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DIFFERENT ATTITUDES TOWARDS MATHEMATICS AMONG ECONOMIC AND BUSINESS STUDENTS AND CHOICE OF BUSINESS COURSE MAJOR IN NORWAY

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Abstract

The purpose of this research is to map out any differences regarding attitudes towards mathematics among students at the Faculty of Economics and Management, Norwegian University of Science and Technology (NTNU). Approximately 200 students from three departments, Economics, Business School, and Industrial Economics and Technology Management, answered a survey about their attitudes towards mathematics.

Through factor analysis, a measuring instrument for 'attitude towards mathematics' was constructed. The chosen methods were an independent samples t-test and binary logistic regression.

This study sought to understand the impact of students' attitudes towards mathematics and how that affects their choices within economics and business courses. Students at the Business School can choose different major courses in third year. There is a substantial difference in attitudes towards mathematics among those students. The findings suggest that students from Industrial Economics and Technology Management have the highest self-confidence in mathematics. Further, students with low self-confidence, value and enjoyment in

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mathematics tend to choose non-quantitative subjects such as marketing, organisation and management, while students with high scores prefer finance subjects.

This research confirms that those students who valued mathematics and view it as useful, choose mathematic related studies. Furthermore, there is a link between students' attitudes towards mathematics (enjoyment, value and self-confidence) and their choice in further studies.

A student's confidence and interest in a field of study is related to their chosen major. One motivation is earlier experience within the field. If a student achieves good grades and has success in mathematics, it creates a positive attitude towards this subject and will influence the choice of studies.

Keywords: attitudes towards mathematics, quantitative analysis, business course major

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Introduction

Mathematics matters (Opstad, 2018; Kukey et. al., 2019). Many studies have examined attitudes towards mathematics using different versions of factors and instruments and analysed how they affect the choice of academic fields. At the Faculty of Economics and Management, Norwegian University of Science and Technology (NTNU), students can choose among many majors, especially in third year at Business School. By constructing an instrument to measure attitudes towards mathematics, we want to determine if Norwegian data show a link between attitudes towards mathematics and selection of business courses.

This study sought to understand the impact of business students' attitudes to mathematics on their choice of major at the Faculty of Economics and Management. The use of mathematics in business schools depends on the type of study fields, but one cannot complete the programme without operating with mathematics. Is there a link between attitudes towards mathematics and the choice of major? Is there any connection between the selection of and attitudes towards mathematics? The hypothesis is that students with a positive attitude towards mathematics choose quantitative subjects and vice versa, that is, those with poor scores in their attitude towards mathematics select non-quantitative majors. This type of information can be useful in planning future economics and business courses.

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Literature review

By using factor analysis, Tapia and Marsh (2004) identified four scales: (1) self-confidence; (2) value; (3) enjoyment; and (4) motivation to measure attitudes towards mathematics. The self-confidence scale achieved a high score. It was a combination of two original variables, anxiety and confidence. Motivation received the lowest score. Many researchers have used this four-scaled model (Guy et al., 2015; Huang &Lin, 2015; Majeed et al., 2013). Other studies have dropped the motivation component and limited the analysis to three indicators (Adelson & McCoach, 2011; Kiwanuka et al., 2017).

Business students find many aspects of mathematics valuable in their future careers (Champion et al. 2011).

There is a concern among researchers that high anxiety related to mathematics will have a negative impact on students' choices. Students with high mathematics anxiety get lower grades in mathematics courses (Sheffield & Hunt., 2006). There is a significant negative correlation between anxiety and results in mathematics.

Wilkins and Ma (2003) noted that taking calculus in high school resulted in viewing mathematics more positively than peers who did not take such courses. There is a connection between students' attitude towards mathematics (beliefs, values and self-concept) and the selection of math and science for further studies (Simkins et al., 2006; Musu-Gillette et al., 2015). Students with low attitudes towards mathematics tend to choose areas with minor mathematical content (Ashcraft, 2002; Morsanyi, 2019; LeFevre et al., 1992). In doing so, they can avoid mathematics. The choice of major is linked to a student's confidence and interest (Larson et al., 2006) and depends on their experience. Students who are not comfortable using mathematics tend to select non-quantitative majors (Brown et al., 2008). Many will try to avoid mathematics even though this field might be important for their careers (Anderson, 2007; Mutawah & Masooma, 2015). If students fail in mathematics, it effects their self-confidence negatively.

