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FACTORS EXPLAINING BUSINESS STUDENTS' PERFORMANCE IN AN INTRODUCTORY MATHEMATICS COURSE. WHAT ARE THE IMPACTS OF GENDER, ACADEMIC ABILITY, PERSONALITY TRAITS, AND ATTITUDES TOWARDS MATHEMATICS?

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Abstract

Mathematics skills are key factors for success in business studies, and for access to business degrees. It is important, therefore, to understand the determinants of mathematics scores among business students. The aim of our study was to identify factors that can explain mathematics performance among a cohort of business school students in Norway. This paper used a linear regression to quantify statistical associations between mathematics performance and the following independent variables: gender, grade point average (GPA) from upper secondary school, background in mathematics education, Big Five personality traits, and attitudes towards mathematics (ATM). Two factors – mathematics background, and self-confidence in mathematics – were positively associated with performance, though the significant effect of mathematics background disappeared after controlling for ATM. Given the importance of mathematics for success

in business studies, we recommend that efforts are made to improve students' confidence in this topic.

Keywords*:* gender, attitudes towards mathematics, Big Five, mathematics skills, performance in business mathematics, regression analysis.

1. Introduction

Few colleges or universities in Norway require a mathematics qualification for entrance to courses in economics and business administration. Although mathematics is compulsory at upper secondary school, students can choose among different pathways spanning the continuum from pure to applied mathematics. For example, students in their second year can select mathematics for natural science (hereafter 'N-maths'), which includes geometry, and the applications of vectors. Students can also choose to specialise in this field during their third year, and in all cases, the mathematics grade is included in the student's grade point average (GPA).

Mathematics plays an important role in business studies. In quantitative subjects like accounting, economics, and finance, mathematics knowledge is a significant predictor of students' grades (Arnold & Straten, 2012; Brown-Robertson et al., 2015; Opstad, 2018). Quantitative ability is the factor that best explains performance in subjects such as microeconomics, and mathematics appears to be important for achieving good grades on investment courses (Ballard & Johnson,2004). Students with a strong mathematics background therefore tend to outperform those without it in business courses such as finance (Alcock et al., 2008), and mathematics skill correlates with performance in business law and marketing (Opstad, 2018). According to Alcock et al. (2008), mathematics knowledge is also a good predictor of success in non-quantitative courses, and

Opstad and Årethun (2020) found that mathematics knowledge strongly influenced students' chosen specialisations in business studies and economics. Given the evident importance of mathematics for success in business studies, it is important to understand how and why competence in mathematics varies. There might also be some gender gap in achievements and attitudes towards mathematics (Lee et al.,2018).

The aim of this study was to identify factors associated with mathematics grades in a cohort of students for whom we had data on gender, skills from upper secondary school, Big Five personality traits, and attitudes towards mathematics. The data is from Norwegian University of Science and Technology.

2. Theory and Literature Review

2.1 Gender and Performance in Mathematics

Women and girls are markedly under-represented in science, technology, engineering, and mathematics (STEM) subjects, though this 'gender gap' has narrowed in recent decades (Wang & Degol, 2016), and is not apparent in all countries (Mejía-Rodríguez et al., 2020). Reasons suggested to explain this gap include career and lifestyle preferences, as well as cultural and national factors. Alcock et al. (2014) reported that male undergraduates outperform females in mathematics, but most research indicates that there is no clear difference in ability between the sexes (Reilly et al., 2019). At the secondary school level, boys are more likely to choose theoretical mathematics than girls (Opstad, 2018), but this is not reflected in a difference in exam results. According to the Organisation for Economic Co-operation and Development, girls perform marginally better than boys in upper secondary schools in Norway in 2018 (OECD Education, 2020), and Brandell and Staberg (2008) reported a similar result from Sweden.

2.2 Impacts of Mathematics Background

Those with only practical mathematics from upper secondary school tend to struggle with introductory courses in business mathematics, and students who selected more theoretical mathematics at secondary school subsequently perform better in mathematics than those who did not (Opstad, 2018). Tuan et al. (2019) reported a strong link between GPA at upper secondary school and academic performance in mathematics, suggesting that admission scores for higher education applications can be a good predictor of success in mathematics.

