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Gendered career expectations in context: the relevance of normative and comparative reference groups

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ABSTRACT

Although women are increasingly entering male-dominated careers, they remain strongly underrepresented in science, technology, engineering and mathematics (STEM) occupations. While previous explanations emphasize the importance of individual preferences or family socialization, less is known about how the school context contributes to these differences. This study aimed to examine the role of the classroom context as a frame of reference for students' career expectations, focusing on comparative and normative reference group effects. Building on gender socialization theory and rational choice models, I investigate whether these contextual effects affect students' occupational expectations in a gender-specific way. Drawing on a large representative sample of secondary school students in Germany, I find that the gender gap in students' occupational expectations is larger in classrooms characterized by a high mathematical confidence and high aspirations toward STEM. In classrooms with a pronounced STEM-related classroom climate, female students less frequently expect to work in a STEM career, while for male students the same classroom climate is associated with higher expectations toward STEM. More generally, this study demonstrates that research on the explanation of gender differences in career expectations profits from incorporating social context effects within schools and classrooms.

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Introduction

A persistent subject of political and social concern is the pertaining gender segregation in science, technology, engineering and mathematics (STEM) occupations, which can be observed in many European countries (Barone 2011; Mann and DiPrete 2013). Adolescence is a crucial developmental stage in which gender-specific preferences and aspirations for a future career start to form (Ceci and Williams 2010). From an inequality perspective, understanding the emergence of gender-specific occupational aspirations is important, since these early differences contribute to persistent inequalities in occupational choices and outcomes across the life-course (Aisenbrey and Bruckner 2008; Schoon and Parsons 2002).

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Previous research has largely focused on individual-level predictors of gendered occupational preferences, suggesting that the decision about which occupation to pursue is based on gender-specific ability perceptions (Sax et al. 2015; Nix, Perez-Felkner, and Thomas 2015), career and life goals (Busch-Heizmann 2015), vocational interests (Ertl and Hartmann 2019) or internalized gender stereotypes (Makarova, Aeschlimann, and Herzog 2019) (for an overview see Yazilitas et al. 2013; Wang and Degol 2017). Yet, these individualistic explanations do not acknowledge the external and social constraints adolescents may consider when forming their preferences. Adolescents are embedded in varying social contexts which provide them with normative cues about appropriate behavior and represent a comparative frame of reference for their actions (Ross, Nisbett, and Gladwell 2011). Through these processes, social contexts convey information on the perceived accessibility and attainability of occupations, which adolescents' incorporate in the formation of their occupational expectations (Gottfredson 1981). Recognizing that occupational expectations do not merely reflect personal motivations for a particular career, but are the result of perceived barriers and opportunities, understanding the social embeddedness of adolescents' career decision-making process deserves further attention. During adolescence, the school context represents the fundamental social space for social interaction and peer socialization. Therefore, research has been increasingly interested in understanding social influences on gendered career plans, for example regarding interaction with peers (Raabe, Boda, and Stadtfeld 2019; Sinclair, Carlsson, and Björklund 2014; van der Vleuten, Steinmetz, and van de Werfhorst 2018) and school composition (Mann, Legewie, and DiPrete 2015; Legewie and DiPrete 2014).

I contribute to this emerging line of research by looking more closely at the classroom context. I ask whether and to what extent the classroom environment structures students' STEM-related occupational expectations and whether these effects differ for male and female students. More specifically, I consider two characteristics of a 'STEM-related classroom climate'. As outlined by reference group theory (Kelley 1952), classmates can serve a 'comparative' and a 'normative' function. *Conformity* represents the normative influence of the reference group and describes the process by which individuals adapt their preferences to those of their peers. I use the share of classmates expressing a STEM-related occupational aspiration to investigate this effect. The comparative function of reference groups means that students use their classmates as a target of social comparison to form evaluations about themselves, which can result in *social contrast* or *social assimilation* effects (Jonsson and Mood 2008). Accordingly, being surrounded by classmates who express high confidence in their mathematical abilities may depress or enhance students' STEM expectations. Both classroom features, which I consider part of a 'STEM-related classroom climate', may shape the size of the gender gap in students' occupational expectations by influencing the perceived social costs and success probabilities associated with entering a STEM career in a gender-specific way.

