Do women outperform men? Gender differences in participation and performance in STEM and non-STEM university subjects of gender dominance

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Motivation

- Women are less likely than men to choose STEM subjects (science, technology, engineering and mathematics), obtain fewer STEM university degrees and are underrepresented in the STEM workforce (Barone & Assirelli 2020; Statistisches Bundesamt 2023)
- The examination of performance is mainly limited to general academic performance at an aggregated level

Research Interest

- Examination of gender-specific differences in performance and success of students at module level from two perspectives is necessary:
  1. between **STEM and non-STEM study programmes**
  2. between **female- and male-dominated study programmes**

Previous Research of Study Performance

- Previous studies of gender differences in STEM higher education have produced inconsistent results
- Some studies suggest an advantage for men and others for women in terms of overall academic performance, while others find no significant differences in performance between the genders (Matz et al., 2017; Vooren et al.,2022)
- Only a few studies examine performance at module level; again, depending on the module content and course format, sometimes women and sometimes men perform better (Salehi et al., 2019; Whitcomb et al., 2020)

Research Question: How do gender differences in student behaviour vary across STEM and gender-dominated programmes?

Data and Methods

Administrative data from a large German research university

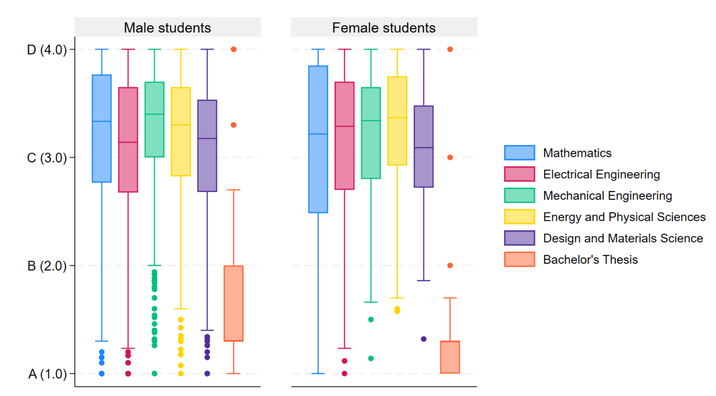
- Students in three study programmes
  - nine cohorts of B.S. Mechanical Engineering (N=3,290, 2017-2021)
    ➡ **STEM, male-dominated**
  - five cohorts of B.A. Political Science (N=1,186, 2016-2021)
    ➡ **Non-STEM, male-dominated**
  - five cohorts of B.A. Sociology (N=1,377, 2016-2021)
    ➡ **Non-STEM, female-dominated**
- **N = 5,853**
- Gender differences in study behaviour: **t-tests and box plots**

Differences in Participation Rates

	Women	Men	Difference (pp)
B.Sc. Mechanical Engineering			
Mathematics	0.38	0.40	1.9 (ns)
Electrical Engineering	0.43	0,47	4.1 (ns)
Mechanical Engineering	**0.31**	**0.35**	**4.3 (+)**
Energy and Physical Sciences	0.22	0.24	2.4 (ns)
Design and Materials Science	**0.31**	**0.35**	**4.8 (*)**
Bachelor's Thesis	0.04	0.05	1.2 (ns)
B.A. Political Science			
Statistics	**0.45**	**0.38**	**6.6 (*)**
Political Theory	**0.43**	**0.36**	**6.8 (*)**
Political Sociology	0.41	0.38	2.8 (ns)
Comparative Government	**0.52**	**0.45**	**6.5 (*)**
Public Administration	0.43	0.39	3.7 (ns)
Bachelor's Thesis	**0.40**	**0.33**	**7.0 (*)**
B.A. Sociology			
Sociological Theory	**0.53**	**0.47**	**6.4 (*)**
Political Science	**0.57**	**0.48**	**9.7 (***)**
Social Structure	**0.59**	**0.47**	**11.6 (***)**
Quantitative Methods	**0.43**	**0.36**	**6.7 (*)**
Qualitative Methods	**0.43**	**0.38**	**5.2 (+)**
Bachelor's Thesis	**0.40**	**0.31**	**9.2 (***)**

