DOI: 10.52950/TE.2023.11.1.004

THE RELATIONSHIP BETWEEN NORWEGIAN BUSINESS STUDENTS' ATTITUDES TOWARDS MATHEMATICS AND SUCCESS IN BUSINESS EDUCATION

LEIV OPSTAD

Abstract:

Although mathematical skills are an important component for business students, many students struggle to understand and meet the demands in different subjects. There is a considerable heterogeneity among the different subjects and the need for good mathematical skills varies from subject to subject. To analyse this, we apply the Attitudes Towards Mathematics Inventory (ATMI) framework. The data are collected by asking students at a business school in Norway. The results are linked to the exam grades in the various subjects. The sample consists of approximately 150 students. As a research method, the standard linear regression model is used. The results show that there is a strong positive correlation between ATMI and success in the various subjects. This applies specifically to the dimension of self-confidence in mathematics. However, there is a considerable variation between the subjects, and in some non-quantitative subjects such as marketing, no correlation was found in this study between ATMI and exam grades. As control variables in the model, gender and Grade Point Average (GPA) from the upper secondary school were included. These variables had a rather small influence on the results for the subjects, but with significant statistical effects on some subjects. This article provides insight into a key factor that can help explain how students are performing in the various business subjects

Keywords:

business students, ATMI, mathematical skills, performance in business courses, linear regression models

JEL Classification: C00, A22, M20

Authors:

LEIV OPSTAD, NTNU Business School, Norwegian University of Science and Technology and Department of Business Administration, Western Norway University of Applied Sciences, 6856 Sogndal, Norway, Norway, Email: leiv.opstad@ntnu.no

Citation:

LEIV OPSTAD (2023). THE RELATIONSHIP BETWEEN NORWEGIAN BUSINESS STUDENTS' ATTITUDES TOWARDS MATHEMATICS AND SUCCESS IN BUSINESS EDUCATION. International Journal of Teaching and Education, Vol. XI(1), pp. 47-60., 10.52950/TE.2023.11.1.004

1. Introduction

Attitudes towards mathematics and the ability to use and think in mathematical terms are a key factor for academic success in many areas such as science, engineering, medicine, economics and more (Hoon et al., 2018). Many articles have been published that have researched the relationship between mathematics skills and achievement in subject areas. This also applies within the discipline of business administration. Mathematical abilities seem to be an important factor for success in economics courses (Ballard and Johnson, 2004).

There is a positive link between attitudes towards mathematics and performance in mathematics (Bhowmik and Roy, 2016; Kundu and Ghose, 2016; Opstad, 2021a). Those dimensions are closely linked to each other (Burstein, 1992).

Few published studies have looked at the relationship between attitudes towards mathematics and achievement in subjects other than mathematics. But some papers do address this question, such as Primi et al. (2020), who investigate the correlation between attitudes towards mathematics and achievement in statistics.

This author does not know of any published article that has specifically studied the connection between attitudes towards mathematics and success in various subjects related to the undergraduate business programme. The purpose of this article is to investigate the relationship between attitudes towards mathematics and performance in the various subjects. There is a substantial heterogeneity of subjects in the bachelor programme for business students, and it affects the role of mathematics. When it comes to quantitative subjects, there is a strong link between mathematical abilities and results, but the relationship is significantly weaker for the more verbal subjects such as organizational theory and marketing (Opstad, 2018). Since the importance of mathematics varies from subject to subject, it is interesting to look at what the relationship between ATMI and performance is like in the different courses. This is useful knowledge in planning the programme for business students.

2. Attitudes towards mathematics

Attitudes towards mathematics is a tool for catching an individual's emotional and cognitive approach towards mathematics. There are many contributors and different versions to measure this. A method that has received a lot of recognition and that is well applied is the Attitudes Towards Mathematics Inventory (ATMI), which was developed by Tapia and Marsh (2004). ATMI has four categories: Self-confidence, Enjoyment, Value and Motivation (see Table 1). It is based on a self-report questionnaire (40 questions/items).

Table 1. Attitudes Towards Mathematics Inventory (ATMI)

Dimension	Explanation: The extent to which:
Self-confidence (S)	an individual believes in success in mathematics, is confident and feels capable in dealing with mathematical issues. Example statement: Mathematics does not scare me at all.
Enjoyment (E)	an individual finds the subject interesting and enjoyable. Example statement: I like to solve new problems in mathematics.
Value (V)	mathematics is useful and relevant for one’s life. Example statement: Mathematics is important in everyday life.

Motivation (M)	it is about motivation and interest in mathematical issues. Example statement: The challenge of mathematics appeals to me.

