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Statistics Anxiety and Self-Concept of Beginning Students in the Social Sciences – A Matter of Gender and Socio-Cultural Background?

Abstract

It is still largely underresearched whether different groups of students in the social sciences begin their studies in higher education with diverging attitudes towards statistics. In this article, we analyze whether gender and socio-cultural background affect statistics anxiety and statistics self-concept at the start of studies. A survey among 504 first-year students from two fields of study and two universities in Germany revealed considerable differences in students' attitudinal preconditions for learning depending on gender and, to a minor degree, depending on migration background. Based on these results, we discuss implications for teaching in higher education.

Keywords

Statistics anxiety, statistics self-concept, social sciences, gender differences, socio-cultural differences

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Angst im Fach Statistik und statistisches Selbstkonzept von Studienanfängerinnen und -anfängern in den Sozialwissenschaften – eine Frage des Geschlechts und des sozio-kulturellen Hintergrunds?

Zusammenfassung

Es ist weitgehend unerforscht, ob bestimmte Studierendengruppen in den Sozialwissenschaften ihr Studium mit unterschiedlichen Einstellungen zum Fach Statistik beginnen. Im Folgenden wird untersucht, inwieweit das Geschlecht und der sozio-kulturelle Hintergrund einen Einfluss auf die Angst und das Selbstkonzept im Fach Statistik zu Studienbeginn haben. Eine Befragung von 504 Studierenden im ersten Studienjahr an zwei Universitäten und zwei Studiengängen zeigt, dass zwischen den Geschlechtern deutliche und zwischen Studierenden mit und ohne Migrationshintergrund geringe Unterschiede in den Lehr-Lernvoraussetzungen bestehen. Hochschuldidaktische Implikationen werden diskutiert.

Schlüsselwörter

Angst in Statistik, Statistisches Selbstkonzept, Sozialwissenschaften, Geschlechterunterschiede, sozio-kulturelle Unterschiede

1 Relevance and Research Question

Statistics education in the social sciences is a highly challenging endeavor in Germany. Many students enroll in social sciences in the mistaken hope of thus avoiding studying mathematics and statistics (WAGNER & BÜNING, 2008). Even though it is undisputed that statistical competencies are important for academic and professional achievement in the social sciences (LIPPE & KLADROBA, 2008), statistics is one of the least popular subjects in this field of studies (HANNA, SCHEVLIN & DEMPSTER, 2008). A lot of students of social sciences indicate that they are afraid of statistics or have a low mathematical or statistical self-

concept, which has been documented to highly affect their academic performance and learning behavior in various academic disciplines (MACHER, PAECHTER, PAPOUSEK & RUGGERI, 2012; ONWUEGBUZIE, 2003).

Even though statistics anxiety and self-concept are important determinants of competency development and knowledge acquisition in statistics courses, little is known about the manifestations of these determinants among beginning students in the social sciences. It is true that there are already findings from higher education in the U.S. and UK (ONWUEGBUZIE, 2003; RAMIREZ, SCHAU & EMMIOGLU, 2012). However, sociodemographic effects on math-related anxiety and math self-concept, particularly those of migration background and gender, vary greatly across OECD countries already in secondary education (GEBHARDT, RAUCH, MANG, SÄLZER & STANAT, 2013; OECD, 2015; OECD, 2014; STANAT & CHRISTENSEN, 2006). It can thus be expected that students' starting conditions in higher education also differ internationally[2]. Therefore, we analyze the extent to which students' gender and socio-cultural background account for differences in statistics self-concept and statistics anxiety at the beginning of higher education. Carried out in Germany, this study is meant to contribute to the international discussion on statistics anxiety and self-concept, while also evaluating if international results can be applied to statistics courses in higher education in Germany. Knowledge of beginning students' sentiments towards introductory statistics courses is a necessary basis for targeted teaching measures to foster students' enculturation already at an early stage of the introductory course.

First, we present the state of research on the effect of gender and socio-cultural background on statistics anxiety and self-concept and derive corresponding hypotheses. We then test our hypotheses using empirical data from a survey of begin-

[2] Another reason why results of international research in statistics education are not easily generalizable lies in the cross-cultural differences between higher education systems (such as different transition rates from secondary to higher education, varying differentiations of institution types and different proportions of private and public universities).

ning students in business and economics and political science at two universities in Germany. Finally, we discuss the results with due regard to implications for teaching in higher education.