This study makes two major contributions to the literature. First, it introduces classroom effects in the study of adolescents' expectations toward STEM occupations. Previous research has either focused on *comparative* (Jonsson and Mood 2008; Mann, Legewie, and DiPrete 2015) or on *normative* reference group effects (van der Vleuten, Steinmetz, and van de Werfhorst 2018; Gabay-Egozi, Shavit, and Yaish 2015; Riegler-Crumb, Farkas, and Muller 2006) when investigating contextual effects on students' preferences for science and technology careers. Considering both effects jointly allows for an assessment of their relative

contribution. Second, this study links reference group effects to the gender gap in students' occupational expectations, thereby adding to the understanding of the gender-specific relevance of proximal social contexts (Legewie and DiPrete 2012, 2014). If male and female students differ in the way they engage in and respond to normative and comparative social influences, certain classroom contexts may amplify the emergence of gender differences in occupational expectations.

Theoretical framework and hypotheses

Motivated by the distinction between 'normative' and 'comparative' functions of social reference groups (Kelley 1952), I will discuss two processes by which the classroom environment influences students' occupational expectations. Predictions about the gender-specific structure of these contextual effects are drawn from socialization-based theoretical approaches (Sewell, Haller, and Portes 1969) and rational choice models of educational decision-making (Jonsson 1999). Both frameworks have been proven fruitful and complementary theoretical perspectives in understanding gender-specific educational and occupational decision-making (e.g. Gabay-Egozi, Shavit, and Yaish 2015).

Socialization approaches attribute gender-specific occupational preferences to gendered socialization of cultural norms and values through significant others. The rational choice model of educational decision-making, on the other hand, conceptualizes individual aspirations as the result of individuals' evaluation of the anticipated costs, benefits and success probabilities of educational alternatives (Breen and Goldthorpe, 1997). Combining both perspectives, individuals use their gendered preferences as an action calculus to weigh the individually perceived costs, benefits and probabilities of success of different occupational options. In the following, I lay out that reference groups may alter the perceived social costs (*normative* effects) and success probabilities (*comparative* effects) associated with pursuing a STEM career in a gender-specific way.

Normative reference groups and the gender gap in STEM expectations

The 'Wisconsin Model of Status Attainment' adopts a socialization perspective to educational and occupational attainment. In this view, social influences through 'significant others' like family and peers occupy a central role in the formation of occupational aspirations (Sewell, Haller, and Portes 1969). Conformity describes the process by which students adapt to the aspirations of their classmates, resulting from their desire to gain acceptance and recognition from their peers and to reduce discrepancies between themselves and their classmates (Festinger 1954). Moreover, when the number of classmates aspiring toward a STEM career increases, students' awareness and knowledge about these career paths is raised.

Since students mainly interact and form friendships with their same-sex peers, conformity influences are most relevant in same-sex social interactions (McPherson, Smith-Lovin, and Cook 2001). Students are more aware of the preferences and values of their friends with whom they frequently interact and whose opinions and attitudes they value. Supporting this view, several studies investigating peer influence found that significant others' and ego's educational choices were related. For example, exposure to college-going friends or friends with college expectations increased ego's college choices and expectations (Giorgi, Pellizzari,

and Redaelli 2010; Fletcher 2012, 2015). Students' and their best friends' curricular choices were also related (Gabay-Egozi, Shavit, and Yaish 2015).

From a socialization perspective, gender-normative ideas about females' incompatibility with math and science domains are highly prevalent and constitute an important explanation for women's underrepresentation and underachievement in STEM fields (Makarova, Aeschlimann, and Herzog 2019; Nosek et al. 2009). Importantly, evidence has shown that these cultural gender norms are context-dependent. For example, occupational gender segregation was more pronounced when cultural gender stereotypes were highly salient (McDaniel 2010, 2016). From a rational choice perspective, working in a gender-atypical career can be conceived as normative and social 'costs' (Jonsson 1999). For example, gender-atypical behavior and occupational choices have been connected to lower peer acceptance and lower levels of social support (Heilman et al., 2004; Taylor, 2010).

The presence of female STEM-oriented peers may alter the salience of gender in the classroom and hence the social costs of pursuing STEM as a woman. Female students oriented toward STEM reduce the normative costs associated with this career path, functioning as relevant counter-stereotype role models. Female students may hence consider these occupations as attainable and normatively acceptable in the presence of a higher share of same-sex students expressing a STEM aspiration. Previous evidence confirms that females are more likely to choose advanced mathematics coursework if their same-sex peers did so (Raabe, Boda, and Stadtfeld 2019) and that the endorsement of gender stereotypes within same-sex peer groups reduced females' participation in STEM fields (Riegle-Crumb and Morton 2017; Frank et al. 2008).

