Attitudes toward mathematics among economics and business students in Norway. Is there any gender difference?

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Abstract

The purpose of this study is to find out if there is any gender difference in attitudes to mathematics among students at the Faculty of Economics and Management, NTNU. More than 200 students from the three departments: (1) Industrial Economics and Technology Management, (2) Economics and (3) Business school were questioned about their attitudes towards mathematics.

Using factor analysis, an instrument for measuring attitudes towards mathematics, was constructed. The method chosen was pairwise comparisons using an independent samples t-test.

Research on the gender gap is mixed. Some studies show a sex difference when it comes to attitude to mathematics, while others do not find any significant gap between male and female students.

Norway is one of the highest-ranking countries in terms of overall gender equality, and female students outperform their male peers at upper secondary school. Nevertheless, women are under-represented in fields like science, technology, engineering and mathematics. This is a gender equality paradox.

About 50 per cent of the students at the Faculty of Economics and Management are females. The data suggest there is a significant gender difference in attitudes towards mathematics among the students. The females have substantially lower values in terms of self-confidence, enjoyment and value in mathematics. The students can choose between practical and theoretical mathematics at upper secondary school, but even if we adjust for that, there is still a significant gender gap. This finding can explain why female students tend to select less quantitative fields and business courses that require fewer mathematical skills.

Keywords: Economics and business students, gender difference, attitudes towards mathematics

Introduction

The issue of sex differences in higher education continues to attract interest among parents, educators and researchers, and a gender gap can be observed. Although there is a rich body of literature about attitudes towards mathematics and the gender gap, there are few studies concerning students in business and economic courses.

The gender difference in mathematics in many countries becomes greater with increased national gender equality (Stoet and Geary, 2018). A student's choice of education and career is based on interest, strengths, skills and enjoyment. Some psychological and social factors might have an influence on the choice of pathway. Women and men look at this differently. Female students tend to focus more on humanities and social sciences, while male students are attracted to mathematics and sciences.

Economics and business studies is not a masculine field in Norway, as around 50 per cent of the students are females.

The instrument for measuring the attitudes toward mathematics is based on methods used in international studies, and a factor analysis was constructed with three factors, namely self-confidence, value and enjoyment.

The gender difference in terms of self-confidence and anxiety towards mathematics will affect the choice of study fields. Devine et al. (2012) found that anxiety towards mathematics has an effect on the mathematics performance of boys, but not that of girls. Females with low self-confidence in mathematics can achieve excellent performance. There is an independent relationship between self-confidence or anxiety and performance in mathematics among female students.

The purpose of this article is to find out if there is any gender difference in attitudes towards mathematics among students attending the Faculty of Economics and Management, which offers different courses and majors with varying use of mathematics. The proportion of females varies among the courses, which might be related to different attitudes to mathematics. This study does not try to find the reasons why there might be a gender gap, which is probably due to a complex set of factors (Ercikan et al., 2005; Mendick, H. (2005).

Literature review

Gender differences in higher education are well documented (Ayalon, 2003). There are fewer female students in mathematics, technology and sciences. There may be many reasons for the low rate of participation of female students in advanced courses in mathematics. One explanation is that female students have fewer basic skills in mathematics from high school. Another factor may be a lack of interest in mathematics and the belief that it is irrelevant to their careers. On the other hand, a stronger mathematical background from high school significantly reduces women's application to humanities studies. However, research on the gender gap in regard to attitudes towards mathematics is mixed. Some studies show a gender difference when it comes to attitude to mathematics. Odell and Schumacher (1998) observed that males had a more positive attitude to maths than females in a business college. Frenzel et al.(2007) and Meelissen and Luyten (2008) found that the gender gap

remains substantial in terms of attitude relating to mathematics. The study of Sax et al. (2015) demonstrates a gender gap in confidence. Ganley and Lubienski (2016) find a larger gender gap in confidence in maths than in interest and achievement. Although girls perform similarly to boys, they have lower self-confidence (Watt, 2006).