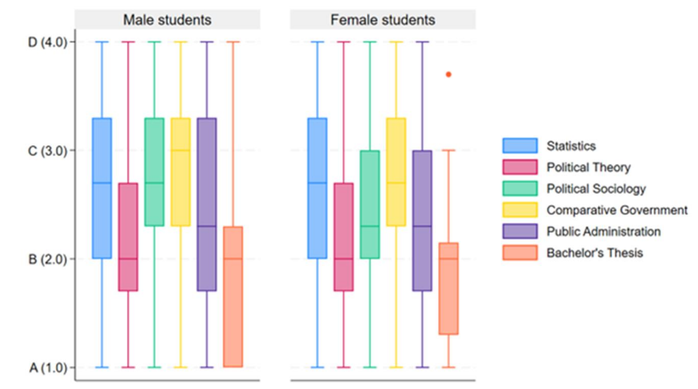
Differences in Grades

Male-dominated STEM



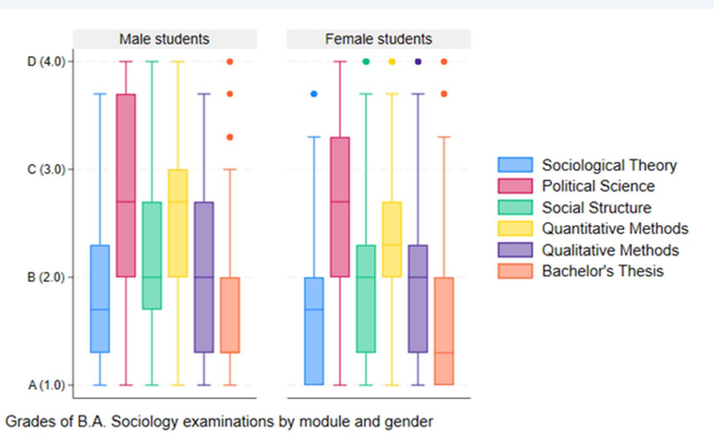
Grades of B.Sc. Mechanical Engineering examinations by module and gender

Male-dominated Non-STEM



Grades of B.A. Political Science examinations by module and gender

Female-dominated Non-STEM



Grades of B.A. Sociology examinations by module and gender

Differences in Exam Taking

	Women	Men	
B.Sc. Mechanical Engineering			
Mathematics			**Positive significant**
Electrical Engineering			**Positive significant**
Mechanical Engineering		Not significant	
Energy and Physical Sciences		Not significant	
Design and Materials Science		Not significant	
Bachelor's Thesis		Not significant	
B.A. Political Science			
Statistics		Not significant	
Political Theory			**Positive significant**
Political Sociology		Not significant	
Comparative Government	**Positive significant**		
Public Administration		Not significant	
Bachelor's Thesis		Not significant	
B.A. Sociology			
All Modules		Not significant	

Summary and Outlook

- Women tend to outperform men, regardless of whether they are studying a STEM degree programme or a gender-specific subject area
  - Women achieve higher grades than men in some modules, regardless of programme
  - In the subjects of the male-dominated STEM degree programme, men resit more often than women. In the male-dominated non-STEM degree programme, there are models in which women resit more often than men, and modules in which men resit more often
  - Men have higher participation rates in STEM, while women have higher participation rates in non-STEM programmes
- Results cannot fully disentangle male-dominance and STEM effects; further studies are needed to fully investigate gendered student behaviour and its causes

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References:
Barone, C. & Assirelli, G. (2020). Gender segregation in higher education: an empirical test of seven explanations. Higher Education, 79, 55–78. https://doi.org/10.1007/s10734-019-00396-2
Federal Statistical Office (2023). Studierende in Mathematik, Informatik, Naturwissenschaft (MINT) und Technik-Fächern. URL: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Hochschulen/Tabellen/studierende-mint-faechern.html
Matz, R. L., Koester, B. P., Fiorini, S., Grom, G., Shepard, L., Stangor, C. G., Weiner, B., & McKay, T. A. (2017). Patterns of Gendered Performance Differences in Large Introductory Courses at Five Research Universities. AERA Open, 3(4). https://doi.org/10.1177/2332858417743754
Salehi, S., Cotner, S., Azarin, S. M., Carlson, E. E., Driessen, M., Ferry, V. E., Harcombe, W., McGaugh, S., Wassenberg, D., Yonas, A., & Ballen, C. J. (2019). Gender performance gaps across different assessment methods and the underlying mechanisms: The case of incoming preparation and test anxiety. Frontiers in Education, 4. https://doi.org/10.3389/feduc.2019.00107
Vooren, M., Haelermans, C., Groot, W., & van den Brink, H. M. (2022). Comparing success of female students to their male counterparts in the STEM fields: an empirical analysis from enrollment until graduation using longitudinal register data. International Journal of STEM Education, 9(1). https://doi.org/10.1186/s40594-021-00318-8
Whitcomb, K. M., Kalender, Z. Y., Nokes-Malach, T. J., Schunn, C. D., & Singh, C. (2020). Comparison of self-efficacy and performance of engineering undergraduate women and men. International Journal of Engineering Education, 36(6), 1996–2014.