Based on these theoretical and empirical considerations on social conformity, I expect that females' STEM expectations more frequently occur in classroom environments where other female students express an aspiration toward STEM:

H1a (female social conformity). Female students have higher STEM expectations in classrooms in which a higher share of female classmates aspires toward a STEM occupation.

Relatedly, if more male students in a classroom aspire toward STEM, the social rewards for gender-conform STEM choices should increase, so that male students will more often consider these options.

H1b (male social conformity). Male students have higher STEM expectations in classrooms in which a higher share of male classmates aspires toward a STEM occupation.

Considering both effects, the gender gap in STEM expectations should be lower in classrooms in which a higher share of female classmates and a lower share of male classmates aspires toward a STEM occupation.

Comparative reference groups and the gender gap in STEM expectations

The previous explanation emphasized the contextual embeddedness of the normative costs and rewards of pursuing a STEM occupation. According to rational choice theory, students further employ their perceived prospects of success as a relevant criterion in educational and occupational decisions (Jonsson 1999). For example, students are more likely to select

STEM courses and careers when they perceive their abilities in mathematics as high, a concept which is known as mathematical self-concept (Sax et al. 2015; Jacobs 2005; Perez-Felkner, Nix, and Thomas 2017). Social comparison theory predicts that adolescents form interpretations of their abilities based on inter-individual comparison processes with their social environment (Festinger 1954). Accordingly, students use their significant others as a standard against which they assess and interpret their individual potential. In this perspective, students may expect that math-intensive occupations are not compatible with their individual abilities if they receive negative signals about their mathematical potential through social comparison with their confident classmates. This *social contrast* mechanism is in line with the well-researched Big-Fish-Little-Pond effect (BFLPE), which entails that students in higher achieving classrooms develop less favorable academic self-concepts (Marsh et al. 2018; Davis 1966). Building on this finding, studies have confirmed that equally achieving students make less demanding educational choices in higher-achieving than in lower achieving schools (Jonsson and Mood 2008; Rosenqvist 2018; Mann, Legewie, and DiPrete 2015). Being among the low achievers compared to their peers is furthermore associated with lower persistence in STEM majors at university (Fischer 2017).¹

Comparative reference groups: Social assimilation

Alternatively, social comparisons with a reference group can serve a self-improving function, the *social assimilation* mechanism (Festinger 1954). Accordingly, individuals engage in social comparisons with slightly better performing students to fulfill their need of self-enhancement and self-improvement. Upward comparisons with higher achieving classmates can motivate students to work harder and keep up with their higher achieving classmates (Mussweiler, Rüter, and Epstude 2004). Competitiveness is thus an important component of the social comparison process. Supporting this perspective, Crosnoe et al. (2008) found that friends' and coursemates' achievement was associated with an increase in adolescents' course-taking in math. Likewise, Frank et al. (2008) showed that female students were more likely to opt for math courses, the higher their same-gender coursemates' math achievement was. Acknowledging the assimilation function of reference groups, one can expect that students whose classmates are confident in mathematics are more likely to opt for math-intensive occupations. If a mathematically confident classroom climate reflects a higher level of competition and a math-supportive climate, students may thus anticipate higher success probabilities for math-related STEM occupations, making these careers more attractive from a rational choice point of view.

Gender-specific effects

The comparative function of reference groups thus either involves *social contrast* or *social assimilation* effects. In the following, I argue that response to a mathematically confident classroom climate may be gender-specific. Females tend to downwardly misperceive their math and science abilities, contributing to gendered educational decisions (Nix, Perez-Felkner, and Thomas 2015; Correll 2001). Hence, female students likely need higher evidence of their individual mathematical potential in relation to their classmates. Consequently, they set a higher threshold at which they perceive themselves as suitable for entering a

STEM career. Since for males, mathematics and science is part of their socialized masculine identity, they are less vulnerable to negative signals from their classmates. Therefore, I expect that female students will develop lower STEM expectations in mathematically confident classrooms.