The boys might have more self-confidence in mathematics, but the gender variance in attitudes is not universal (Reilly et al., 2019). Research studies have emphasized that the differences between males and females are getting smaller (Recber et al., 2018). Hyde et al. (1990) find the gender difference in mathematics to be moderate, but results indicate that males are more confident than females. On the other hand, many studies have found no significant gender differences (Yeo et al., 2015; Mohd et al., 2011; Köğce et al., 2009. The attitudes towards mathematics among students might change. According to Hyde et al. (1990), the gender differences in self-confidence and general mathematics attitudes are larger among high school and college students than among younger students.

Worthington and Higgs (2004) observed that female undergraduates are less likely to continue in economics or finance after completing introductory courses. Females tend to prefer accounting, marketing and management. More women than men find economics and finance irrelevant or uninteresting. One reason might be that female students are generally less interested in these subjects due to their mathematical background and they are not so comfortable using mathematics. However, controlling for a number of other factors, Dynan and Rouse (1997) found that mathematical background only explained the gender gap in choosing economics to a certain extent since there is a gender difference in terms of preferences, personalities and interests.

Other researchers have pointed out that mathematics might be a key factor. A student's interest and confidence in a domain of study is related to his or her choice of major (Larson et al., 2010). Motivation is a result of earlier experience in this field. If a student gets good grades and enjoys success in mathematics, it creates a positive attitude towards this subject, and it will have an influence on the choice of studies. Students with good skills in mathematics tend to choose quantitative fields of study.

Many studies have examined attitudes towards mathematics using different factors and instruments. A classical article on this is written by Fennema and Sherman (1976). Their analysis consists of nine scales: (1) Attitude towards Success in Mathematics, (2) Male Domain, (3) Mother Scale, (4) Father Scale, (5) Teacher Scale, (6) Confidence, (7) Anxiety, (8) Motivation and (9) Usefulness. There are modifications of the Fennema-Sherman scale. Adediwura (2011) focused on confidence, anxiety, motivation and usefulness. Tapia and Marsh (2004) constructed new instruments to measure attitudes towards mathematics including confidence, anxiety, value, enjoyment, motivation and parent/teacher expectation. They performed a factor analysis that identified four scales: (1) Self-Confidence, (2) Value, (3) Enjoyment and (4) Motivation. They dropped the parent/teacher factor since the parents or teacher pursuing and encouraging did not seem to have a substantial impact. The self-confidence scale had the highest score and was a combination of

the two original variables, anxiety and confidence. Motivation received the lowest score. A lot of studies have used this four-scaled model (Guy et al., 2015; Huang and Lin, 2015; Majeed et al., 2013).

Kiwanuka et al. (2017) limited the study to three indicators by dropping motivation. Adelson and McCoach (2011) developed three factors (Mathematical self-perceptions, enjoyment and usefulness of Mathematics) by using factor analysis. The level of those scales will influence the decision to choose level of mathematics and achievement.

There is a concern among researchers that high anxiety related to mathematics will have a negative impact on students' choices. Many will try to avoid mathematics even if it is a very important subject for their future career (Anderson, 2007; Mutawah and Masooma, 2015).

Some students are not aware of the importance of mathematics. It is an issue of international concern that many students select less advanced mathematics subjects at upper secondary school. Australia has experienced a decline in mathematics skills (Murray, 2011).

This study sought to see if there is any gender gap in attitudes towards mathematics among economics and business students. Norway has a high level of gender equality. The majority of students at colleges and universities are female and they achieve good grades.

Data, Methodology and Results

Study sample

In accordance with the research objective, data were gathered by asking the students. The sample includes 217 students from the first half-year from three departments at the Faculty of Economics and Management.

Table 1a The Sample

Department	**Males**	**Females**	**Total in the survey**	**Number of students who took exam in this subject**
Industrial Economics and Technology Management	37	36	75	130
Economics	13	7	20	38
Business school	59	63	122	213
All	109	106	217	381

The students from the Business school department can choose between different majors. Table 1 shows the gender mix for the three fields: finance, non-quantitative courses (management, marketing) and other business courses (accounting, financial management). There is obviously a gender difference in the choice of majors among the students.