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Furthermore, those who have unenthusiastic attitudes towards mathematics obtain low grades in final exams (Nunez-et al., 2013). On the other hand, those successful with mathematics is more likely to choose mathematical related subjects (Federman et al., 2006; Watt, 2006).

Many students are not aware of the importance of mathematics. It is an issue of international concern that fewer students chose advanced mathematics (Hine, 2019; Murray, 2011). A skilled teacher can have an impact on students' attitudes towards mathematics, though Sonnert et al. (2015) did not find that using educational technology had any impact on attitudes towards mathematics.

The studies on the gender gap regarding attitudes towards mathematics give a mixed result. Frenzel et al. (2007) and Recber et.al.(2018) found a positive difference between male and female students in terms of attitude relating to mathematics. However, other studies did not find any significant gender differences (Mohd et al., 2011; Yeo et al., 2015).

Data, methodology and results

The first part presents the collected dat. In the next section methods of analyses and results are provided.

Study sample

Data were gathered by asking the students from the second year of three departments at the Faculty of Economics and Management to fill out a survey.

Table 1a. The sample.

Department	**Total in the survey**	**Number of students who took exams in this subject**
Industrial Economics and Technology Management	75	130
Economics	20	38
Business School	122	213

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All	217	381

The students taking a bachelor's degree at Business School have the same courses in the two first years but can choose from different majors in the third year. They can choose from different options, including finance, non-quantitative courses (management, marketing) and other business courses (accounting, financial management), as shown in Table 1b.

Table 1b. Business School sample.

	All
Finance courses	39
Non-quantitative courses	16
Other business courses	46
Business School	101

The results are from autumn 2018. The students responded to a survey during an obligatory course except for the Economics Department where questionnaires were from a voluntary subject. Most of students chose to answer, but the data did not include students who were absent at the course on that day. Responses were received from 217 students (106 females), which is less than 60 per cent. The survey was non-randomly allocated. Due to the lack of data, the representativeness of the final sample is not compared with the final sample of all enrolled students. However, this has been done in an earlier research (Bonesrønning & Opstad, 2015). There were small differences between the sample and the entire population. We suppose the situation is the same for this sample as well.

Methodology and results

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Students' attitudes towards mathematics can be measured by using the Attitudes Towards Mathematics Inventory (ATMI) (Tapia & Marsh, 2004). Sundre et al. (2012) used this method for Norwegian students without making any factor analysis. It is not obvious how well these international questions fit Norwegian students. The instrument for measuring attitudes towards mathematics was constructed from the collected data. The factors were extracted by using a fixed factor matrix. Like many other studies (Lim & Chapman, 2013), the analysis is limited to only three factors: (i) enjoyment of mathematics; (ii) self-confidence in mathematics; and (iii) value of mathematics. The given motivation did not give a clear result using factor analysis and was removed from the analysis. Lim & Chapman (2013) eliminated this subscale due to a high correlation between motivation and enjoyment (r = 0.96). This shorter version met the requirements for using factor analysis.

The creation of the factor analysis was founded on the following principles (Adelson & McCoach, 2011):

(a) The coefficient for each item was 0.4 or more;

(b) The coefficient for non-relevant items was not higher than 0.3;

(c) The difference between relevant and non-relevant factors was higher than t 0.2;

(d) The value if Cronbach's alpha is at least 0,70.

The results of the factor analysis 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.

	No.	***Item (seven-point Likert scale)***	***Factor loading***	***Cronbach's alpha***

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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*	

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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*	

The self-confidence category contains items measuring a student's certainty in a subject. The self-confidence category depends on a student's ability for success in mathematics. A nine-item scale was made to reflect this classification. The Cronbach's alpha score was high (0.91). The value factor, which includes four items, had a lower Cronpach' alfa score. It measures the usefulness and relevance of mathematics. The impact from the enjoyment category was weaker. It includes only two items, due to low factor loading.