3. Literature review

According to Tanveer et al. (2015), it is difficult to complete a bachelor programme in business studies without mathematical skills. For instance, introductory courses in economics require basic mathematical skills. This explains why there is a positive relationship between mathematical knowledge and success in introductory microeconomics (Johnson and Kuennen, 2004). Quantitative abilities are a key factor for success in introductory economics (Ballard and Johnson, 2004).

Johnson and Kuennen (2006) discuss the link between mathematical skills and success in introductory statistics. Although the introductory course in statistics is quantitatively oriented, the content is different to that in the introductory course in mathematics. But there are a lot of technical computations in statistics. Hence, strong mathematical abilities are probably important factors for good grades in statistics. Primi et al. (2016) point out that students with relevant basic mathematical knowledge tend to receive good results in statistics. Mathematical abilities are important for achieving success in statistics courses. Primi et al. (2020) find a significant relationship between ATMI and performance in statistics among Italian college students. Some authors (e.g. Johnson and Kuennen, 2006) do not find any significant correlation between skills in mathematics and performance in statistics.

Good performance in the compulsory course in mathematics is important for success in business subjects (Lagerlöf and Seltzer, 2009). A lack of mathematical competency can cause anxiety in studying quantitative subjects at business schools (Benedict and Hoag,, 2002). But the positive effect of mathematical knowledge will probably be reduced over time (Pozo and Stull, 2006).

Cerbito (2020) reports that students have different attitudes towards mathematics depending on study fields. Although many see the value of mathematics, they still have negative attitudes towards mathematics (in terms of self-confidence, enjoyment and motivation). Students from Science, Technology, Engineering and Mathematics (STEM) have the highest scores in ATMI. Matotek (2017) and Duggan et al. (2017) point out that STEM students have higher scores in ATMI than non-STEM students. This is consistent with the finding of Opstad (2019). He concludes that students from Industrial Economics and Technology Management have higher ATMI scores than economics and business students.

The literature shows there is a strong link between mathematical skills and self-confidence in mathematics (Hathella and Priyanath,2021). As an individual's mathematical skills improve, their confidence in their ability to solve mathematical problems also tends to increase. Studies report a strong correlation between ATMI and performance in quantitative analysis: for instance, Wakhata et al. (2023) conclude that ATMI is strongly positively related to achievements in linear programming analysis.

4. Hypotheses

This study assumes there is a connection between ATMI and success in business education. Mathematics is an important foundation for many business subjects, such as accounting, finance and economics. Students who have positive attitudes towards mathematics may be more likely to engage with, and succeed in, these fields.

In addition, students who have positive attitudes towards mathematics may be more likely to pursue careers in fields that require mathematical skills, such as finance, accounting or data analysis. This can increase their opportunities for success in these fields.

Overall, the relationship between attitudes towards mathematics, as measured by ATMI, and success in business subjects is complex and may be influenced by various factors, such as students' prior knowledge and skills in mathematics, their motivation to learn and the teaching methods used in the courses. Positive attitudes towards mathematics can be a predictor of success in business subjects that require mathematical skills. Yousef (2011) points out that the academic success among business students differs between quantitative and non-quantitative subjects. One assumption may be that students who have positive attitudes towards mathematics are more likely to perform well in quantitative courses in business. This leads to the following:

Hypothesis 1 (H1): There is a positive link between ATMI and success in business subjects.

Hypothesis 2 (H2): The relationship between ATMI and performance varies among business subjects.

Overall, these studies suggest that students' attitudes towards mathematics can have an impact on their performance in courses outside of mathematics, such as business and accounting courses. Positive attitudes towards mathematics and reduced mathematics anxiety are expected to be associated with better performance in these courses.