2 Theoretical Foundations and Hypotheses

In the domain of statistics education, the Attitudes Towards Statistics model (RAMIREZ et al., 2012) postulates that socio-demographic characteristics, such as gender and socio-cultural background, impinge on learners' attitudes towards statistics, including anxiety and self-concept. Statistics anxiety is construed as situation-specific anxiety which arises when students cope with statistical information, tasks, or educational settings (MJI & ONWUEGBUZIE, 2004). Self-concept in general refers to students' self-reported confidence in their own capabilities and whether they believe they can successfully answer test questions (OECD, 2015). Accordingly, statistics self-concept refers to students' self-assessed belief in their own ability to cope with statistics problems (MACHER et al., 2013). Due to the lack of research into sociodemographic effects on statistics self-concept and anxiety in higher education statistics courses in Germany, there are currently only two possible approaches to examining students' starting conditions: For each of the effects to be examined, we consider, first, international research into higher education statistics and, secondly, national studies on German secondary education mathematics. Thus, our empirical study indicates whether international findings on higher education statistics can be replicated for Germany and whether effects reported for German secondary education still persist in German higher education[3].

[3] Students' choice of a specific degree course implies a selection process. For instance, students with low levels of math anxiety are likely to choose scientific degree courses with high mathematical requirements. Moreover, the existence of gender-related selection processes in higher education is indicated by the fact that only 28.8 % of female students choose to study mathematics, sciences, and engineering (winter term 2013/2014) compared to 51.6 % of female students in law, business, and social sciences (DESTATIS, 2014).

Internationally, gender effects tend to be in favor of males, who seem to be less prone to statistics anxiety (MACHER et al., 2012; MACHER et al., 2013; RODARTE & SHERRY, 2008; etc.). A smaller number of studies show no significant relationship between gender and the anxiety score (MJI & ONWUEGBUZIE, 2004; SUTARSO, 1992). Studies on gender differences concerning the statistics self-concept tend to find more positive self-assessments among male students (RODARTE & SHERRY, 2008; SCHAU, 2003a; TEMPELAAR, 2004). In this case, there is also contrary evidence indicating that the relationship between gender and statistics self-concept is insignificant, but the respective samples are smaller (COETZEE & VAN DER MERWE, 2010; FAGHIHI & RAKOW, 1995). Effect sizes for the relationship between gender and statistics self-concept or statistics anxiety are usually small or, occasionally, moderate[4].

These international findings correspond with results from the subject of mathematics in German secondary education; math anxiety tends to be smaller and mathematical self-concept tends to be higher among male students (GEBHARDT et al., 2013; GOETZ, BIEG, LÜDTKE, PEKRUN & HALL, 2013; OECD, 2015). To investigate whether the national and international findings can be replicated in German higher education, we raised the following hypotheses:

H1:	*First-year female students in German higher education have higher self-reported statistics anxiety than first-year male students.*
H2:	*First-year female students in German higher education have lower self-reported statistics self-concept than first-year male students.*

Hence, it is an important question whether such processes contribute to a homogenization of, for instance, gender differences related to statistics anxiety and self-concept among social science students.

[4] In various studies, generalizability of gender effects is limited due to overrepresentation of female participants in the samples (such as MACHER et al., 2013; MJI & ONWUEGBUZIE, 2004).

International research on socio-cultural background mostly focuses on differences between African-American and Caucasian students. African American students in higher education occasionally exhibit higher levels of statistics anxiety than Caucasians (ONWUEGBUZIE, 1999). In contrast, other studies find no statistical differences (PIERCE, 2006; SUTARSO, 1992). In a study by BELL (2008), international students reported significantly higher levels of statistics anxiety than U.S. students. The relationship between self-concept and nationality was found to be insignificant (TEMPELAAR, 2004), while the relationship between self-concept and ethnicity is either insignificant (ONWUEGBUZIE, 1999), in favor of Caucasian Americans (SCHAU, 2003a), or in favor of African Americans (FAGHIHI & RAKOW, 1995). Overall, findings on nationality and ethnicity tend to be inconsistent and sparse. More importantly, a differentiation by race or complexion is common in the U.S., but seems inapplicable to higher education contexts in many other OECD-countries, including Germany, and does not provide meaningful information from which to infer consequences for teaching. For example, international large-scale studies of educational performance, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), rather differentiate between students of native-born parents ("without migration background") and first or second generation immigrants with at least one of their parents born abroad ("with migration background"; FEDERAL MINISTRY OF THE INTERIOR, 2015)[5]. To account for the educational disparities between the above-mentioned groups, we use the more general term socio-cultural background in the present study.