2.3 Impacts of Attitudes towards Mathematics

Attitudes towards mathematics seem to be strongly associated with performance (Farooq & Shah, 2008; Ngussa & Mbuti, 2017), but whilst the research indicates that students who report confidence and interest in mathematics perform better than those who do not (Opstad & Årethun, 2019), the mechanism behind this association is unclear. It is plausible that the causal effect could go in either direction (or both); success will tend to increase self-confidence, and vice-versa (Manzana et al., 2019). Enjoyment also appears to have a positive impact on learning style, behaviour, effort, study time, and engagement with this topic (Syyeda, 2016). Many students have negative feelings towards mathematics, possibly related to negative experiences, feelings of helplessness, or lack of concentration, and mathematics anxiety has negative impacts on motivation and performance (Hoorfar & Taleb, 2015).

One of the more popular methods for quantifying attitudes towards mathematics is the Attitudes Toward Mathematics Inventory (ATMI), with a four-item version (Tapia & Marsh, 2000). This method has high validity and reliability, and is widely used in education research (Asante, 2012; Guy et al., 2015). Numerous studies have demonstrated that scores on the four ATMI dimensions are correlated with mathematics performance (Ajisuksmo & Saputri, 2017; Bal, 2020; Tapia & Marsh, 2004).

2.4 Impacts of Personality Traits

The Big Five personality traits (Costa & McCrae, 1995) comprise a popular taxonomy for measuring personality based on extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience (Roccas et al., 2002). Prior research on the link between personality traits and performance in mathematics is mixed. Pipere and Mieriņa (2017) reported that, of the five dimensions, openness had the strongest positive relationship to success in mathematics, but Meyer et al. (2019) found no significant correlation, and Lipnevich et al. (2016) reported a significant negative correlation between openness and mathematics grades.

Pipere and Mirina (2017) found a negative association between mathematics performance and emotional stability, extraversion, and agreeableness, though the last was not statistically significant. They also found a positive correlation between conscientiousness and performance, in line with studies that suggest a positive link between conscientiousness and various educational fields (Heaven & Ciarrochi, 2008). However, after controlling for attitudes towards mathematics (anxiety, evaluation, self-efficiency, and self-confidence), the association with conscientiousness was negative. Other than anxiety, the attitude factors were themselves significantly associated with performance, with the strongest effect shown for self-belief. Other authors, however, have suggested that personality traits do not contribute much to the performance in mathematics (Lipnevich et al., 2016; Meyer et al., 2019. Meyer et al. (2019) did not find any significant impact of agreeableness, emotional stability, or extraversion on mathematics performance. According to Lipnevich et al. (2016), the key factor explaining success in mathematics is the student's attitude towards the subject.

2.5 Gender and Attitudes towards Mathematics

Asante (2012) found a significant gender difference in all four dimensions of the ATMI (self-confidence, enjoyment, value, and motivation), reporting that females' attitudes towards mathematics were more negative than those of their male peers, potentially influencing their choice of specialisations. Frenzel et al. (2007) also reported a gender gap in attitudes towards mathematics, though, according to Cvencek et al. (2011), the gap has narrowed in recent decades, and some studies indicate that it has now closed completely (Matotek, 2017; Utvær, 2019). According to Alcock et al. (2014), the gender gap in performance (as opposed to attitudes) in mathematics disappears if one controls for personality traits, which are widely believed to differ between the sexes, with females scoring higher on average in agreeableness, extraversion, and conscientiousness, and males scoring higher in emotional stability and openness (Ock et al., 2020; Schmitt, 2008).

3. Hypotheses

We aimed to address the following hypotheses in this study:

H1: There is a gender difference in performance in mathematics.

H2: There is a link between academic and mathematics background, and success in mathematics.

H3: There is a link between personality traits and performance in mathematics.

H4: Attitudes towards mathematics influence performance in mathematics.