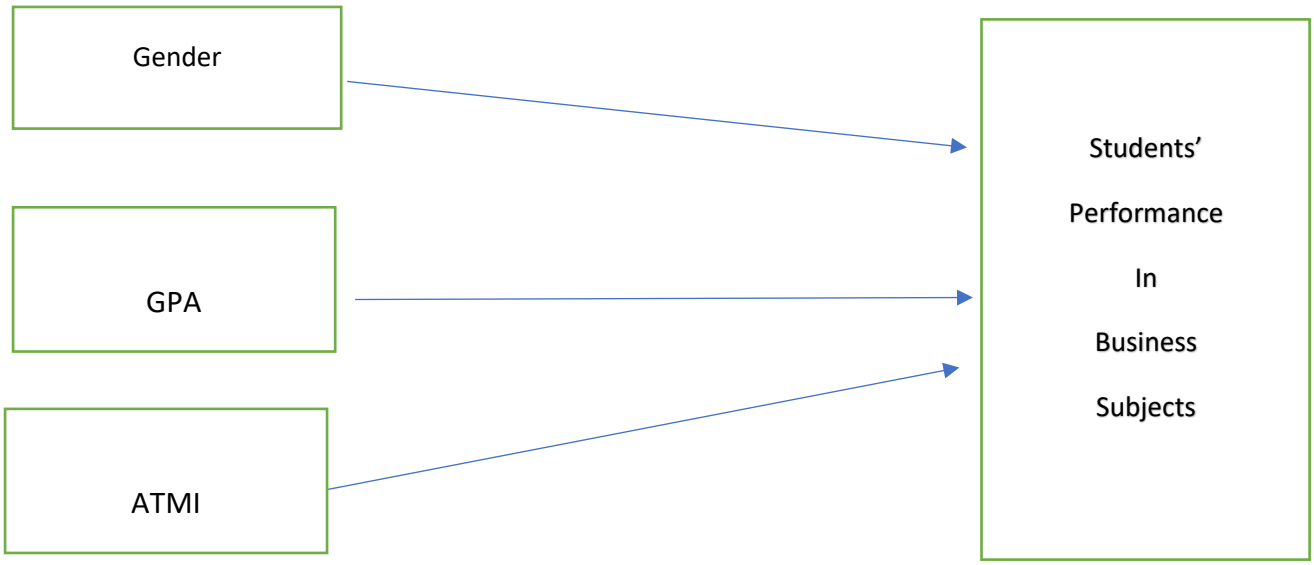

Figure 1. Model assuming a link between gender, GPA, ATMI and success in business education

The focus of this article is to look at the link between ATMI and students' success in business courses. The model includes two control variables, namely gender and Grade Point Average (GPA) from upper secondary school (see Figure 1).

Research suggests there may be a relationship between gender and students' performance in business subjects (Krishna and Orhun, 2022). Males and females tend to have different

learning styles and approaches to studying: females tend to be collaborative and less risk-taking than males. However, the observed differences in performance between male and female students seem to be rather small in business education (Arnold, 2020; Opstad and Årethun, 2020; Opstad 2021b). This can also be influenced by factors like prior knowledge, motivation, interest, effort and personality traits.

There is some evidence to suggest that there may be an association between a student's Grade Point Average (GPA) from upper secondary school and their performance in business courses at the university level (Brookshire and Palocsay, 2005; Opstad, 2021c; Sulphey et al., 2018). Students who have achieved high GPAs in upper secondary school have demonstrated a level of academic aptitude and discipline that can translate to success in university-level coursework. Additionally, students who have performed well in previous business-related coursework in upper secondary school may have a better foundation of knowledge and skills that can be applied in university-level business courses. However, there are many factors influencing students' performance. Hence, GPA may not be a strong indicator. We postulate the third hypothesis:

Hypothesis 3 (H3): Gender and GPA are correlated with achievement in business courses.

It is reasonable to assume a positive correlation regarding GPA, while it can be either a positive or negative relation with respect to gender. It is not obvious whether male or female students perform best. It probably depends again on the subjects.

5. Data and methodology

5.1 The data set

The data in this analysis are based on information obtained by distributing a questionnaire in 2018 and 2019 to the undergraduates attending a compulsory course at a business school in Norway. About 60 per cent of the students were present. To link the information to administrative data on performance in the various subjects, one depends on the permission of the individual student. About half of the students gave such an approval. The final sample therefore comprises around 150 students. Like many other studies, the original version of ATMI is used without conducting a separate factor analysis (Cerbito, 2020; Shuilleabhain et al., 2020).

Table 2 presents an overview of the descriptive statistics including the different subjects that are studied in more detail in this analysis.

Note: the high values on the different dimensions included in ATMI.

5.2 Methodology

The quantitative methodological approach is a standard linear regression model. It is based on the presentation in Figure 1. The model looks like this:

$$Yi = a_0 + a_1X_{1i} + a_2X_2i + a_3X_{3i} + a_4X_{4i} + a_5X_{5i} + a_6X_{6i} + \varepsilon_i$$

where:
Y_i = grade attained in the business subject (1: E, 2:D, 3:C, 4:B, 5:A)
i = student, α_0 = constant
X_1 = gender (0:F, 1:M)
X_2 = upper secondary school GPA
X_3 = self-confidence in mathematics (7-point Likert scale, 1 = strongly disagree, 7 = strongly agree)
X_4= value of mathematics (7-point Likert scale, 1 = strongly disagree, 7 = strongly agree)
X_5 = motivation in mathematics (7-point Likert scale, 1 = strongly disagree, 7 = strongly agree)
X_6 = enjoyment in studying mathematics (7-point Likert scale, 1 = strongly disagree, 7 = strongly agree)
ε = stochastic error