Even though the PISA and TIMSS studies point to performance deficits of non-native students in German secondary math education (GEBHARDT et al., 2013; MULLIS, MARTIN & FOY, 2008; OECD, 2014), these students were shown to have even a slightly higher mathematics self-concept than students without migration background. However, students with migration background also experience

[5] Students with migration background may also be non-native speakers of German or predominantly use a non-German language in their home environment (KMK, 2011).

slightly higher levels of math anxiety (SHAJEK, LÜDTKE & STANAT, 2006; STANAT & CHRISTENSEN, 2006). Further clarification and validation of these effects in higher education is urgently needed as they might account for differences in performance (STANAT & CHRISTENSEN, 2006), which is of particular relevance for countries with increasing numbers of non-native students.[6] Based on the evidence from German secondary education, we raise the following hypotheses:

H3: *In higher education in Germany, first-year students with migration background have higher self-reported statistics anxiety than first-year students without migration background.*

H4: *In higher education in Germany, first-year students with migration background have higher self-reported statistics self-concept than first-year students without migration background.*

3 Design and Participants

In the summer term 2015, we surveyed altogether 504 students of business and economics as well as political science at two German universities at the beginning of their introductory courses to statistics within their first year of study. In order to avoid stereotyped answers, the students were not told that one objective of the study was to determine gender-related and socio-cultural effects. Table 1 shows the sample characteristics according to field of study and university.

[6] In Germany, for instance, the number of students with migration background increased by approximately 50 % from 2003 to 2013 (FEDERAL MINISTRY OF THE INTERIOR, 2015).

Table 1: Descriptive statistics of the sample based on the field of study and universities

	Business & Economics Univ. 1	Business & Economics Univ. 2	Political Science Univ. 2	Total
N	157	184	163	504
Average Final School Grade (1=best grade; 4=lowest pass grade)	1.90	2.17	2.28	2.12
Missing (absolute)	5	1	9	15
Average Final School Grade (Math only) (1=best grade; 4=lowest pass grade)	1.95	2.42	2.73	2.38
Missing (absolute)	2	0	1	3
Math Major in School	40.8 %	40.8 %	23.9 %	35.3 %
Missing (absolute)	0	1	0	1
Male	42 %	44.6 %	46 %	44.2 %
Missing (absolute)	2	1	1	4
Exchange Student	0 %	0.5 %	0.6 %	0.4 %
Missing (absolute)	0	7	3	10
German Native Speaker	73.2 %	87 %	85.9 %	82.3 %
Missing (absolute)	2	3	3	8
Both Parents from Germany	56.7 %	73.9 %	75.5 %	69 %
Missing (absolute)	2	2	3	7

The share of male and female participants was almost equal across all three subsamples. Students from university 1 had better final school grades on average and specifically in mathematics. Compared to business and economics students from both universities, students of political science from university 2 had graduated from school with worse math grades and had less often chosen mathematics as a major

school subject[7]. This finding may already indicate a selection effect, as students who enroll in political science may lack affinity for mathematics and statistics compared to students of business and economics. Comparing the subsamples, it is striking that notably more students with migration background were enrolled at university 1 than at university 2. This indicates that the selected universities are well suited for our purpose of an extreme-group comparison: University 1 is located in a large city in Germany, while university 2 is located in a small city with a rural background.

Statistics self-concept was measured by means of the cognitive competence subscale from the Survey of Attitudes Towards Statistics-36 (SCHAU, 2003b).[8] Students were also asked to indicate which grade they expected to achieve in the ongoing statistics course as a further indicator of statistics self-concept. Statistics anxiety was operationalized by means of the Statistical Anxiety Rating Scale (STARS; CRUISE, CASH & BOLTON, 1985). For the present study, we included three subscales related to statistics anxiety[9]: The Fear of Interpretations scale assesses students' anxiety when interpreting statistical material. Test and Class Anxiety assesses students' discomfort when attending statistics classes or when taking statistics exams. The Fear of Asking for Help subscale measures students' anxiety when asking fellow students or teachers for help. The items were adapted for Germany by professional translators and were validated by statistics instructors. Prior to the main survey, the STARS subscales were validated in a pretest with a sample

[7] In the final two years of upper secondary education in Germany, students must choose major subjects, for example mathematics, in which to attend more classes per week and which cover topics in greater depth.

[8] The questions on self-concept were answered on a 5-point Likert scale (1=I do not agree at all; 5=I completely agree).