Males are more inclined to behave in a competitive manner than females. Evidence suggests that men tend to be more willing to enter competition (Niederle and Vesterlund 2007, 2011). Competitiveness has also been introduced as an explanation for gender differences in the choice of math and science tracks, given that STEM occupations are generally perceived as more competitive and difficult than non-STEM occupations (Buser, Niederle, and Oosterbeek 2014). To the extent that a confident classroom climate is indicative of a competitive environment, male students may therefore be inspired by their mathematically confident peers to perform equally well or even better, thus facilitating the formation of STEM expectations. Female students, in contrast, will likely abandon their orientation toward these occupations in a competitive surrounding. From these perspectives, I expect the following:

H2a. Female students hold lower STEM expectations in classrooms characterized by a strong mathematical confidence (social contrast)

H2b. Male students hold higher STEM expectations in classrooms characterized by a strong mathematical confidence (social assimilation)

The gender gap in STEM expectations should therefore be larger in classrooms with a higher share of confident classmates.

Data and methods

Data

The empirical analyses are based on representative data from the starting cohort 4 'School and Vocational Training: Educational Pathways of Students in Grade 9 and Higher' from the German National Educational Panel Study (NEPS) (Blossfeld and Roßbach 2019; <http://dx.doi.org/10.5157/NEPS:SC4:10.0.0>). Respondents were selected in a stratified cluster sampling design. First, schools were randomly selected and second, a sample of two classes was drawn within every school. I considered data on ninth-graders, which have been collected in two subsequent waves during the 2010/11 school year. Information was provided by various sources, including students, parents and teachers. The full sample comprised 16,425 ninth graders at German secondary schools, including students from regular schools and students at special-needs schools. I limited my analyses to the regular sample of 15,147 students, because special-needs students were lacking information about their occupational expectations. Among this sample, 38% of students did not respond to the assessment of their occupational expectations. Throughout the analyses, missing information on the covariates were imputed through chained equation modeling (MICE) (Allison 2002), generating 15 complete data sets. The imputation model included all covariates, the dependent variables and auxiliary variables (e.g. type of non-response of occupational expectations). In the subsequent regression analyses, I considered only those cases for which the dependent variable was fully observed (von Hippel 2007). Owing to the estimation strategy, I further restricted the analytical sample to schools for which two classrooms have been sampled.

The final analysis sample ended up being $n_i = 8711$ students in $n_s = 458$ schools and $n_c = 916$ classrooms. A description of the variables for the analysis sample (before imputation) is available in [Table 1](#).

Variables

The dependent variable indicates whether students expected a STEM related occupation. It was based on an open-ended question ('Based on everything you currently know, what kind of job will you most likely have later on?'). The answer to that question relates to the theoretical concept of a 'realistic occupational aspiration', which is modulated by the perceived accessibility of occupations (Gottfredson 1981). Responses were coded based on the four-digit level of the International Standard Classification of Occupations (ISCO-08). A dummy variable was created which indicated whether students expected a STEM career or not. To acknowledge the heterogeneity within STEM occupations, I further distinguished between 'soft' (including e.g. biology), 'hard' (e.g. engineering) and health-related STEM occupations. The definition of STEM occupations used in this study is similar to the one adopted by the European Parliament (2015). The appendix includes a detailed list of occupations treated as STEM ([Table A1](#)).

The central explanatory variables depict two aspects of a STEM-related classroom climate:

The normative classroom climate was measured by two variables indicating the share of male (female) students in the classroom expressing an aspiration to work in a STEM occupation. Classmates' aspirations were measured using the question: 'Imagine you had all opportunities to become what you want. What would be your ideal occupation?'. This question relates to the concept of an idealistic occupational aspiration, comprising students' unconstrained willingness and desire to work in this occupation (Gottfredson 1981).

Table 1. Descriptive statistics (pre-imputation sample).

Variable	Obs	Mean	SD	Min	Max
<i>Occupational expectation</i>					
STEM (hard)	8711	0.1	0.3	0	1
STEM (hard and soft)	8711	0.15	0.36	0	1
STEM (hard, soft and health)	8711	0.29	0.45	0	1
<i>Individual-level covariates</i>					
Gender	8711	0.51	0.5	0	1
Migration background	8588	0.13	0.33	0	1
Parents: STEM occupation	7737	0.2	0.4	0	1
Parents: highest educational degree	7757	2.53	0.72	1	3
Parents: occupational status (ISEI)	7737	53.1	20.37	11.56	88.96
Grade (math)	8477	4	1.03	1	6
Grade (German)	8526	4.13	0.83	1	6
Mathematical competencies	8354	0.03	1.22	-4.37	4.62
Reading competencies	8520	-0.02	1.24	-4.75	3.3
Mathematical self-concept	8134	2.52	0.93	1	4
Occupational aspiration (STEM)	8016	0.12	0.32	0	1
<i>Classroom-level covariates</i>					
Classroom size	8711	18.09	6.1	1	33
Share of boys	8711	49.67	17.59	0	100
Share of migrants	8711	12.89	14.48	0	100
Average mathematical confidence	8711	2.51	.3	1	4
Share: females with STEM aspiration	8711	0.15	0.15	0	1
Share: males with STEM aspiration	8711	0.03	0.06	0	1

Source: NEPS, starting cohort 4. Own calculations.