Table 2. Descriptive statistics and success in different business subjects (For the performance the measurement is 1:E, 2:D, 3:C, 4:B, 5:A, F is not included, SD: Standard Deviation

	Mean	SD
Gender (0:F,1:M)	.44	.50
GPA (Upper Secondary School)	51.23	3.32
Finance		
Investment and Financial Analysis	4.06	.84
Economics etc.		
Macroeconomics	3.31	1.12
Microeconomics	3.54	1.12
Applied Microeconomics	3.65	.85
Managerial Economics and Accounting	3.66	1.02
Statistics and Methods		
Business Statistics	3.93	1.20
Quantitative and Qualitative Methods	3.50	.88
Accounting		
Financial Accounting with Financial Analysis	3.61	1.17
Cost Accounting and Budgeting	3.88	1.15
Management and Strategy		
Organizations and Management	3.31	1.01
Business Strategy	3.42	.79
Marketing		
Marketing Basic	3.41	.86
Marketing Communication and Brand Building	3.37	.98
ATMI		
Self-Confidence	5.03	1.07
Value	5.01	.95
Motivation	4.81	1.12
Enjoyment	4.56	1.25

Some of the subjects were only taught in one year, others are electives and in some cases no data are available for both years. Therefore, the number of observations varies from 42 to 153 for the different subjects.

Due to multiculturality high VIF (variance inflation) values, not all four dimensions of ATMI can be included. Therefore, two model versions are presented. In Model 1, motivation is not included, and in Model 2, value and enjoyment are not included.

6. Findings and discussion

Tables 3 to 6 show the results of the regression analysis. There are identical explanatory answers for all subjects, but the number of observations varies depending on the course. Table 3a) to c) presents the quantitatively oriented courses. Tables 4 and 5 are mixed between a quantitative and non-quantitative focus. Table 5 shows subjects that are perceived as not very quantitative in their approach.

Table 3a. Results from regression model. Standardized B-coefficients (quantitative courses)

	Investment and Financial Analysis (2nd year)				Macroeconomics (2nd year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	.146	1.06	.149	1.09	.186	2.52**	.162	2.19**
GPA	.155	1.12	.157	1.14	.120	1.57	.101	1.32
Self-Confidence	-.172	-.91	-.250	-1.07	.334	3.04***	.190	1.51
Value	-.090	-.46			-.038	-.38		
Enjoyment	.491	2.14**			.097	.75		
Motivation			.460	1.96*			.205	1.60
	Adj. R^s = .082, N = 50		Adj. R^s = .071, N = 50		Adj. R^s = .179, N = 151		Adj. R^s = .168, N = 153	

*: P< .1, **: P <.05, ***: P<.001

Table 3b. Results from regression model. Standardized B-coefficients (quantitative courses)

	Microeconomics (1st year)				Applied Microeconomics (Voluntary 2nd year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	.070	.93	.056	.74	-.168	-1.74*	-.177	-1.81*
GPA	.089	1.15	.065	.83	.129	1.34	-111	1.14
Self-Confidence	.451	3.93***	.370	2.87***	.410	2.98***	.394	2.48**
Value	-.111	-1.08			-.104	-.92		
Enjoyment	.022	.165			-.110	-.73		
Motivation			.027	.21			-.144	-.91
	Adj. R^s =.164, N = 148		Adj. R^s = .145, N = 150		Adj. R^s = .098, N = 98		Adj. R^s = .080, N = 99	

*: P < .1, **: P < .05, ***: P < .001

Table 3c. Results from regression model. Standardized B-coefficients (quantitative courses)

	Managerial Economics and Accounting (Ist year)				Business Statistics (1st year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	.150	2.02**	.146	1.98**	.092	1.37	.092	1.39
GPA	.180	2.34**	.157	2.04**	.164	2.38**	.141	2.07**
Self-Confidence	.364	3.26***	.266	2.10**	.557	5.59***	.466	4.81***
Value	-.147	-1.42			-.017	-.19		
Enjoyment	.048	.355			.025	.22		
Motivation			.077	.59			.133	1.17
	Adj. R^s = .148, N = 155		Adj. R^s = 148, N = 157		Adj. R^s = .346, N = 145		Adj. R^s = .363, N = 147	

*: P< .1, **: P <.05, ***: P<.001

6.1 ATMI and success in business courses (H 1 and H2)

This study shows a clear correlation between the dimension ATMI and performance in the quantitative business subjects. There is, in particular, a strong link between self-confidence and achievements. The effect is greatest for statistics with a value of the standardized B-coefficients of as much as .557 (and with a t-value of more than 5.5). One standard deviation increase in the grade of business statistics is associated with a .557 rise in standard deviation of self-confidence in mathematics. The value of the B-coefficient is also high for microeconomics and applied microeconomics (between .4 and .5). If we disregard the subject investment and financial analysis, the link between self-confidence and success is lowest for macroeconomics and managerial economics and accounting (B around .35). Based on the use of mathematics in the various subjects, this is not a surprising result.