[9] The questions on anxiety were also answered on a 5-point Likert scale (1=No Anxiety; 5=Very High Anxiety).

of 376 students in the winter term 2014. Table 2 gives a short overview of the subscales, with item examples and Cronbach's alpha.

Table 2: Subscales, example items, Cronbach's alpha, and number of items per scale

Subscales	Reliability (α)	Number of Items
Fear of Interpretations	**0.685**	**6**
Trying to understand statistical analyses reported in a journal article.		
Test and Class Anxiety	**0.877**	**6**
Writing an examination for a statistics course.		
Fear of Asking for Help	**0.831**	**5**
Asking my statistics instructor for help with material I am having difficulty understanding.		
Cognitive Competence	**0.755**	**5**
I will understand statistics equations.		

As a control variable, we used students' prior experience with mathematics, operationalized through their final school grade in mathematics and through whether or not they had attended mathematics as a major school subject. Migration background was operationalized through students' mother tongue (German or not German) and their parents' country of origin.

4 Results

First, we conducted t-tests to analyze the extent to which statistics self-concept and statistics anxiety varied according to students' gender, native language, and their parents' country of origin. The t-tests and effect sizes offered a first impression of the existence and magnitude of differences between the subgroups. After calculating the overall effects, we controlled for other covariates, such as completion of

study courses or experiences with mathematics, in a linear regression to see if the effects changed depending on other factors.

Table 3: T-test and effect sizes according to gender

	Female	Male	p-Value	Cohen's d
	M (SD)	M (SD)		
Interpretations	2.383 (0.677)	2.213 (0.676)	0.006	0.252
Test and Class	3.561 (0.930)	3.090 (0.970)	0.000	0.497
Asking for Help	2.390 (0.963)	2.309 (0.841)	0.326	0.089
Self-Concept	3.318 (0.768)	3.474 (0.730)	0.024	-0.207
Expected Course Grade	2.734 (0.782)	2.495 (0.814)	0.001	0.299
Note: M = Mean, SD = Standard Deviation				

Table 3 shows the extent to which male and female students differed in terms of their statistics anxiety and self-concept. It is striking to note that male students were significantly less afraid of statistics than female students in two out of three anxiety dimensions. Female students experienced more anxiety when interpreting statistics and when taking tests or being in class while there were no significant gender differences in the fear of asking for help. Moreover, female students had lower statistics self-concept, as they rated themselves lower in this respect and expect to achieve lower grades in the statistics course. On average, male and fe-

male students expected to achieve a grade of 2.5 and 2.7, respectively. Overall, effect sizes (Cohen's d) were low to moderate.[10]

Table 4: T-test according to parents' origin

	Both Parents Born in Germ.	Parent Not Born in Germ.	p-Value	Cohen's d
	M (SD)	M (SD)		
Interpretations	2.273 (0.647)	2.392 (0.751)	0.077	0.175
Test and Class	3.388 (0.956)	3.277 (1.003)	0.247	-0.115
Asking for Help	2.304 (0.875)	2.483 (0.985)	0.048	0.197
Self-Concept	3.410 (0.762)	3.340 (0.739)	0.358	-0.092
Expected Course Grade	2.636 (0.777)	2.582 (0.879)	0.510	-0.066
Note: M = Mean, SD = Standard Deviation				

[10] According to COHEN (1988), values around 0.2 indicate a small effect, values around 0.5 a medium-sized effect, and values around 0.8 and higher a large effect.

Table 5: T-test according to native language

	Native Language German	Other Native Language	p-Value	Cohen's d
	M (SD)	M (SD)		
Interpretations	2.264 (0.662)	2.542 (0.738)	0.001	-0.413
Test and Class	3.386 (0.952)	3.176 (1.083)	0.086	0.215
Asking for Help	2.293 (0.896)	2.652 (0.958)	0.002	-0.397
Self-Concept	3.395 (0.750)	3.323 (0.778)	0.455	0.096
Expected Course Grade	2.635 (0.794)	2.571 (0.892)	0.530	0.079
Note: M = Mean, SD = Standard Deviation				

Regarding differences in students' socio-cultural background (see Tables 4 and 5), the discriminating criterion was native language rather than parents' origin, as the respective effect sizes were slightly higher. Students with migration background showed a higher fear of asking questions and of interpreting statistics compared to students without migration background. Students' self-evaluation of their performance in the ongoing statistics course did not vary significantly according to migration background.