There is still discussion about whether gender is a valid predictor of mathematics performance, but since fewer women choose theoretical mathematics at secondary school, one can assume that there are gender differences in mathematics skills in educational settings beyond secondary school, purely as a result of this discrepancy in educational background (Opstad, 2018). Recent research also shows that gender and mathematics abilities have an impact on attitudes towards mathematics (Opstad, 2021a). Given the suggested link between gender and personality traits (Ock et al., 2020; Schmitt et al., 2008), it is reasonable to assume that personality traits also affect attitudes to mathematics, though the results of previous research have been mixed. Figure 1 illustrates this hypothesised set of relationships between gender, personality traits, mathematics skills, attitudes to mathematics, and performance in mathematics.

By using mediation analyses one can distinguish between direct and indirect impact (Kane et al., 2017). Another approach is to put different sets of variables in the regression model (Baldry, 2004; García et al., 2016; Opstad, 2020). In this model, Step 1 presents only gender as an independent variable, Step 2 includes gender and mathematical background and GPA, in Step 3 personality traits enter, and finally Step 4 will add attitudes towards mathematics. The differences between the steps can indicate or be interpreted as the indirect impacts as presented in figure 1 (of the different control variables) (Baldry, 2004). However, the focus in this paper is to the see how the statistical effects changes by using different sets of independent variables.

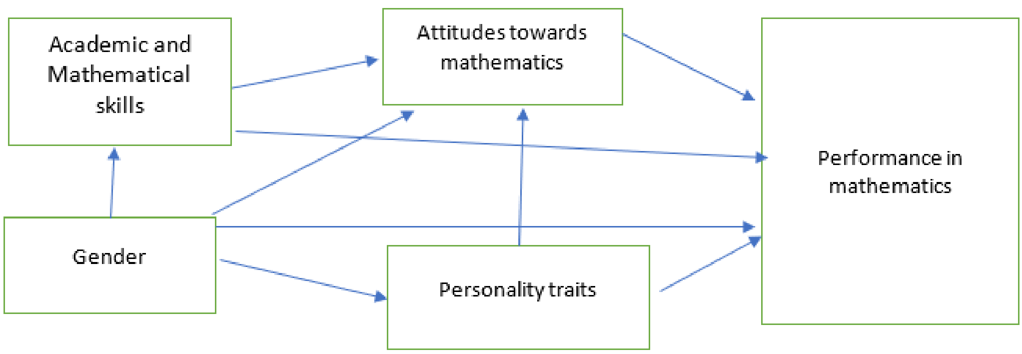

Figure 1. *Theoretical model illustrating links between gender, personality traits, mathematics skills, attitudes to mathematics, and performance in mathematics.*

4. Method

4.1 Sample

The initial sample consisted of 260 undergraduates in 2018 and 2019 combined (see Table 1), all of whom answered a questionnaire designed to assess their attitudes towards mathematics and their Big Five personality traits. In a similar study by Bonesrønning and Opstad (2015), there were more girls, and a marginally higher GPA among the respondents than among all second-year undergraduates at this school. The instruments for measuring ATM followed Tapira and Marsh (2004), and personality traits were assessed using a 20-item Norwegian version of the Big-Five Inventory (BFI-20; Engvik & Clausen, 2011). Only those students who provided personal details (which allowed survey data to be linked to mathematics exam results) could be included, and this reduced the sample to 140.

Table 1 *Descriptive data for the sample of students in the study (NTNU Business School).*

	Min	Max	Mean	St. Dev.	Skewnes s	Kurtosis	Scale Reliability 1)
Gender	0	1	0.45	0.499	0.209	-1.986	
GPA (from Upper Secondary School)	46.9 0	66.70	50.9162	2.76287	1.700	6.452	
Gender	0	1	0.44	0.499	0.229	-1.975	
Performance in business mathematics	0	5	3.44	1.485	-0.877	-0.141	
N-Maths	0	1.00	0.3169	0.46692	0.795	-1.387	
Personality Traits:							
Openness	1.25	5.00	3.3091	0.73703	-0.066	-0.159	0.57