Table 1b The Sample from Business school

	Females	Males	All
Finance courses	11	29	40
Non-quantitative courses	12	5	17
Other business courses	32	22	54
Business School	63	59	122

The surveys are from fall 2018 and from students in the second year at the university. The students responded to a designed questionnaire during a compulsory course except for the Economics Department where data are from a chosen subject. Most of them chose to answer, but the survey did not catch up with students who were absent from the course that day. The response rate was less than 60 per cent and the students were non-randomly allocated. We have not evaluated the representativeness of the final sample by comparing the average student's characteristics from the final sample with the characteristics of all the enrolled students. But this has been done in a previous similar study (Bonesrønning and Opstad, 2015). There were slightly more girls than boys and the average student in the sample had a slightly higher GPA than the average student. The reason is that higher percentages of male students and of students with lower achievement were absent from the lectures. The difference was small. We assume the situation is the same for this sample as well, but data are not available for testing out this hypothesis.

Methodology and results

Students' attitudes towards mathematics can be measured by using the Attitudes Towards Mathematics Inventory (ATMI) (Tapia and Marsh, 2004). Sundre et al. (2012) used that method for Norwegian students without doing any factor analysis. Since it is not clear how well the ATMI-questions fit to Norwegian students, we decided to explore factor analysis. It is not necessarily the case that a research instrument that has been proven reliable and effective in an American educational context is valid for Norwegian conditions. Like many other studies (Kiwanuka et al., 2017; Adelson and McCoach, 2011), we limit the analysis to only three factors (i) Enjoyment of mathematics, (ii) Self-Confidence in mathematics, and (iii) Value of mathematics. We removed the motivation factor since the factor loading was too low.

Lim and Chapman(2013) did the same since there was high correlation between enjoyment and motivation (r = 0.96). This shorter ATMI did not have an impact on the property of the instrument.

The criteria for choosing items for the construction of the factor analysis were (Adelson and McCoach, 2011):

(a) the coefficient was at least 0.4;

(b) the pattern coefficient for non-relevant factors was less than 0.3;

(c) the pattern coefficient for non-relevant factors was 0.2 or less than the value of the relevant factor;

(d) the Cronbach's alpha was above 0.70.

The results of the factor analysis by using principal components are shown in Table 2.

Table 2a Factor Analysis (A seven-point Likert scale was selected where strongly disagree = 1 and strongly agree = 7. This choice is not obvious, but a seven-point scale might perform better than a five-point scale (Joshi et al., 2015).

	No.	*Item (seven-point Likert scale)*	*Factor loading*	*Cronbach's alpha*
Self-confidence	*1*	*It makes me nervous to even think about having to do a mathematical problem (reversed score)*	*0.908*	*0.921*
	2	*Mathematics makes me feel uncomfortable (reversed score)*	*0.863*	
	3	*Studying mathematics makes me feel nervous (reversed score)*	*0.855*	
	4	*I am always confused in my mathematics class (reversed score)*	*0.823*	
	5	*I am always under a terrible strain in a maths class*	*0.810*	
	6	*Mathematics does not scare me at all*	*0.719*	
	7	*Mathematics is one of my most dreaded subjects (reversed score)*	*0.719*	
	8	*My mind goes blank and I am unable to think clearly when working with mathematics (reversed score)*	*0.634*	
	9	*When I hear the word mathematics, I have a feeling of dislike*	*0.585*	
Value	*1*	*Mathematics is a very worthwhile and necessary subject*	*0.834*	*0.843*
	2	*Mathematics is one of the most important subjects for people to study*	*0.790*	
	3	*A strong maths background could help me in my professional life*	*0.773*	
	4	*Mathematics is important in everyday life*	*0.753*	
	5	*I believe studying maths helps me with problem solving in other areas*	*0.614*	

Enjoyment	*1*	*I would prefer to do an assignment in maths than to write an essay*	*0.820*	*0.687*
	2	*I am happier in my maths class than in any other class*	*0.779*	

Table 2b The Categories

Category	**Description**
Self-Confidence	To measure students' confidence and self-concept of their performance in mathematics. It measures whether or not students believe they have enough ability to succeed in mathematics.
Value of mathematics	To measure students' beliefs in the usefulness, relevance and worth of mathematics in their life now and in the future.
Enjoyment of mathematics	To measure the degree to which students enjoy working with mathematics.