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Table 3. Attitudes among students depending on department and gender. Mean values (standard deviation in parenthesis).

	Department			**Gender**		**All**
	Industrial Economics and Technology Management	**Economics**	**Business School**	**Females**	**Males**	
Self-confidence	5.25 (0.87)	5.21 (1.08)	5.40 (0.84)	5.15 (0.88)	5.48 (0.85)	5.33 (0.87)
Value	5.83 (0.97)	5.25 (1.29)	5.18 (1.05)	5.18 (1.02)	5.52 (1.11)	5.41 (1.09)
Enjoyment	4.12 (1.30)	4.03 (1.54)	4.20 (1.35)	3.96 (1.43)	4.35 (1.25)	4.17 (1.35)

The attitudes towards mathematics varies among departments. Students belonging to Industrial Economics and Technology Management have high values in attitudes towards mathematics. However, these students have slightly lower self-confidence than those belonging to the Business School. The data reveal a rather poor score in enjoyment for all three departments.

Table 4 a and 4b show the result of pairwise comparisons of means among business students using an independent samples t-test. The mean values for the three dimensions are between 2.7 and 5.8 for the three majors. The score is highest among the finance course students. Using an independent samples t-

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test, there is a significantly higher score in self-confidence and value in mathematics than among those studying accounting and financial management. Students who have chosen non-quantitative courses have the lowest values in all three scales for measurement attitudes towards mathematics. Those students have poor enjoyment in mathematics and find mathematics less useful, having lower self-confidence than their fellow students. The difference is strongly significant for all three categories of pairwise comparison with students from other business courses (Table 4b).

Table 4a. Independent samples t-test (two-tailed) (Business School). Finance courses compared with other business courses (standard deviation in parenthesis).

	Mean values			**T-values (assuming not equal variances)**
	Finance courses	**Other business courses**	**Difference**	
Self-confidence	5.71 (0.53)	5.35 (0.90)	0.35	2.22 (**)
Value	5.48 (0.73)	5.16 (1.10)	0.32	1.72(*)
Enjoyment	4.49 (1.14)	4.39 (1.32)	0.10	0.39
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.				

Table 4b. Independent samples t-test (two-tailed) (Business School). Non-quantitative compared with other business courses (standard deviation in parenthesis).

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	Mean values			T-values (assuming not equal variances)
	Non-quantitative courses	**Other business courses**	**Difference**	
Self-confidence	4.73 (1.03)	5.35 (0.90)	−0.62	−2.22 (**)
Value	4.44 (1.30)	5.16 (1.10)	−0.72	−2.25(**)
Enjoyment	2.76 (1.09)	4.39 (1.32)	−1.62	−5.07(***)
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.				

By using pairwise comparison one does not take into count how different factors affect the result simultaneously. By using binary logistic regression model one can find out more how attitudes towards mathematics will affect the choice of majors. The independent variables are gender, self-confidence, value and enjoyment of mathematics. In the model, α_0 is a constant, e denotes the stochastic error and α_i is the regression coefficient. The chosen linear binary production function is:

$$Yi = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + e$$

where:

Yi: Choice of majors at the faculty

α_0: Constant

X_1: Gender (F: 1, M:O).

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X_2: Mean value of self-confidence using a seven-point Likert score.

X_3: Mean value of use of mathematics using a seven-point Likert score.

X_4: Mean value of enjoyment of mathematics using a seven-point Likert score.

Binary logistic regression was selected since the dependent variable has only two values. The analysis is limited to:

a. Comparing students from the Department of Industrial Economics and Technology with students from other departments within the same faulty (1: students from Industrial Economics and Technology Management 0: students from other departments)

b. Comparing students from finance courses with other business courses (accounting, financial management) at the Business School (1: students from finance courses, 0: students from other business courses)

c. Comparing students from non-quantitative courses with other business courses at the Business School (1: students from finance courses, 0: students from other business courses).

By using multivariate data and including control variables in the model, it is possible to identify more clearly the relationship between attitudes, gender and choice of departments or subjects and examine the simultaneous connections. Tables 5 a-c present the results.

Table 5a. Result of the binary logistic regression. Dependent variable: students from the Department of Industrial Economics or from another department.