Extraversion	1.75	5.00	3.6856	0.75615	-0.175	-0.527	0.82
Agreeableness	2.00	5.00	3.9882	0.53076	-0.641	0.819	0.61
Conscientiousness	1.50	5.00	3.7583	0.62602	-0.483	0.517	0.70
Emotional stability	1.50	5.00	3.3121	0.73087	-0.087	-0.535	0.73
Attitudes towards Mathematics:							
Self-Confidence	1.59	6.65	5.1011	1.13550	-0.896	0.514	0.92
Value	2.63	7.00	5.0975	0.87506	-0.308	-0.136	0.83
Motivation	1.29	7.00	4.9135	1.11635	-0.285	-0.066	0.84
Enjoyment	1.00	6.86	4.7078	1.24971	-0.332	-0.227	0.81
Valid N	140			1) Cronbach's Alfa			

Note. Performance in business mathematics is coded as follows: 0 = F, 1 = E, 2 = E, 3 = C, 4 = B, 5 = A. N-maths is a binary variable denoting whether (1) or not (0) the student took mathematics for natural sciences. Gender is coded as follows: 1 = male, 0 = female.

4.2 Model

The linear regression to determine the impacts of gender, previous mathematics experience, attitudes towards mathematics, and Big Five personality traits on performance in business mathematics is:

$$Y_i = a_0 + a_1\mathrm{X1}_i + a_2\mathrm{X2}_i + a_3\mathrm{X3}_i + a_4\mathrm{X4}_i + a_5\mathrm{X5}_i + a_6\mathrm{X6}_i + a_7\mathrm{X7}_i + a_8\mathrm{X8}_i + a_9\mathrm{X9}_i + a_{10}\mathrm{X10}_i + a_{11}\mathrm{X11}_i + a_{12}\mathrm{X12}_i + \varepsilon_i$$

where Y = grade attained in business mathematics (0: F, 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 = dummy variable for N-maths (0: did not take N-maths, 1: took N-maths), X_4 = openness, X_5 = extraversion, X_6 = agreeableness, X_7 = conscientiousness, X_8 = emotional stability, X_{10} = self-confidence in mathematics, X_{11} = perception of the value of mathematics, X_{12} = enjoyment to study mathematics , ε = stochastic error. The Big Five personality traits were measured on a 5-point Likert scale, where 1 = strongly disagree, and 5 = strongly agree. The four ATMI dimensions were measured on a 7-point Likert scale, where 1 = strongly disagree, and 7 = strongly agree.

5. Results

The sample contained of 56 percent women and 45 percent of men. Since there is considerable competition for spaces at this business school (NTNU), the average GPA score was high. Around 30% of the students had taken N-maths at secondary school. Among the personality traits, the average value for agreeableness was highest. The average attitude towards mathematics was noticeably high (around 5 for all dimensions on a 7-point Likert scale). Skew, kurtosis, and scale reliability were all within acceptable ranges for the chosen variables (with the possible exception of Cronbach's alpha value for openness).

The correlation coefficients (Table 2) provide information about the variables. Notice, there was high inter-correlation among the four ATMI dimensions.

Table 2 *Correlation coefficients between independent variables.*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2	0.783												
3	0.731	0.878											
4	-0.022	-0.036	-0.042										
5	0.320	0.258	0.282	0.058									
6	-0.010	-0.040	-0.110	-0.154	0.004								
7	0.030	0.017	0.004	-0.140	0.057	0.252							
8	0.125	0.079	-0.003	0.414	0.042	-0.002	-0.079						
9	-0.030	0.006	-0.052	-0.108	-0.079	0.212	-0.047	0.260					
10	-0.115	-0.063	-0.062	0.179	-0.015	-0.093	-0.232	0.201	0.216				
11	0.614	0.556	0.532	-0.074	0.287	-0.010	0.103	-0.087	-0.045	-0.234			
12	0.088	0.223	0.168	-0.025	0.107	-0.020	-0.012	-0.005	-0.196	0.032	-0.015		

13	0.516	0.727	0.711	0.004	0.210	-0.091	0.088	0.035	0.014	0.047	0.355	0.211

Note. 1 = self-confidence in mathematics, 2 = motivation to study mathematics, 3 = enjoyment of mathematics, 4 = gender, 5 = N-maths, 6 = agreeableness, 7 = conscientiousness, 8 = emotional stability, 9 = extraversion, 10 = openness, 11 = performance in mathematics, 12 = GPA, 13 = perceived value of mathematics.

