents' actual and perceived mathematical competence, as well as their interest in mathematics, may serve to promote students' participation in STEM at the college and university level.

Women are underrepresented in tertiary education and careers in the STEM fields in most industrialized countries around the world (Blickenstaff, 2005). Looking at the STEM fields as a whole, the present study found no substantial gender differences in the 3MX students' plans for post-secondary studies (table 5). It is, however, important to be aware of the gender distortion in upper secondary school mathematics participation. Only 38 % of the 3MX students were female, which may imply that many girls have opted away from science, technology, and mathematics at an earlier stage. Furthermore, large gender differences appear in the specific STEM subjects listed in table 5. Notably, the girls opt away from engineering and computer science in favor of health sciences. These results add to a long list of research that has revealed that females are underrepresented in physics, engineering, and technology subjects, and overrepresented in life and health sciences (e.g. Charles & Bradley, 2002; Dobson, 2007; EU, 2009; NIFU STEP, 2008; UNESCO, 2012). It is hard to explain this difference by referring to the variables included in the present study—for one thing, I found no gender differences in favor of the boys for any of the constructs *expectation of success*, *interest in mathematics as a school subject*, *utility value for further studies*, or *influence of social agents* (table 3). Therefore, it appears reasonable to look for other explanatory factors.

According to Eccles and her colleagues (2007), socialization processes linked to gender roles are likely to induce gender differences in the characteristics and values most closely linked to students' core identities. Hence, gender role socialization is likely to influence students' short- and long-term goals, and some prior research indicates that young females are more likely to aspire to health-related careers primarily because they place higher value on helping others or contributing to society than the young males. Interestingly, researchers have also found some evidence that young people who opt for careers in physical science or engineering place unusually low value on having a job that directly relates to helping others or contributing to society (Eccles, 2007). Acknowledging such differences in values linked to students' core identities, Bøe and her colleagues (2011) claimed that the attainment value (how participating in the course relates to the student's identity or self) in the Eccles et al. model is an especially important factor when considering the impact gender has on students' decisions about participation in STEM subjects. One may thus hypothesize that including a measure of attainment value in the present study could possibly have contributed to explaining the gender differences in table 5. The omission of this variable could be seen as a weakness of this study.

Another limitation of the present investigation is the population the participating students were drawn from. As participants belonged to the group of final-year upper secondary school students who had chosen to enroll in the most advanced mathematics course offered, the study cannot shed any light on the motivations of the large group of students who have opted away from mathematics at an earlier stage. Do they, for instance, not see mathematics as useful for future studies or career opportunities? Or do they perhaps recognize mathematics as useful and important, but have a low confidence in their mathematical abilities? Such questions would better be addressed by including the entire age cohort in a study, which has been done in several cycles of TIMSS and PISA (Programme for International Student Assessment). The results of these studies indicate that prior to making any enrollment decisions, Norwegian students value the instrumental aspects (the utility) of mathematics, but that to a lesser degree, they find the subject interesting or enjoyable. Furthermore, boys value the utility of mathematics more than girls, and they also report a higher confidence in their mathematical abilities than girls (Grønmo & Onstad, 2009; Kjærnsli et al., 2004). The previous cycles of TIMSS and PISA were, however, not suited for investigating how these motivational constructs influence Norwegian students' decisions to participate in elective mathematics courses, as these studies have not included information about students' enrollment decisions. The publication of the results from the most recent cycle of PISA (due December, 2013) may however offer some insights into this question, as PISA 2012 included questions related to students long-term intentions (e.g. "I would like to work in a career involving mathematics") as well as an educational career interest questionnaire (OECD, 2013).

As the last two paragraphs illustrate, several questions are left unanswered by both the present investigation and by earlier studies (i.e., TIMSS and PISA). However, as the mechanisms underlying students' educational choices are complex, no single study can be expected to provide a comprehensive account. Additional research, for instance involving a longitudinal design where students valuing of mathematics and expectations for success is measured both before and after they make enrollment decisions[6], may give us information about how students' motivations develop over time as well as about which aspects of motivation are the best predictors of mathematics participation. Using other theoretical perspectives and/or measures of student motivation (such as self-efficacy (Bandura, 1997), interest (Hidi & Renninger, 2006) or self-concept (Markus & Wurf, 1987)) may also be fruitful. Together, this may serve to build up a more comprehensive knowledge about Norwegian students' motivations for participating in STEM-related fields.

Concluding remarks

This study investigated Norwegian upper secondary school students' motivations for enrolling in advanced mathematics courses and their aspirations for post-secondary education. The results show that, to a large extent, these students have chosen specialization in mathematics in order to have more options after upper secondary school, and/or because they need mathematics in order to pursue their chosen careers. This was especially the case for students planning post-secondary studies in the STEM fields, who were shown to place great value on the utility of mathematics. Demonstrating that the STEM fields offer many exciting career options and opportunities to realize one's potential, and highlighting that participating in mathematics is a prerequisite for studying science, technology, and mathematics-related subjects, should thus have great potential for increasing the recruitment to both upper secondary school mathematics and tertiary studies in the STEM fields. Such interventions aimed at encouraging student engagement in STEM should not, however, be limited to upper secondary school, as research suggests that young people decide whether or not to study STEM-related fields well before they reach this level of schooling (Tytler et al., 2008).

The results further indicate that efforts to heighten students' interest in mathematics and their confidence in their mathematical abilities have the potential for promoting their participation in mathematics. This may be especially important for the girls, as they, to a greater extent than boys, reported that their interest in mathematics as a school subject was important for their choice to enroll in advanced mathematics courses. Some research indicates that teaching approaches focusing on solving problems with practical implications and/or opportunities for creative solutions, using instructional material that appears meaningful, relevant, and related to students' personal interests and goals, encouraging peer collaboration rather than social comparison and competition among the students, and emphasizing understanding of mathematical concepts rather than rote learning have a positive impact on students' academic motivation and academic self-concept (Eccles, 1989; Ginsburg-Block & Fantuzzo, 1998; Middleton & Spanias, 1999; Wang, 2012). There is, however, need for more research on instruction that fosters students' interest in, and enjoyment of, mathematics and their confidence in own mathematical abilities.

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Notes

1 See e.g. Bandura, Barbarandelli, Caprara & Pastorelli (2001); Hackett (1985); Hackett & Betz (1989); Pajares & Miller (1994); Simpkins & Davis-Kean (2005).

2 See e.g. Hannula, Maijala, Pehkonen & Nurmi (2005); Jacobs & Eccles (1992); Nagy et al. (2006); Perez-Felkner, McDonald, Schneider & Grogan (2012); Simpkins, Davis-Keane & Eccles (2006); Watt (2006).

3 The usefulness of expectancy-value theory is further demonstrated in Bøe, Henriksen, Lyons & Schreiner (2011).

4 A subsequent school reform (the Knowledge Promotion, K06) has changed the advanced mathematics program in Norwegian upper secondary school somewhat. The present term for the most advanced mathematics course offered is R2.

5 $d = \frac{M_1 - M_2}{SD}$, where M_1 and M_2 are the group means and SD is the pooled standard deviation given by $\sqrt{\frac{(N_1 - 1)\, SD_1^2 + (N_2 - 1)\, SD_2^2}{N_1 + N_2}}$. N_1 and N_2 are the number of respondents in each group, and SD_1 and SD_2 are the standard deviations in each group.

6 See Ma (2001); Watt et al. (2006) for examples.

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