Responses were coded into STEM or non-STEM occupations and aggregated to the classroom level.

The comparative classroom climate was operationalized as the average mathematical self-concept in the classroom, which was measured using a scale of three items, with students indicating their agreement to the following statements on a 5-points scale: ‘mathematics is one of my best subjects’, ‘I learn quickly in mathematics’ and ‘I’ve always been good at mathematics’. Individual values on this scale were aggregated into a classroom average. In all cases of aggregation, I used the imputed dataset.

Covariates were selected based on theoretical arguments about which variables relate to students’ occupational expectations and classroom climate, thus potentially confounding this relationship. Students’ academic performance was measured in two ways. First, students reported their teacher-assigned math and verbal grades from their official school report in the middle of ninth grade (coded such that 1: lowest grade, 6: highest grade). Second, students’ performance was assessed through standardized tests, capturing their competencies in math and reading. Since parents and their socioeconomic position play an important role in their children’s career selection process, I considered whether at least one parent works in a STEM occupation, as well as parents’ highest educational degree (1: low (Hauptschulabschluss), 2: medium (Realschulabschluss), 3: high (Abitur, the German university-entrance diploma) and parents’ highest occupational status based on the Socio-Economic Index of Occupational Status (ISEI-08). Information on these variables was obtained from the parents’ questionnaire and complemented with information from the students’ questionnaire. At the individual level, I further considered students’ migration background (distinguishing between students with and without German as a mother tongue).² At the classroom level, I took into account basic demographic indicators, comprising the share of female students, the share of students with migration background and classroom size. School-level characteristics, such as educational track or socioeconomic composition, were not considered as control variables, since their influence was ruled out through the modeling strategy (see below).

Analytical strategy

To test the hypothesis of a relationship between classroom climate and the gender gap in occupational expectations, I estimate linear probability regression models (LPM),³ allowing for a direct interpretation of coefficients as marginal effects, reducing bias of unobserved heterogeneity and increasing comparability between different model specifications (Mood 2010). All standard errors are clustered at the school level to correct for dependency between observations within the same school.

When estimating contextual effects, bias may arise from unobserved variables at the school or neighborhood level that are correlated with both the outcome variable and the predictors of interest. Schools and neighborhoods might differ in terms of various compositional and organizational characteristics confounding the relationship between STEM-related school climate and students’ career expectations. These characteristics include for example the socio-economic composition of the student body and neighborhood, educational track, teacher quality or career counseling. Since I cannot observe all of the possible confounders and to eliminate as many biasing factors at the school level as possible, I

estimate school fixed-effects models. This estimation strategy effectively compares individuals within the same school belonging to different classrooms, thus relying on within-school variation (Allison 2009).

At the center of this study lies the relationship between classroom climate and the gender gap in students' career expectations. In a first set of models, I examine the overall associations between normative and comparative classroom effects on students' STEM expectations. In a second set of models, I introduce a cross-level interaction between gender and the respective indicator of classroom climate, thus reflecting the context-dependent gender gap in STEM expectations.

Results

Descriptive statistics

Overall, 10% of the total analysis sample indicated that they expected to work in a (hard) STEM occupation. The data reveals substantial gender differences: among those students who formulated a STEM expectation, 84% are male and 17% are female. The average classroom climate is about $M = 2.51$ (mathematical confidence) and $M = 8.83$ (STEM aspiration), varying between schools ($SD_{\text{confidence}} = 7.18$; $SD_{\text{aspiration}} = 0.24$) and within schools ($SD_{\text{confidence}} = 6.83$ $SD_{\text{aspiration}} = 0.19$). Obviously, a larger part of the variation in classroom climate is located between schools, but there is also some noteworthy variation within schools, which provides a good basis for using school fixed effects models.