Mathematical skills seem to be essential for success in business statistics and microeconomics. Both fields rely heavily on mathematical concepts such as algebra, calculus and statistics to analyse and interpret data, make informed decisions and solve complex problems. In statistics, mathematical abilities are a key factor for using and understanding the topics (Lunsford and Poplin, 2011). It is difficult to analyse and interpret data sets, calculate probabilities and make predictions without mathematical skills. Statistical analyses are based on mathematical models to identify trends and patterns in data. This explains the strong correlation between self-confidence in mathematics and achievements in business statistics. Green et al. (2009) point out that mathematics courses that focus on calculus are specifically correlated with success in business statistics. Similarly, in microeconomics, a mathematical background is necessary to understand topics like the behaviour of individuals, firms and the markets. One uses mathematical models to analyse supply and demand and to find optimal pricing strategies. Therefore, one can expect ATMI to be closely linked because microeconomics is a discipline that relies heavily on mathematical concepts and analytical skills. The ability to understand and apply mathematical concepts is crucial to mastering microeconomic theory and its various applications. Mathematical skills are a good predictor of success in microeconomics (Parker, 2006). This study is in line with this finding.

The two courses macroeconomics and managerial economics and accounting place less emphasis on mathematics than microeconomics. This probably explains why the value of the B-coefficient is lower for these two subjects than for microeconomics.

The subject investment and financial analysis is based largely on advanced mathematics. The research shows that in this subject there is a close link between mathematical abilities and success (Ross, 2022; Ross and Wright, 2020). Somewhat surprisingly, this study shows no

statistical correlation between self-confidence in mathematics and achievement in this subject. In contrast, there is a strong correlation between enjoyment and motivation in mathematics and the grade obtained for the final exam (B-coefficient is close to .5). For the other quantitative business subjects, these two dimensions (Enjoyment and Motivation) do not have any statistical effect. Perhaps the explanation is that in this subject the mathematical tool is used extensively. Those who like mathematics will have great pleasure and interest in this course. This motivates them and they are rewarded with better grades.

Table 4. Results from regression model. Standardized B-coefficients (Accounting courses)

	Financial Accounting with Financial analysis (1st year)				Cost Accounting and Budgeting (2nd year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	.150	2.02**	.146	1.98**	.130	1.69*	.125	1.64
GPA	.180	2.34**	.157	2.04**	.077	.98	.069	.87
Self-Confidence	.364	3.26**	.266	2.10**	.262	2.28	.259	2.00**
Value	-.147	-.142			-.030	-.29		
Enjoyment	.048	.355			.134	.99		
Motivation			.077	.59			.097	.74
	Adj. R^s = .148, N = 155		Adj. R^s = .148, N = 157		Adj. R^s = .124, N = 149		Adj. R^s = .120, N = 151	

*: P < .1, **: P < .05, ***: P < .001

Accounting is all about numbers. In the introductory courses, the focus is on simple algebraic calculations such as plus, minus, multiply, divide and more. Fedoryshyn et al. (2010) find a strong positive relationship between arithmetic thinking and performance in accounting courses. The more advanced part of mathematics, on the other hand, is not used to any great extent in this subject. Accounting requires attention to detail and a high level of precision, which is probably linked to mathematical skills. Furthermore, accounting courses require students to analyse data, interpret financial statements and make recommendations. These are properties that are associated with mathematical skills. This probably explains why the literature shows there is a substantial link. This is in line with the investigation in this paper that finds a strong positive correlation between self-confidence in mathematics and performance in accounting (Table 4). Hence, self-confidence in mathematics seems to be a critical component of success in accounting.

In addition, strong mathematical skills can help students in accounting courses to better understand and apply accounting principles and concepts. Many of the concepts in accounting, such as accrual accounting, depreciation and financial ratios, rely heavily on mathematical calculations. Students who are proficient in maths can more easily grasp these concepts and apply them in real-world scenarios.

Overall, strong mathematical skills are essential for success in accounting courses. By improving their mathematical abilities, students can better understand and apply accounting concepts, perform calculations accurately and succeed in their accounting coursework.

Several authors claim that mathematical abilities and achievements in accounting are strongly positively correlated (McCarron and Burstein, 2017; Mkhize, 2019).