Thus far, we examined the effect of each indicator on statistics self-concept and statistics anxiety separately. However, some effects might change if the influence of other variables is controlled. Therefore, we calculated the following regression, which comprises all determinants discussed above as independent variables. In addition, we included further control variables, such as the degree course and university students attended, whether or not they had attended mathematics as a major subject in school, as well as their final school grade in mathematics.

Table 6: Regression on statistics anxiety and self-concept

	Fear of Interpretations	Test and Class Anxiety	Fear of Asking for Help	Cognitive Competence	Expected Course Grade
	β-coef.				
Intercept	2.325***	3.073***	2.273***	3.714***	2.144***
Business and Economics degree course	-.195***	-.190*	0.009	.116	-.097
University 2	.080	.181*	-.023	-.024	-.028
Math Not Major Subject	.067	.341***	-.032	-.191***	.355***
Final Math Grade	.056*	.223***	.094**	-.268***	.335***
Male	-.165***	-.525***	-.072	.198***	-.324***
Non-native speaker of German	.302***	-.097	.357***	-.121	.052
Both Parents from Germany	-.052	.013	-.061	.049	.036
Adjusted R^2	6.9 %	20.1 %	2.2 %	18.5 %	27.4 %

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; β-coef. refers to the unstandardized β-coefficient

The regression analysis showed that the field of studies had an effect on the anxiety to interpret statistics. Students of business and economics experienced considerably lower levels of this anxiety type than students of political science. Furthermore, male students and German native speakers also had a significantly lower level of fear of statistical interpretations compared to other groups of students.

About 20 % of the variance of statistics test and class anxiety was explained by the small number of predictors chosen. In this case, all predictors except students' so-

cio-cultural background had a significant influence. The effects of gender and prior mathematical experiences at school were particularly high. Students who did not major in mathematics at school experienced higher levels of test and class anxiety. What is more, the worse students had performed concerning their final math grade from school, the higher was their test anxiety.

Only a small proportion of the variance in fear of asking for help was explained by the selected variables. However, it is noteworthy that non-native speakers of German experienced higher levels of this anxiety type. When we controlled for this effect, the parents' origin had no significant impact anymore. The worse students performed in terms of their final math grade in school, the higher was their fear of asking statistical questions.

The regression analysis also showed that students with more experience (math major) and more positive experience (better grades) considered themselves more capable of handling statistics tasks and more likely to achieve a significantly better grade than students with worse school grades in mathematics and students who had taken mathematics only as a minor school subject. Furthermore, male students expected they would achieve better course grades and be more proficient in statistics than female students. These few variables explained 18.5 % and 27.4 % of the variance in statistics self-concept.

In order to analyze whether effects differed between male and female students depending on their mother tongue, three dummy variables were added to the model to estimate separate effects for these subgroups.[11]

[11] We also calculated interaction effects between prior experience in math as well as gender and mother tongue. However, these models did not yield any new insights.

Table 7: Regression on statistics anxiety and self-concept with dummy variables for interaction effects of gender and native language

	Fear of Interpretations	Test and Class Anxiety	Fear of Asking for Help	Cognitive Competence	Expected Course Grade
	β-coef.				
Intercept	2.269***	2.829***	2.166***	3.958***	1.831***
Business and Economics degree course	-.195***	-.183*	0.014	.124	-.103
University 2	.080	.184*	-.021	-.021	-.030
Math Not Major Subject	.067	.347***	-.029	-.185***	.348***
Final Math Grade	.056*	.223***	.094**	-.268***	.335***
Both Parents from Germany	-.052	.011	-.063	.046	.037
German native speaker - Male	-.166**	-.497***	-0.054	0.231***	-.352***
Non German native speaker - Male	.140	-.728***	0.217	-0.042	-.187
Non German native speaker - Female	.300***	-0.028	0.402***	-0.036	-.019
Adjusted R^2	6.7 %	20.1 %	2.0 %	18.6 %	27.4 %

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; β-coef. refers to the unstandardized β-coefficient

In the models, the reference group are female native speakers of German. Comparing the coefficients of the other influencing variables, we see that their effects remain nearly constant. Table 7 shows that male native speakers of German experience less anxiety and have a higher self-concept than any of the other groups of

students. Solely male non-native speakers of German form an exception by experiencing even less test anxiety. The effects indicating that this group has higher fear of interpretations and of asking for help in absolute values as well as a slightly lower self-concept than female native speakers of German are, however, insignificant. Female non-native speakers of German showed the most negative values in fear of interpretations and fear of asking questions even compared to female native speakers.