The association between classroom context and STEM expectations

Table 2 displays the results of four linear probability models for the full sample of male and female students, calculating the probability of expecting a STEM occupation. With these models, I examine whether there is a general link between aspects of a STEM-related classroom climate and students' occupational expectations. I do not yet distinguish gender-specific effects. For sake of robustness, I consider three different specifications of STEM occupations (see Table A2 in the appendix). Besides the contextual variables, I include individual-level occupational aspirations and mathematical self-concept, thereby ensuring that the effect of the aggregate context variables is not driven by students' individual values. The results reveal that for all model specifications, neither classmates' mathematical confidence nor (male or female) classmates' STEM aspirations substantially relate to students' occupational expectations.

Does the gender gap in STEM expectations vary by classroom context?

In the next set of models, I explore whether the gender gap in STEM expectations varies by classroom context, as formulated in the hypotheses. For this purpose, I introduce a cross-level interaction between the three features of classroom context and gender (results are displayed in Table 3). The multiplicative two-way-interaction term between classroom context and gender indicates whether male and female students respond differently to the classroom environment. The main effect of average classroom achievement reveals the predicted change in the probability of expecting a STEM occupation for a one-unit increase of the contextual variable, given the gender variable takes the value 0 (male). Adding the interaction term to the main effect produces the predicted change for girls (coded as 1). In

Table 2. Results from linear probability models with school fixed effects.

Dependent variable:	STEM (hard)			
	(1)	(2)	(3)	(4)
Gender	−0.040*** (0.006)	−0.040*** (0.006)	−0.110*** (0.008)	−0.036*** (0.006)
STEM aspiration	0.515*** (0.019)	0.515*** (0.019)		0.514*** (0.019)
Mathematical self-concept			0.028*** (0.005)	0.018*** (0.004)
<i>Social conformity:</i> Classroom: share of females with STEM aspiration	−0.011 (0.065)			−0.010 (0.065)
Classroom: share of males with STEM aspiration		−0.005 (0.029)		−0.006 (0.029)
<i>Social comparison:</i> Classroom: mathematical self-concept			0.002 (0.018)	0.006 (0.015)
Observations	8711	8711	8711	8711
N (schools)	458	458	458	458
N (classrooms)	916	916	916	916

Source: NEPS, starting cohort 4. Clustered standard errors in parentheses. Control variables include migration background, parental STEM occupation, highest parental educational degree, parental occupational status, grades in math and German, math and verbal test scores, classroom size, demographic classroom composition.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

the following, I will discuss results from the first four models, which includes the narrowest definition of STEM as an outcome variable (see Table A2 in the appendix for a replication for broader STEM definitions). The first two models refer to the social conformity mechanism (distinguishing between male and female classmates), the third model investigates the social comparison mechanism and the fourth model considers all classroom effects jointly.

Models 1–3, considering each classroom effect separately, yield a negative interaction term between gender and the contextual variables. Male students express higher STEM expectations than females when they are schooled in classrooms with a stronger confidence in mathematics and a higher share of (male or female) STEM-aspiring students. The gender gap in occupational expectations is thus associated with the classroom environment.

The social conformity mechanism is assessed in Models 1 and 2, revealing the influence of female and male classmates' aspirations on students' expectations. Model 1 shows that an increase in the share of female classmates aspiring toward STEM is associated with an increase in males' probability of expecting a STEM occupation, but a decrease in females' probability. This result clearly contradicts the hypothesis about a positive counter-stereotype effect from STEM-interested female classmates (*H1a. Female students have higher STEM expectations in classrooms in which a higher share of female classmates aspires toward a STEM occupation*). The presence of STEM-interested males shows similar associations with students' expectations, as is depicted in Model 2. Male students show higher STEM

expectations in classrooms in which a higher share of male classmates aspires toward a STEM occupation, which confirms hypothesis H1b of a social conformity effect among male classmates. Apparently, normative reference group effects do not only involve social conformity among same-sex classmates, but higher aspirations among classmates generally favors the development of STEM expectations among male students. Interestingly, a higher share of STEM-aspiring (male or female) classmates depresses females' STEM expectations. Both normative reference group effects are generally more pronounced in Models 1–3 than in the joint regression (Model 4). This indicates that normative and comparative classroom effects are partially intertwined with one another. Concerning the normative effects, effect sizes are reduced and remain in the discussed direction, but they lose statistical significance. They can therefore not be generalized above the sample at hand.