Independent variable	**Coef. B (std. err.)**	**WALD**	**Exp(B)**
Constant	−2.51	4.14 (**)	0.081

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	(1.24)		
Gender	0.32 (0.30)	1.14	1.38
Self-confidence in mathematics	−0.71 (0.26)	7.58 (***)	0.49
Value of mathematics	1.03 (0.20)	25.71 (***)	1.51
Enjoyment of mathematics	−0.06 (0.15)	0.15	0.94
R^2 (Nagelkerke) = 0.21, N = 217			
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.			

Table 5b. Result of the binary logistic regression. Dependent variable: students from finance or other business courses within the same department.

Independent variable	**Coef. B (std. err.)**	**WALD**	**Exp(B)**
Constant	−3.52 (2.10)	2.81 (*)	0.30
Gender	−1.23 (0.48)	6.58 (**)	0.29
Self-confidence in mathematics	0.81 (0.42)	3.67 (**)	2.24
Value of mathematics	0.06 (0.28)	0.05	1.06
Enjoyment of mathematics	−0.27	0.97	0.79

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	(0.24)		
R^2 (Nagelkerke) = 0.19, N = 94			
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.			

Table 5c. Result of the binary logistic regression. Dependent variable: students from non-quantitative or other business courses within the same department.

Independent variable	**Coef. B (std. err.)**	**WALD**	**Exp(B)**
Constant	1.90 (2.02)	0.89	6.71
Gender	0.11 (0.74)	0.02	1.12
Self-confidence in mathematics	0.43 (0.47)	0.81	1.53
Value of mathematics	−0.31 (0.33)	0.85	0.74
Enjoyment of mathematics	−1.06 (0.35)	9.47 (***)	0.35
R^2 (Nagelkerke) = 0.36, N = 71			
Notes: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.			

SPSS does not provide collinearity diagnostics in logistic regression. But one can get the VIF value by running a linear regression. The results were

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VIF scores between 1.0 and 1.6. This means that multicollinearity is not regarded as a problem in this study.

The value of mathematics has a substantial positive effect for students belonging to Industrial Economics and Technology Management. Self-confidence also has an impact on this choice, but it is significantly negative.

Pairwise comparisons show higher values for males than females for all the chosen measurements for attitudes towards mathematics (Using binary regression there is only a substantial gender effect in the selection of finance courses. In the choice of finance or other business courses, males tend to favour finance courses. Out of 40 students taking this course, 29 were males (72.5%).

Self-confidence is significantly positive for those choosing a finance major compared with other business courses (Table 5b). Enjoyment has a substantial negative influence on students selecting non-quantitative courses (compared with other business courses) (Table 5c).

Discussion

Although the whole sample is rather small, the results show clear trends. The development of an instrument for measuring attitudes towards mathematics using the factors self-confidence, value and enjoyment exploit questions used in international research. The data were adjusted to Norwegian conditions by constructing factor analysis. The scores of these unobserved values are correlated with the choice of pathways among business and economics students. Students' attitudes towards mathematics have an influence on their choice of study fields.

Students who find mathematics useful prefer to attend the department of Industrial Economics and Technology Management. There are homogenous students at the department of Industrial Economics and Technology Management. This area of study is a very popular field in Norway. To get access, one must have a top GPA score and a high level of skill in theoretical mathematics from upper secondary school. After graduation, the candidates

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obtain attractive jobs. Many of the courses are quantitatively orientated. Mathematics is an important tool for those students. One cannot pass this study without good qualifications and an interest in mathematics. The result in this research shows high scores in attitudes towards mathematics for those students. The binary regression model indicates that the value of mathematics has a substantial positive effect for those students. More surprising is that the self-confidence in mathematics is negatively significant. Table 3 shows that the mean value among those students is slightly lower than among business students. One reason might be that the department of Industrial Economics and Technology Management is using more advanced and theoretical mathematics than the other two departments. The students might experience the content of mathematics as being difficult and challenging, which can lower their self-confidence in this area. Based on their experience and success in mathematics the attitude towards mathematics can change over time (Hyde et al.,1990). Another reason for this finding can be linked to different instructors and educational tools (Sonnert et al., 2015).