Table 3 presents the result of different versions (Steps) of the regression model. There was no significant relationship between gender and mathematics performance, so hypothesis 1 is rejected, and no significant relationship between GPA and performance. There was a significant association between N-maths and performance, but the association was no longer apparent after controlling for ATM, so hypothesis 2 is rejected. No significant effects of Big Five personality traits were found, so hypothesis 3 is rejected. Self-confidence in mathematics was significantly and positively associated with performance, supporting hypothesis 4.

Table 3 *Outputs from stepwise linear regression.*

Variable	Model 1 (Step1)		Model 2 (Step2)		Model 3 (Step3)		Model 4 (Step4)		
	B	*p*	B	*p*	B	*p*	B	*p*	VIF 1)
Constant	3.47		3.85		4.77		1.40		
Gender	-0.078 (0.253)	0.76	-0.154 (0.245)	0.532	0.063 (0.294)	0.829	0.296 (0.247)	0.233	1.55
GPA			-0.13 (0.044)	0.775	0.008 (0.045)	0.856	-0.016 (0.141)	0.673	1.11
N-Maths			0.938 (0.261)	0.000	0.881 (3.368)	0.001	0.268 (0.228)	0.241	1.17
Openness					-0.438 (0.181)	0.017	-0.157 (0.153)	0.306	1.31

Extraversion			0.101 (0.184)	0.586	0.053 (0.151)	0.725	1.34
Agreeableness			-0.181 (0.242)	0.454	-0.204 (0.202)	0.316	1.17
Conscientiousness			0.051 (0.242)	0.802	0.145 (0.168)	0.390	1.13
Emotional Stability			-0.136 (0.207)	0.513	-0.351 (0.179)	0.052	1.72
Self-confidence					0.702 (0.141)	0.000	2.59
Value					0.065 (0.156)	0.679	1.91
Motivation[2]							
Enjoyment					0.097 (0.143)	0.495	3.28
	N=140 Adj.R^2 = -0.07	N=140 Adj.R^2 = 0.067	N=138 Adj.R^2 = 0.401		N=138 Adj.R^2 = 0.398		

[1] Variance Inflation Factor.
[2] Not included due to high VIF value (8.5)

6 Discussion

6.1 Gender and Academic Background

We found no evidence to suggest that gender predicts performance in business mathematics, in line with previous research (Reilly et al., 2019). According to

Else-Quest et al. (2010), in 60% of countries there is a negligible or no gender difference in mathematics performance among students. In this study there was no link between secondary school GPA and performance in mathematics. Since GPA is a measure of overall academic ability, it would not be surprising to find an association between GPA and success in business courses, though our result is consistent with Opstad’s (2018) suggestion that GPA may not be a good predictor of success in economics courses. Recent data further support this conclusion (Opstad, 2021b). The conclusion is that the background in mathematics is more important than general academic ability.

6.2 Personality Traits

Prior studies have established a positive relationship between conscientiousness and academic success (Wang et al., 2019), but this study found no evidence for this effect for business mathematics, in line with the conclusions of Lipnevich et al. (2016). This is nonetheless an interesting observation, given that Big Five personality traits do appear to contribute to success in economics and business courses (Opstad, 2021b).

6.3 Attitudes towards Mathematics

The finding that ATM predicts mathematics performance is consistent with previous research (Brezavšček et al., 2020; Ngussa & Mbuti, 2017). In the model in this study, only the self-confidence dimension was statistically significant, but as Table 2 shows, the ATMI dimensions were closely correlated, so it is possible that all or any of the other three could be linked to performance.

Another important result is that the significant effect of mathematics background disappeared after controlling for ATM. The significant negative association between openness and performance also disappeared at this stage, in line with the finding of Lipnevich et al. (2016). This result may reflect the fact that business mathematics is an introductory course, which may not stimulate the intellectual curiosity of more skilled students; previous work has reported a positive correlation between performance and openness in subjects that require advanced analysis and thinking (Lipnevich et al., 2016).