Table 5. Results from regression model. Standardized B-coefficients (Quantitative and qualitative methods is partly a quantitative and partly a non-quantitative course; Organizations and management is a non-quantitative course)

	Quantitative and Qualitative Methods (3rd year)				Organizations and Management (1st year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	-.008	-.07	-.025	-.20	.068	.84	.058	.72
GPA	.135	1.08	.118	.93	.015	.182	.024	.29
Self-Confidence	-1.83	-1.08	-.176	-.85	.213	1.78*	.255	1.87*
Value	-.298	-1.66			.062	.53		
Enjoyment	.572	2.67**			-.234	-1.61		
Motivation			.305	1.47			-.233	-1.67*
	Adj. R^s = .058, N = 64		Adj. R^s = -.003, N = 64		Adj. R^s = -.005, N = 154		Adj. R^s = .002 N = 156	

*: P < .1, **: P < .05, ***: P < .001

Table 6. Results from regression model. Standardized B-coefficients (non-quantitative courses)

	Marketing Basic (1st year				Marketing Communication and Brand Building (Voluntary 3rd year)			
	Model 1		Model 2		Model 1		Model 2	
	B	t-value	B	t-value	B	t-value	B	t-value
Gender	.162	1.56	.127	1.22	-.143	-.90	-.223	-1.49
GPA	.081	.75	.050	.471	-.59	-.37	-.040	-.27
Self-Confidence	.114	.784	-.018	-.10	-.019	-.09	.122	.56
Value	-.213	-1.36			-.083	-.48		
Enjoyment	.048	.263			-.270	-1.18		
Motivation			.037	.21			-.451	-2.06**
	Adj. R^s = -.003, N = 95		Adj. R^s = -.023 N = 96		Adj. R^s = .021, N = 42		Adj. R^s = .83, N = 42	

*: P< .1, **: P <.05, ***: P<.001

The link to ATMI is weaker for subjects that are less likely to use mathematics as an aid in the presentation (Tables 5 and 6). Only the course Organizations and Management shows a positively significant link between self-confidence and exam grades. At the same time, there is a significant negative relationship between motivation in mathematics and success. This negative impact is even stronger for the voluntary organization course (Marketing Communication and Brand Building) that runs for a third year. The reason may be due to personal characteristics, personal interest or preferences. Maybe studying mathematics requires a different kind of skills compared to organizational subjects.

It is worth noting that success in the course Quantitative and qualitative methods is strongly positively related to the dimension enjoyment of mathematics. Students must apply mathematics to analyse cases in this course. Perhaps students who enjoy using mathematics tend to perform better.

This research cannot demonstrate any significant correlation between performance in the introductory marketing course and ATMI.

Stenberg et al. (2010) suggest that success in business education depends on students' degree of mathematical skills (Stenberg et al., 2010). This may explain the finding in this study that ATMI is strongly correlated with performance in business subjects (cf. Hypotheses 1). The effects vary greatly depending on, among other things, how quantitatively oriented the subjects are. This confirms Hypothesis 2.

6.2 Gender, GPA and success in business courses (H3)

There is a lot of research on gender and performance in economic and administrative subjects and with mixed results. Milun et al. (2006) report that female students outperform male students in subjects like accounting, economics, marketing and business mathematics. Borde et al. (1998) suggest the opposite in the introductory finance course. In this study, there is no significant gender impact for most subjects. In some subjects, the results in this study favour men (macroeconomics, managerial economics and accounting as well as financial accounting with financial analysis), while women do best in others (applied microeconomics). To explain these differences, access to other explanatory variables are necessary.

The value of the GPA determines who gets to access the undergraduate business programme. This study shows that GPA is a rather weak predictor of success in business education. For most subjects, there is no significant connection. The following subjects show a positive correlation: managerial economics and accounting, business statistics and inclusive financial accounting and financial analysis. This is consistent with published articles suggesting that GPA from high school is not a good indicator of performance in business subjects (Brookshire and Palocsay, 2005). There are probably many other factors influencing an undergraduate business student's success.

We can conclude that gender and GPA are to some extent linked to success in business subjects (cf. hypothesis 3).

7. Limitations

The analysis in this research has some limitations: the analysis is from only one business school; and in some of the subjects there are few observations. This creates uncertainty about the findings. There are low values of adjusted R square. Hence, there are many other variables that can explain the success in the various subjects. However, the focus of this article was the correlation between ATMI and achievements.

8. Conclusion

Previous research has shown that there is a close link between ATMI (Attitudes Towards Mathematics Inventory) and achievements in mathematics. Furthermore, mathematical skills are a very important component in explaining success for business students. ATMI contains several dimensions and there is a heterogeneous subject portfolio. By asking students at a business school in Norway, this study investigates the link between ATMI and achievements in business education. The findings show a strong relationship between ATMI and success. It is especially the self-confidence factor that has a significant impact. There is a significant difference among the subjects. In some of the non-quantitative subjects, the impact is small. There is also an example of negative correlation between the dimension of motivation to study mathematics and success.