Splitting the data based on the choice of majors, there are some interesting results from the Business School.

The conclusion of this study confirms those of other studies. There is a selection based on attitudes towards mathematics. Those with high scores prefer finance courses, those with low scores choose non-quantitative courses (marketing, management), while those in the middle choose to take other business courses (accounting or finance management). This assortment is closely linked to the extent of use of mathematics and quantitative analysis. 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. Students who find mathematics useful apply for mathematics-related studies (Federman, 2007; Watt, 2006). There is a connection between students' attitudes towards

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mathematics (beliefs, values and self-concept) and the choice of mathematics and science for further studies (Simpkins et al., 2006). Students who enjoy mathematics and have high self-confidence are attracted to quantitative subjects. With high self-confidence in mathematics, those students can probably handle quantitative courses more easily. They think they can solve mathematical problems without hesitation and believe they can handle those challenges.

On the other hand, students with poor attitudes towards mathematics are likely to select areas with less mathematical content. They search for a way that does not involve too much mathematics (LeFevre et al., 1992). Students who are less comfortable using mathematics are likely to select non-quantitative majors (Brown et al., 2008; Worthington & Higgs, 2004). Our findings seem to confirm this. Attitude towards mathematics affects the choice of major among business students. Since a student's choice of major subject occurs during the second year of study, he (or she) has gained insight into his (or her) own skills. Students who do not enjoy mathematical analysis tend to choose marketing or management. In this way, they can minimise the use of mathematics at Business School. They are more likely to discourage the use of mathematical tools and the pleasure of using quantitative methods is limited. Even if they see the value of mathematics and that it could be important for their future careers, many might try to avoid mathematics (Anderson, 2007; Mutawah & Masooma, 2015).

Students who like business courses, but neither approve nor disapprove of mathematics choose other business courses. Their mean scores for all three measurements of attitudes towards mathematics lie between the scores for the finance courses group and the non-quantitative courses group.

The binary logistic regression model supports this conclusion. Compared with students selecting other business courses, self-confidence and value in mathematics have a substantial positive impact on those choosing finance courses, while enjoyment in mathematics is negatively significant for the group

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of students choosing non-quantitative courses. Students with a lack of enjoyment in mathematics try to avoid using mathematics at Business School.

There is some gender effect in this study. Males achieve higher scores in all three factors measuring attitudes towards mathematic. This might explain why there is a significant gender effect in favour of males choosing the most mathematically orientated majors at Business School. The majority of the students attending finance courses are males.

The results from the Department of Economics indicate no clear direction. The scores are close to the average for the whole sample. The sample from the Department of Economics is quite small and one should therefore be careful when interpreting the data.

Limitation

In this study, the author did not consider other depended variables than attitudes towards mathematics and gender. The value of the R square is rather low. Obviously, other factors have an effect on students' choices. Several studies have identified those elements (Easterling & Smith, 2008; Riley & Collins, 2016).

Conclusion and future research

This study shows there is a link between attitudes towards mathematics and the choice of study fields among economics and business students at a university in Norway. Attitudes towards mathematics can help to explain why students choose differently. Students at Business School are more heterogenous than those belonging to the other departments at the Faculty of Economics and Management.

Admittance to Business School is based on GPA scores from upper secondary school. Unlike the Department of Industrial Economics and Technology Management, there is no prerequisite level of skills in mathematics.

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The background in mathematics from upper secondary school varies. As long as the criterion for enrolment at Business School is unchanged, a heterogenous group of students can be expected. Therefore, it is important that the students can choose between different major subjects depending on interest, preferences and attitudes towards mathematics. For students with poor self-confidence and enjoyment in mathematics, non-quantitative courses help them complete their study programme. This must be taken into account in the further development of the study programme at business schools in Norway.

There are some options for further research. Instead of analyzing attitudes towards mathematics one could use the actual performance in business mathematics and evaluate if success in mathematics is a good predictor for selection of majors. An extension of this study is to consider other factors than attitudes towards mathematics that can influence the choice of majors like salary, career opportunities, job security etc. Another approach is to examine how the outcome in different courses depends on the attitudes towards mathematics.

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