6.4 Implications for Practice

The study from NTNU Business School found that self-confidence in mathematics was the most important predictor of grades in business mathematics. Self-confidence will likely facilitate concentration and engagement but gaining good grades will also tend to increase self-confidence in mathematics, so the causal relationship could plausibly be in either direction, or both. Given the importance of mathematics for success in business studies, educators should consider methods to boost their students' self-confidence, especially at secondary school, where many students decide not to continue their mathematical education. Assuming that our results are representative of the general student population, we also suggest that GPA may not be a useful criterion for admission to business studies courses.

7. Limitations

The dataset in this research comprises just 140 students from a single business school in Norway, so care should be exercised in extrapolating the results to wider contexts. For example, a different result might have been obtained if we had looked at Masters-level students, rather than undergraduates. We used the original version (translated into Norwegian) of the Big Five personality traits and ATMI; a more robust analysis might have been possible if we had employed an explanatory factor analysis to produce an altered version of ATMI and the Big

Five personality traits, but we elected to use the unaltered versions in order to maintain consistency with previous studies.

8 Conclusion

Previous studies have reported that male students outperform female students in mathematics subjects, but this gap appears to be shrinking. This research from NTNU Business School found no impact of gender on performance in mathematics among business students. GPA from upper secondary school is a good proxy of academic skills, and is used to assign places on business courses, but we did not find any correlation between secondary school GPA and performance in mathematics. A background in mathematics from upper secondary school appears to be more influential, though when attitudes towards mathematics are taken into account, even this factor has no impact on performance in business mathematics. The author found no significant link between Big Five personality traits and performance. The only significant predictor of performance was the student's attitudes towards mathematics, and specifically, self-confidence, which was positively associated with the grade in business mathematics. Since mathematics skills are essential for success in business studies, further research should be directed towards understanding the factors that influence achievement in the subject.

References

Ajisuksmo, C. R. P., & Saputri. G. R. (2017). The influence of attitudes towards mathematics, and metacognitive awareness on mathematics achievements. *Creative Education*, *8*(03), 486–497. https://doi.org/10.4236/ce.2017.83037

Alcock, J., Cockcroft, S., & Frank, F. (2008). Quantifying the advantage of secondary mathematics study for accounting and finance undergraduates. *Accounting & Finance*, *48*(5), 697–718. https://doi.org/10.1111/j.1467-629X.2008.00261.x

Alcock, L., Attridge, N., Kenny, S., & Inglis, M. (2014). Achievement and behaviour in undergraduate mathematics: Personality is a better predictor than gender. *Research in Mathematics Education*, *16*(1), 1–17. http://dx.doi.org/10.1080/14794802.2013.874094

Arnold, I., & Straten, J. T. (2012). Motivation and math skills as determinants of first-year performance in economics. *The Journal of Economics Education*, *43*(1), 33–47. https://doi.org/10.1080/00220485.2012.636709

Asante, K. O. (2012). Secondary students' attitudes towards mathematics. *IFE PsychologIA*, *20*(1), 121–133.

Bal, A. P. (2020). Attitudes and beliefs of primary school teaching undergraduate students towards mathematics and their effects on mathematics achievement. *Çukurova Üniversitesi Eğitim Fakültesi Dergisi*, *49*(2), 826–841. https://doi.org/10.14812/cufej.694626

Baldry, A. C. (2004). The impact of direct and indirect bullying on the mental and physical health of Italian youngsters. *Aggressive Behavior: Official Journal of the International Society for Research on Aggression*, *30*(5), 343-355.https://doi.org/10.1002/ab.20043

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

Bonesrønning, H., & Opstad, L. (2012). How much is students' college performance affected by quantity of study*? International Review of Economics Education, 11(2), 46*–63. https://doi.org/10.1016/s1477-3880(15)30012-8

Brandell, G., & Staberg, E. M. (2008). Mathematics: A female, male or gender-neutral domain? A study of attitudes among students at secondary level. *Gender and Education*, *20*(5), 495–509. https://dx.doi.org/10.1080/09540250701805771

Brezavšček, A., Jerebic, J., Rus, G., & Žnidaršič, A. (2020). Factors influencing mathematics achievement of university students of social sciences. *Mathematics*, *8*(12), 21–34. https://doi.org/10.3390/math8122134

Brown-Robertson, L. T. N., Ntembe, A., & Tawah, R. (2015). Evaluating the "underserved student" success in economics principles courses. *Journal of Economics and Economic Education Research*, *16*(3), 13–23.