Gender and GPA from upper secondary school were included as explanatory variables in the regression models. Overall, they had rather small impacts, but with effects for some of the subjects.

The findings of this study are probably of general interest. This author is not aware of any published articles on this subject. More research is needed to explain why, for example, the category enjoyment in using mathematics was positively correlated to success in only two of the business subjects.

References

Arnold, I. J. (2020). Gender and major choice within economics: Evidence from Europe. *International Review of Economics Education*, 35, 100191.

Ballard, C. L., and Johnson, M. F. (2004). Basic math skills and performance in an introductory economics class. *The Journal of Economic Education*, 35(1), 3–23. https://doi.org/10.3200/JECE.35.1.3-23

Benedict, M. E., and Hoag, J. (2002). Who's afraid of their economics classes? Why are students apprehensive about introductory economics courses? An empirical investigation. *The American Economist*, 46(2), 31–44.

Bhowmik, M., and Roy, B. B. (2016). A study on the relationship between achievement in mathematics and attitude towards mathematics of secondary school students. *Scholar*, 1(2), 49–55.

Borde, S. F., Byrd, A. K., and Modani, N. K. (1998). Determinants of student performance in introductory corporate finance courses. *Journal of Financial Education*, 23–30.

Brookshire, R. G., and Palocsay, S. W. (2005). Factors contributing to the success of undergraduate business students in management science courses. *Decision Sciences Journal of Innovative Education*, 3(1), 99–108.

Burstein, L. (1992). The analysis of multilevel data in educational research and evaluation. *Review of Research in Education*; 8, 158–223. Federal Republic of Nigeria 2004: National Policy on Education (Revised), NERC.

Cerbito, A. F. (2020). Comparative analysis of mathematics proficiency and attitudes toward mathematics of senior high school student. *Online Submission*, 10(5), 211–222. https://doi.org/10.29322/IJSRP.10.05.2020.p10125

Duggan, L., Cowan, P., and Cantley, I. (2017). Are first year undergraduates mathematically resilient? A comparison of a STEM and a non-STEM discipline in an Institute of Technology. *International Journal for Cross-Disciplinary Subjects in Education*, 8(3), 3169–3178.

Fedoryshyn, M. W., O'Brien, M., Hintz, A., and Bosner, K. (2010). Arithmetical reasoning skills as a predictor of success in principles of accounting. *Academy of Educational Leadership Journal*, 14, 93.

Green, J. J., Stone, C. C., Zegeye, A., and Charles, T. A. (2009). How much math do students need to succeed in business and economics statistics? An ordered probit analysis. *Journal of Statistics Education*, 17(3). https://doi.org/10.1080/10691898.2009.11889532

Hathella, H. V. R. G., and Priyanath, H. M. S. (2021). Demographic features and mathematics performance of students: A case of GCE O/L students in Ratnapura Educational Zone. https://doi.org/10.1016/j.stueduc.2020.100838

Hoon, T. S., Singh, P., Han, C. T., Nasir, N. A. M., Rasid, N. S., and Yusof, M. M. (2018).

Mathematical thinking attainment among university students. *Journal of Economic & Management Perspectives*, 12(1), 623–629.

Johnson, M., and Kuennen, E. (2004). Delaying developmental mathematics: The characteristics and costs. *Journal of Developmental Education*, 28(2), 24–29.

Johnson, M., and Kuennen, E. (2006). Basic math skills and performance in an introductory statistics course. *Journal of Statistics Education*, 14(2). https://doi.org/10.1080/10691898.2006.11910581

Krishna, A., and Orhun, A. Y. (2022). Gender (still) matters in business school. *Journal of Marketing Research*, 59(1), 191–210.

Kundu, A., and Ghose, A. (2016). The relationship between attitude towards and achievement in mathematics among higher secondary students. *International Journal of Multidisciplinary Research and Development*, 3(6), 69–74.