5 Discussion

The results show that there are significant differences in how beginning students perceive their own ability to cope with statistics and their feelings of anxiety of statistics, depending on different personal variables. Our hypotheses were confirmed for the most part, which strengthens the generalizability of current international findings. Our findings also highlight the necessity to implement didactic means tailored to the heterogeneous needs of beginners as early as possible to facilitate their enculturation. Based on the empirical results, some pedagogical recommendations are discussed in the following.

Regarding the influence of gender on statistics anxiety (H1), female students were significantly more anxious in two out of three dimensions. Particularly for test and class anxiety in statistics, the effect sizes indicated medium-sized gender differences. Moreover, female students had a significantly lower self-concept (H2). They evaluated themselves as less proficient in statistics than male students. Empirical results of H1 and H2 also correspond with findings from German secondary education (GEBHARDT et al., 2013; OECD, 2015). CASSADY and JOHNSON (2004) argue that test anxiety among female students is more pronounced since they have a stronger perception of exam situations to be threatening rather than challenging. By means of experiments, ARCH (1987) already found that female participants have significantly more positive feelings and a higher self-concept when there is no or only an unimportant test situation involved. Since test situations in statistics classes can hardly be avoided, teachers can instead consider offering specific test

preparation. Moreover, self-attribution trainings showed some signs of success. Male students are more likely to ascribe success to their own abilities whereas female students tend to seek coincidental reasons for their success (ZIEGLER & SCHOBER, 2001). When implementing feedback systems in lectures and complementary tutorials, due consideration must be given to how to ascribe success to students' abilities. Some studies (MACHER et al., 2012; TEMPELAAR et al., 2004) provide evidence that the gender gap in statistics performance can be reduced by female students applying volitional learning strategies, for example, by organizing their learning environment efficiently and by investing more effort and concentration.

The results only showed small differences between students with and without migration background with regard to statistics self-concept (H4). However, a significant difference depending on socio-cultural background was that non-native speakers of German had more fear of interpreting results and of asking questions (H3). Hence, these students seem to have higher anxiety when it comes to processing statistical tasks phrased in German and to communicating in German. This might indicate that they do not judge themselves to be sufficiently proficient in the foreign language. Studies in secondary education also indicate that students with migration background have a lower verbal self-concept (SHAJEK et al., 2015), which seems to persist when they take up their studies in higher education. This finding was quite surprising, as these students mostly graduated from German secondary education, earning a university entrance certificate. Future research should control for verbal self-concept and language ability to shed more light on differences between German native speakers and students with other mother tongues. This could answer the question whether non-native speakers of German actually have significantly lower language skills than native speakers of German, or whether they solely have a lower verbal self-concept. This study has shown that language barriers also exist in numerical subjects. In teaching practice, such barriers could be reduced by complementing lectures with tutorials that include a stronger focus on group or partner work and learner-centered approaches. Smaller group sizes help create greater familiarity, which can make it easier for students with migration

background to ask questions. Moreover, online communication platforms enable students to ask questions anonymously without being exposed to the whole class.

Another possibility would be to offer preparatory courses in methodology and mathematics. Such courses can also contribute to make students feel better prepared for statistics courses in their prospective study programs. In addition, preparatory courses without exams mean less pressure for students and can evoke more positive feelings and associations particularly among female students. Overall, very few concepts have been developed for teaching and addressing the specific needs of heterogeneous groups of students in large lecture classes in higher education statistics courses

6 Limitations and Outlook

The presented results offer an insight into students' heterogeneous starting conditions at the beginning of studies in business and economics and political science. They also emphasize the substantial need for research on how students' preconditions determine learning in statistics. The evaluation of effects of gender and sociocultural background in this study could be criticized for investigating only two institutions in the sample. While the sample enabled an initial examination of our hypotheses in an extreme-group design, further investigations should include a much larger number of institutions. Nevertheless, the fact that the investigations at both universities and in both fields of study yielded similar empirical results for gender and migration background serves as a preliminary endorsement of applying this research approach more broadly. Furthermore, this study examined students' affective starting conditions at the beginning of studies in higher education. This raises the question how statistics anxiety and self-concept develop over the course of an introductory lecture in statistics. Such longitudinal studies could also provide information on potentially varying developments in different student groups. With regard to intervention programs, we would need to conduct comparative studies in order to explore ways to successfully foster students with low self-concept and high statistics anxiety. We must also note that there are further indicators of aca-

demic achievement beyond statistics self-concept and anxiety. Particularly, prior knowledge and learning strategies are important influence factors.

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