Costa, P. T., & McCrae, R. R. (1995). Domains and facets: Hierarchical personality assessment using the revised Neo Personality Inventory. *Journal of Personality Assessment*, *64*, 21–50. https://doi.org/10.1207/s15327752jpa6401_2

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children. *Child Development*, *82*(3), 766–779. https://10.1111/j.1467-8624.2010.01529.x

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, *136*(1), 103–127. https://doi.org/10.1037/a0018053

Engvik, H., & Clausen, S. (2011). Norsk kortversjon av big five inventory (BFI-20). *Tidsskrift for norsk psykologforening*, *48*(9), 869–872. (In Norwegian).

Farooq, M. S., & Shah, S. Z. U. (2008). Students' attitude towards mathematics. *Pakistan Economic and Social Review*, *46*(1), 75–83.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics – a "hopeless" issue? A control-value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education*, *22*(4), 497–514. http://dx.doi.org/10.1007/bf03173468

García, T., Rodríguez, C., Betts, L., Areces, D., & González-Castro, P. (2016). How affective-motivational variables and approaches to learning predict mathematics achievement in upper elementary levels. *Learning and Individual Differences*, *49*, 25-31. doi.org/10.1016/j.lindif.2016.05.021

Guy, G. M., Cornick, J., & Beckford, I. (2015). More than math: On the affective domain in developmental mathematics. *International Journal for the Scholarship of Teaching and Learning*, *9*(2), 7. https://doi.org/10.20429/ijsotl.2015.090207

Heaven, P., & Ciarrochi, J. (2008). Parental styles, gender, and the development of hope and self-esteem. *European Journal of Personality*, *22*(8), 707–724. https://doi/org/10.1002/per.699

Hoorfar, H., & Taleb, Z. (2015). Correlation between mathematics anxiety with metacognitive knowledge. *Procedia – Social and Behavioral Sciences*, *182,* 737–741. https://doi.org/10.1016/j.sbspro.2015.04.822

Kahn, S., & Ginther, D. (2017). *Women and STEM* (No. w23525). NBER Working Paper n. 19894 National Bureau of Economic Research.

Kane, L.; Ashbaugh, A.R. Simple and parallel mediation: {A} tutorial exploring anxiety sensitivity, sensation seeking, and gender. Quant. Methods Psychol. 2017, 13, 148–165. https://doi.org/10.20982/tqmp.13.3.p148

Lee, C. Y., & Kung, H. Y. (2018). Math self-concept and mathematics achievement: Examining gender variation and reciprocal relations among junior high school students in Taiwan. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(4), 1239-1252. https://doi.org/10.29333/ejmste/82535

Lipnevich, A. A., Berg. D. A., & Smith. J. K. (2016). Toward a model of student response to feedback. In G. T. Brown, & L. R. Harris (Eds.), *Handbook of Human and Social Conditions in Assessment* (pp. 169–185). Routledge.

Mazana, Y. M., Suero Montero, C., & Olifage, C. R. (2019). Investigating students' attitude towards learning mathematics. *International Electronic Journal of Mathematics Education*, *14*(1), 207–231. https://doi.org/10.29333/iejme/3997

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,* (pp. 209–222). Element.

Meyer, J., Fleckenstein, J., & Köller, O. (2019). Expectancy value interactions and academic achievement: Differential relationships with achievement measures. *Contemporary Educational Psychology*, *58*, 58-74.https://doi.org/10.1016/j.cedpsych.2019.01.006

Mejía-Rodríguez, A. M., Luyten, H., & Meelissen, M. R. (2020). Gender differences in mathematics self-concept across the world: An exploration of student and parent data of TIMSS 2015. *International Journal of Science and Mathematics Education*. https://doi.org/10.1007/s10763-020-10100-x

Ngussa, B. M., & Mbuti, E. E. (2017). The influence of humour on learners' attitude and mathematics achievement: A case of secondary schools in Arusha City, Tanzania. *Journal of Educational Research*, *2*(3), 170–181.