The self-confidence category contains items measuring a student's certainty in the subject. It depends on the ability and expectation of getting good grades. Following the definition, we constructed nine items to reflect this category. The factor loading is high and the Cronbach's alpha score is 0.91. The value factor contains five items. The impact from the category enjoyment was weaker. It contains only two items. Many items had to be rejected due to low factor loading or due to loading on more than one factor. The Cronbach's alpha value on the factor enjoyment is rather low.

Table 3a Self-confidence in mathematics

Department	**Total**	**St.d**	**Male**	**Female**	**Mean Diff-erence**	**Independent Sample t-test, t-value**	**Significance** (assuming unequal variance)	
Industrial Economics and Technology Management	5.25	0.87	5.55	4.93	0.63	3.22	0.02	**
Economics	5.21	1.08	5.13	5.35	-0.23	-0.42	0.683	

Business school (all)	5.40	0.84	5.53	5.28	0.25	1.67	0.098	*
-Finance courses	5.71	0.54	5.67	5.80	-0.13	-0.74	0.381	
-Non-quantitative courses	4.73	1.03	4.67	4.76	-0.09	-0.16	0.872	
-Other business courses	5.35	0.90	5.53	5.22	0.30	1.26	0.214	
All	5.33	0.87	5.49	5.17	0.32	2.75	0.006	***
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.								

Table 3b Value of mathematics

Department	**Total**	**St.d**	**Male**	**Female**	**Mean Diff-erence**	**Independent Sample t-test, t-value**	**Signifi-cance** (assuming unequal variance)	
Industrial Economics and Technology Management	5.83	0.97	5.97	5.66	0.33	1.38	0.173	
Economics	5.25	1.29	5.32	5.11	0.21	0.35	0.729	
Business school (all)	5.18	1.05	5.45	4.90	0.56	3.04	0.003	***
-Finance courses	5.48	0.73	5.48	5.47	0.01	0.04	0.961	
-Non-quantitative courses	4.44	1.30	4.20	4.53	-0.33	-0.46	0.655	
-Other business courses	5.52	1.10	5.65	4.82	0.83	2.86	0.007	***
All	5.41	1.09	5.62	5.18	0.45	3.06	0.002	***
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.								

Table 3c Enjoyment of mathematics

Department	**Total**	**St.d**	**Male**	**Female**	**Mean Diff-erence**	**Independent Sample t-test, t-value**	**Significance** (assuming unequal variance)	
Industrial Economics and Technology Management	4.12	1.30	4.50	3.72	0.78	2.61	0.011	***
Economics	4.03	1.54	4.04	4.00	0.04	0.05	0.962	

Business school (all)	4.20	1.35	4.32	4.09	0.23	0.963	0.338	
- Finance	4.49	1.14	4.38	4.77	-0.39	-0.92	0.372	
- Non-quantitative courses	2.77	1.09	2.50	2.88	-0.37	.0.51	0.609	
-Other business courses	4.39	1.32	4.59	4.25	0.34	0.98	0.332	
All	4.156	1.35	4.35	3.96	0.39	2.13	0.034	**
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.								

Table 3 presents the result of pairwise comparisons of mean using an Independent sample t-test. The results are mixed regarding gender difference. If we include all students, there is a significant gender gap. Overall, the male students get a higher score than the females, but the difference depends on the department and the selected majors at the Business school. The women have lower scores at the Department of Industrial Economics and Management Technology, but not in the Department of Economics or finance courses (Business school).