Lagerlöf, J. N., and Seltzer, A. J. (2009). The effects of remedial mathematics on the learning of economics: Evidence from a natural experiment. *The Journal of Economic Education*, 40(2), 115–137. https://doi.org/10.3200/JECE.40.2.115-137

Lunsford, M. L., and Poplin, P. (2011). From research to practice: Basic mathematics skills and success in introductory statistics. *Journal of Statistics Education*, 19(1). https://doi.org/10.1080/10691898.2011.11889604

Matotek, J. (2017). Mathematics attitudes among students of Civil Engineering. In Z. Kolar-Begović,

R. Kolar-Šuper, & L. Jukić Matić (Eds.), *Mathematical Education as a Science and a Profession, 209–222 Element.*

McCarron, K. B., and Burstein, A. N. (2017). The importance of mathematics as a prerequisite to introductory financial accounting. *Community College Journal of Research and Practice*, 41(9), 543–550. https://doi.org/10.1080/10668926.2016.1179235

Milun, T., Mardešić, J., and Kovač, G. (2016). Do gender and age impact student success?. Retrieved from https://bib.irb.hr/ datoteka/931745.Do_gender_and_age_impact_student_suc cess.pdf

Mkhize, M. V. (2019). Transdisciplinary relationship between mathematics and accounting. *TD: The Journal for Transdisciplinary Research in Southern Africa*, 15(1), 1–18.

Opstad, L. (2018). Success in business studies and mathematical background: The case of Norway. *Journal of Applied Research in Higher Education*. https://doi.org/10.1108/JARHE-11-2017-0136

Opstad, L. (2019). Different attitudes towards mathematics among economic and business students and choice of business course major in Norway. *Social Sciences and Education Research Review*, 6(2), 6–30.

Opstad, L. (2021a). Factors explaining business students' performance in an introductory mathematics course. What are the impacts of gender, academic ability, personality traits, and attitudes towards mathematics? *Advances in Education Sciences*, 3(1), 23–43. https://org/10.5281/zenodo.5791926

Opstad, L. (2021b). Can we identify the students who have success in macroeconomics depending on exam format by comparing multiple-choice test and constructed response test?. *International Journal of Education Economics and Development*, 12(4), 311–328.

Opstad, L. (2021c). Performance and differences in grading practices among undergraduates at business schools. *International Journal of Assessment Tools in Education*, 8(4), 785–800.

Opstad, L., and Årethun, T. (2020). Skills, gender, and performance matter when undergraduate business students choose specialisation within business courses. .*International Journal of Management, Knowledge and Learning*, 9(1), 95–107

Parker, K. (2006). The effect of student characteristics on achievement in introductory microeconomics in South Africa. *South African Journal of Economics*, 74(1), 137–149.

Pozo, S., and Stull, C. A. (2006). Requiring a math skills unit: Results of a randomized experiment. *American Economic Review*, 96(2), 437–441. https://doi.org/10.1257/000282806777212486

Primi, C., Bacherini, A., Beccari, C., and Donati, M. A. (2020). Assessing math attitude through the

Attitude Toward Mathematics Inventory–Short form in introductory statistics course students. *Studies in Educational Evaluation*, 64,https://doi.org/10.1016/j.stueduc.2020.100838

Primi, C., Donati, M. A., and Chiesi, F. (2016). A mediation model to explain the role of mathematics skills and probabilistic reasoning on statistics achievement. *Statistics Education Research Journal*, 15(2), 169–178.

Ross, M. M. (2022). Graduate corporate finance: Are math skills an obstacle?. *Journal of Education for Business*, 1–8.https://doi.org/10.1080/08832323.2022.2063238

Ross, M. M., and Wright, A. M. (2020). Quantitative skill and introductory finance. *Journal of Financial Education*, 46(2), 193–220.

Shuilleabhain, A. N., Cronin, A., and Prendergast, M. (2020). Maths sparks engagement programme: investigating the impact on under-privileged pupils' attitudes towards mathematics. *Teaching Mathematics and Its Applications: International Journal of the IMA*, 40(1), 133–153.

Stenberg, L. C., Varua, M. E., and Yong, J. (2010). Mathematics aptitude, attitude, secondary schools and student success in quantitative methods for business subject in an Australian Catholic university experience.

Sulphey, M. M., Al-Kahtani, N. S., and Syed, A. M. (2018). Relationship between admission grades and academic achievement. *Entrepreneurship and Sustainability Issues*, 5(3), 648–658.

Tanveer, M. A., Rizwan, M., Ali, N., Arif, M., Saleem, U., and Rizvi, S. (2015). Examining the role of attitude towards mathematics in students of management sciences. *Journal of Business and Management(IOSR_JBM)*, 67–73.

Tapia, M., and Marsh II, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, 8(2), 16–21.

Wakhata, R., Mutarutinya, V., and Balimuttajjo, S. (2023). Relationship between active learning heuristic problem-solving approach and students' attitude towards mathematics. *EURASIA Journal of Mathematics, Science and Technology Education*, 19(2), em2231. https://doi.org/10.29333/ejmste/12963

Yousef, D. A. (2011). Academic performance of business students in quantitative courses: A study in the faculty of business and economics at the UAE University. *Decision Sciences Journal of Innovative Education*, 9(2), 255–267. https://doi.org/10.1111/j.1540-4609.2011.00305.x