Ock. J., McAbee, S. T., Mulfinger, E., & Oswald, F. L. (2020). The practical effects of measurement invariance: Gender invariance in two Big Five personality measures. *Assessment, 27*(4), 657–674. https://doi.org/10.1177/1073191119885018

Organisation for Economic Co-operation and Development (2020). *Norway: Student performance (Pisa 2018)*. https://gpseducation.oecd.org/CountryProfile?primaryCountry=NOR&treshold=10&topic=PI

Opstad, L. (2018). Success in business studies and mathematical background: The case of Norway. *Journal of Applied Research in Higher Education*, *10*(3), 399–408. http://dx.doi.org/10.1108/JARHE-11-2017-0136

Opstad, L. (2020). Attitudes towards Statistics among Business Students: Do Gender, Mathematical Skills and Personal Traits Matter?. *Sustainability*, *12*(15), 6104. **https://doi.org/10.3390/su12156104**

Opstad. L. (2021a). Factors explaining business student attitudes towards mathematics: Does gender still matter? *European Journal of Science and Mathematics Education*, *9*(2), 13–25. https://doi.org/10.30935/scimath/10771

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* (in press)

Opstad, L. & Årethun, T. (2019). Choice of courses in mathematics at upper-secondary school and attitudes towards mathematics among business students: The case of Norway. International Journal of Learning, Teaching and Educational Research, 18(7), 228-244. ***https://doi.org/10.26803/ijlter.18.7.15***

Opstad, L., & 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.

Pipere, A., & Mieriņa, I. (2017). Exploring non-cognitive predictors of mathematics achievement among 9th grade students. *Learning and Individual Differences*, *59*, 65–77. https://doi.org/10.1016/j.lindif.2017.09.005

Reilly, D., Neumann, D. L., & Andrews, G. (2019). Investigating gender differences in mathematics and science: Results from the 2011 Trends in Mathematics and Science Survey. *Research in Science Education*, *49*(1), 25–50. https://dx.doi.org/10.1007/s11165-017-9630-6

Roccas, S., Sagiv, L., Schwartz, S. H., & Knafo, A. (2002). The Big Five personality factors and personal values. *Personality and Social Psychology Bulletin*, *28*(6), 789–801. https://doi.org/10.1177/0146167202289008

Schmitt, D. P., Realo, A., Voracek, M., & Allik, J. (2008). Why can't a man be more like a woman? Sex differences in Big Five personality traits across 55 cultures. *Journal of Personality and Social Psychology*, *94*(1), 168. https://doi.org/10.1037/0022-3514.94.1.168

Syyeda, F. (2016). Understanding attitudes towards mathematics (ATM) using a multimodal model: An exploratory case study with secondary school children in England. *Cambridge Open-Review Educational Research e-Journal, 3*, 32–62.

Tapia, M., & Marsh, G. E. (2000, November 15–17). *Effect of gender, achievement in mathematics, and ethnicity on attitudes toward mathematics* [conference presentation]. Annual Meeting of the Mid-South Educational Research Association, Bowling Green, KY, United States.

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

Tuan, N. M., Anh, P. T., & Tho, N. H. (2019). Admission score, family Income, HSGPA, and learning approaches to predict academic performance in mathematics. *The International Journal of Learning in Higher Education*, *26*(2), 17–33. https://doi.org/10.18848/2327-7955/CGP/v26i02/17-33

Utvær, H. T. (2019). *Elevenes motivasjon for matematikk i barneskolen* [Unpublished undergraduate thesis]. Norwegian University of Science and Technology. (In Norwegian).

Wang, M. T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review*, *29*(1), 119–140. https://10.1007/s10648-015-9355-x

Wang, S., Zhao, Y., Li, J., Wang, X., Luo, K., & Gong, Q. (2019). Brain structure links trait conscientiousness to academic performance. *Scientific Reports*, *9*(1), 1–12. https://doi.org/10.1038/s41598-019-48704-1