Overall, there is a gender gap in the value of mathematics (Table 3b). The impact is substantial among the business students and especially in accounting and financial management (other business courses). For the two other departments there is only a minor difference and it is not significant. Negative but no significant difference is observed for this factor among students who had chosen marketing and management (non-quantitative subjects)

Men belonging to the Department of Industrial Economics and Technology Management find a substantially higher enjoyment of mathematics than women (Table 3c). Among the rest of the students, there is only a minor difference. The females get higher scores than the males for the finance major, but it is not significant.

Our method does not take into account other factors that could have influenced the results. Mathematical background from upper secondary school might have an impact on attitudes to mathematics. Most of the students at the Faculty of Economics and Management, NTNU have taken theoretical mathematics. The Department of Industrial Economics and Technology Management requires mathematical science as a criterion for enrolment. Therefore there is no difference in mathematical background among those students. The two other departments can accept applications with only practical mathematics at upper secondary school. There are not so many of them. The proportion is around 10 per cent. Only two percent of the students at the Department of Economics and 20 percent at the Business school had a background in practical mathematics from upper secondary school. Among those students at the Business school the most popular major is the non-quantitative field (marketing or management). More than 40 per cent who chose these subjects

have a background in non-theoretical maths. More females than males prefer this kind of maths. In our data set, there are 14 women and 8 men.

The non-quantitative study fields attract women. Out of 17 participants 12 are females (Table 1b). For the most quantitative major (finance), the situation is the opposite. Few women prefer this field. Here the men dominate. There are 11 women and 29 men taking this major.

An Independent Sample t-test reveals significantly lower scores among the students with a practical maths background in all three factors measuring the attitudes towards mathematics (Table 4).

Table 4 Comparing students with practical and theoretical backgrounds from upper secondary school

Mean Value	**Practical Mathematics**	**Theoretical Mathematics**	**Mean Difference**	**t-value**	**Significance** assuming unequal variance)	
Self-confidence	4.79	5.43	-0.63	-2.87	0.008	***
Value	4.31	5.56	-1.25	-4.70	0.000	***
Enjoyment	3.25	4.28	-1.03	-3.32	0.003	***
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.						

Limiting the analysis to students with a background in practical mathematics from upper secondary school, there is still a gender difference (Table 5).

Table 5 Practical Mathematics from Upper Secondary School, Gender Gap

Mean Value	**Females**	**Males**	**Mean Difference**	**t-value**	**Significance** assuming unequal variance)	
Self-confidence	4.39	5.50	-1.10	-3.00	0.012	**
Value	3.84	5.12	-1.28	-2.80	0.013	**
Enjoyment	2.85	3.93	-1.08	-1.77	0.100	
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively						

DISCUSSION

The development of a research instrument for measuring attitudes towards mathematics using the three factors self-confidence, value and enjoyment is based on questions used in international studies. The data were adapted to Norwegian conditions by constructing factor analysis. The scores of these unobserved values are correlated with gender choices.

The results from this study support and are consistent with other findings about the gender gap. Male students have higher self-confidence than female students (Sax et al., 2015).

The students at the Department of Economics and Technology Management are quite homogeneous. This study is in one of the most popular fields in Norway. Only applicants with a top GPA score and a high level of skills in theoretical mathematics from upper secondary school get access. The students who have graduated are in demand and receive attractive job offers. About 50 per cent of the students are female and many of the subjects are quantitatively orientated. Mathematics is important and the students are familiar with using mathematics in their presentations. Without a good qualification and interest in mathematics one cannot pass through this study. There is still a gender gap. The female students have less self-confidence and enjoyment of mathematics than the male students. Students at the Department of Industrial Economics and Technology Management see mathematics as a useful tool, and there are no gender differences in the assessment of the value of using mathematics.

The results from the Department of Economics indicate no gender difference. The sample is quite small and one should therefore be careful when interpreting the data.

There are some interesting results from the Business school. The majority of the students are female and there is a substantial gender gap in self-confidence and value of mathematics, but not in enjoyment. Generally, women think mathematics is less important for careers in administration. This confirms the finding of Ayalon (2003) that more women believe mathematics is irrelevant to their careers. In the two other departments quantitative skills are more important since the subjects are more mathematically and quantitatively oriented. Our data do not show any gender gap in value of mathematics among those students.

If we split the data based on the choice of majors among business students, we get a more distinct picture. Mathematics is very relevant in financial courses (Alcock et al., 2008). Skills in mathematics are strongly related to success in those subjects. Therefore, students who are clever and interested in mathematics prefer this field. We do not find any gender difference in value of mathematics among those students. The same conclusion can be drawn for students attending marketing and management. The scores are low for both sexes, and the difference is negative, but not significant. Males received the lowest score, but not significantly so. However, for accounting and financial management there is a substantial gender difference. Unlike the females, the male students in this major find mathematics a useful and important subject.

The finance major at the Business school is analogous with the courses at the Department of Industrial Economics and Technology Management. For the finance group there is no gender difference. The females tend to have higher scores in self-confidence and enjoyment, but not significantly so. There is no obvious reason why the data show different results for the finance major and the Department for Industrial Economics and Technology Management. Students taking finance courses at the Business School have a more mixed background, but it is not clear how this affects the result.

Students who value mathematics as useful seek to undertake mathematics-related studies (Watt, 2006). There is a link between students' attitudes towards mathematics (beliefs, values and self-concept) and the choice of maths and science for further studies (Simpkins et al., 2006). LeFevre et al. (1992) found that students with poor attitudes towards mathematics tend to choose areas with less mathematical content so they can avoid getting involved with mathematics. People tend to avoid tasks they find unpleasant. Students with low confidence have less practice in mathematics (Ashcraft, 2002), and this might have a negative impact on working memory.

According to Worthington and Higgs (2004), students who are less comfortable using maths are more likely to choose non-quantitative majors. Our findings seem to confirm this. This is true for both sexes and the results show no gender gap.

Although the females get at least the same grades as the males in mathematics, there is a gender difference in the choice of type of mathematics. Women choose simple practical mathematics to a greater extent. Statistics from the Norwegian Ministry of Education show that the percentage of women who take practical mathematics is 57 per cent. In the most theoretical course in mathematics at upper secondary school only 38 per cent of the students are women.

The choice of major depends on preferences and experience. The students are more mature and know more about the role of mathematics. They have gained more insight into their own skills, and they know more about how to use their mathematical knowledge in business courses when they select a major subject in the second year of study. It looks like this attitude affects the choice of major among the business students. This is probably one of the reasons for the substantial gender difference in preferences in majors among the business students. It looks very traditional. More females than males prefer majors in marketing and management. They want to avoid mathematics. Relatively few women want to study finance since it requires good skills in mathematics. This major is dominated by male students. Our data show there is a gender difference in choices of fields, but not all over among students within the same major. The gender difference in attitude towards mathematics disappears for those taking the most and least quantitative courses. There is no obvious explanation for this result.

The students with backgrounds in practical mathematics from upper secondary school get lower scores in terms of attitudes towards mathematics (Table 4). This might have an impact on the gender difference among the students at the Business school since female students tend to prefer practical mathematics at upper

secondary school. It will probably have only a minor effect since the percentage of those with a practical maths background is small. Taking this into account and comparing students with the same mathematical background, there is still a gender difference. This applies both to those who have practical mathematics (Table 5) and to those who have the same theoretical mathematics (Department of Industrial Economics and Technology Management).

Conclusion

This study shows there is a gender difference among the economics and business students at a university in Norway. The attitudes towards mathematics can help to explain why women and men make different choices. The factors used have different impacts in terms of gender and they depend on the field of study.

Among the business students choosing finance or non-quantitative majors (management, marketing) the gender difference in attitudes towards mathematics disappears. Women tend to prefer marketing and management. The opposite is true for men. They are in favour of finance. Future research may shed light on why this is the case.

This study brings evidence that could be important for discussions on the design of courses and the gender mix. Mathematics is important for economics and business students and the students appreciate maths. The score for enjoyment is substantially lower, and the female students have a significantly lower score than the males for this factor. One way to follow this up is to encourage the females to appreciate mathematics more. By doing this, the gender differences in selecting majors among business students might decrease.

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