Table 3. Results from linear probability models with school fixed effects, interaction between gender and classroom context.

Dependent variable:	STEM (hard)			
	(1)	(2)	(3)	(4)
Gender	–0.032*** (0.006)	–0.018* (0.009)	0.200** (0.063)	0.165*** (0.049)
STEM aspiration	0.518*** (0.019)	0.506*** (0.020)		0.508*** (0.020)
Mathematical self-concept			0.028*** (0.005)	0.019*** (0.004)
<i>Social conformity:</i>				
Female # classroom: share of females with STEM aspiration	–0.239* (0.110)			–0.212+ (0.110)
Classroom: share of females with STEM aspiration	0.098 (0.094)			0.093 (0.095)
Female # classroom: share of males with STEM aspiration		–0.115* (0.045)		–0.086+ (0.046)
Classroom: share of males with STEM aspiration		0.064 (0.045)		0.047 (0.046)
<i>Social comparison:</i>				
Female # classroom: mathematical self-concept			–0.124*** (0.025)	–0.071*** (0.020)
Classroom: mathematical self-concept			0.065** (0.025)	0.041* (0.020)
Observations	8711	8711	8711	8711
N (schools)	458	458	458	458
N (classrooms)	916	916	916	916

Source: NEPS, starting cohort 4. Clustered standard errors in parentheses. Control variables include migration background, parental STEM occupation, highest parental educational degree, parental occupational status, grades in math and German, math and verbal test scores, classroom size, demographic classroom composition.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Turning to the social comparison mechanism, Model 3 reveals that an increase by one additional scale point on classmates' mathematical confidence is associated with a 6.5-percentage-point increase in males' probability of expecting a STEM occupation, while such a shift leads to a decrease of 5.9 percentage points for females. These effects are statistically significant at $p < 0.01$. Providing a substantial interpretation of these effects, an increase by one within-school standard deviation in classmates' confidence ($SD = 0.29$) is associated with a 1.86-percentage-point increase (1.74-percentage-point decrease) in males' (females') probability of expecting toward STEM. These findings confirm the two hypotheses about the gender-specific social comparison effects. The social contrast effect was confirmed for females (*H2a. Females hold lower STEM expectations in classrooms characterized by a strong mathematical confidence*) and the social assimilation effect was confirmed for male students (*H2b. Males hold higher STEM expectations in classrooms characterized by a strong mathematical confidence*). Model 4 further reveals that effect sizes of this comparative context effect are somewhat reduced when all contextual variables are included simultaneously. Still, the comparative context effect remains of importance even when normative context effects are added to the model. Its statistical significance at $p < 0.05$ increases confidence in the occurrence and generalizability of the effect beyond the sample.

Results from Model 4 are illustrated in [Figure 1](#) which shows that the gender-specific normative and comparative effects are comparable in size (displayed in terms of within-school standard deviations). These results are robust to different operationalizations of the dependent variable (see appendix, [Table A2](#)). Direction, size and statistical significance of the effects do not considerably differ according to a wider or narrower definition of STEM occupations, therefore the interpretation is not substantially altered. Normative effects were, however, more pronounced when using a broader STEM definition.

Conclusion and discussion

The topic of occupational gender segregation is rooted in students' early career expectations. In this study, I concentrated on the distinction of STEM versus non-STEM occupational expectations, which is one of the most visible demarcation lines in occupational gender segregation in Germany. Moving beyond individualistic explanations, I examined whether classrooms are associated with adolescents' occupational expectations. More specifically, I looked at how normative and comparative reference group effects relate to the gender gap in students' STEM expectations. Thereby, I connected two separate literatures and research traditions, one on the development of aspirations (Schoon and Parsons 2002) and the other on reference and peer group effects (Kelley 1952; Riegle-Crumb and Morton 2017).

Understanding how gender differences in occupational expectations come about is an important endeavor, since early aspirations shape future engagement and inequalities in STEM careers (Correll 2001; Schoon and Parsons 2002). The results of this study emphasize that classrooms are relevant contexts to young people's career expectations. Understanding the processes generating gender inequality within schools is crucial for educators and policymakers alike, so that adolescents' career-decision-making-process can best be understood and guided. The present study emphasizes the need to address students' social embeddedness and orientation toward classmates in policy measures targeting the STEM gender gap.

Building on the insights of frame of reference theory in relation to rational choice and socialization perspectives on the role of classmates to shape males' and females' occupational

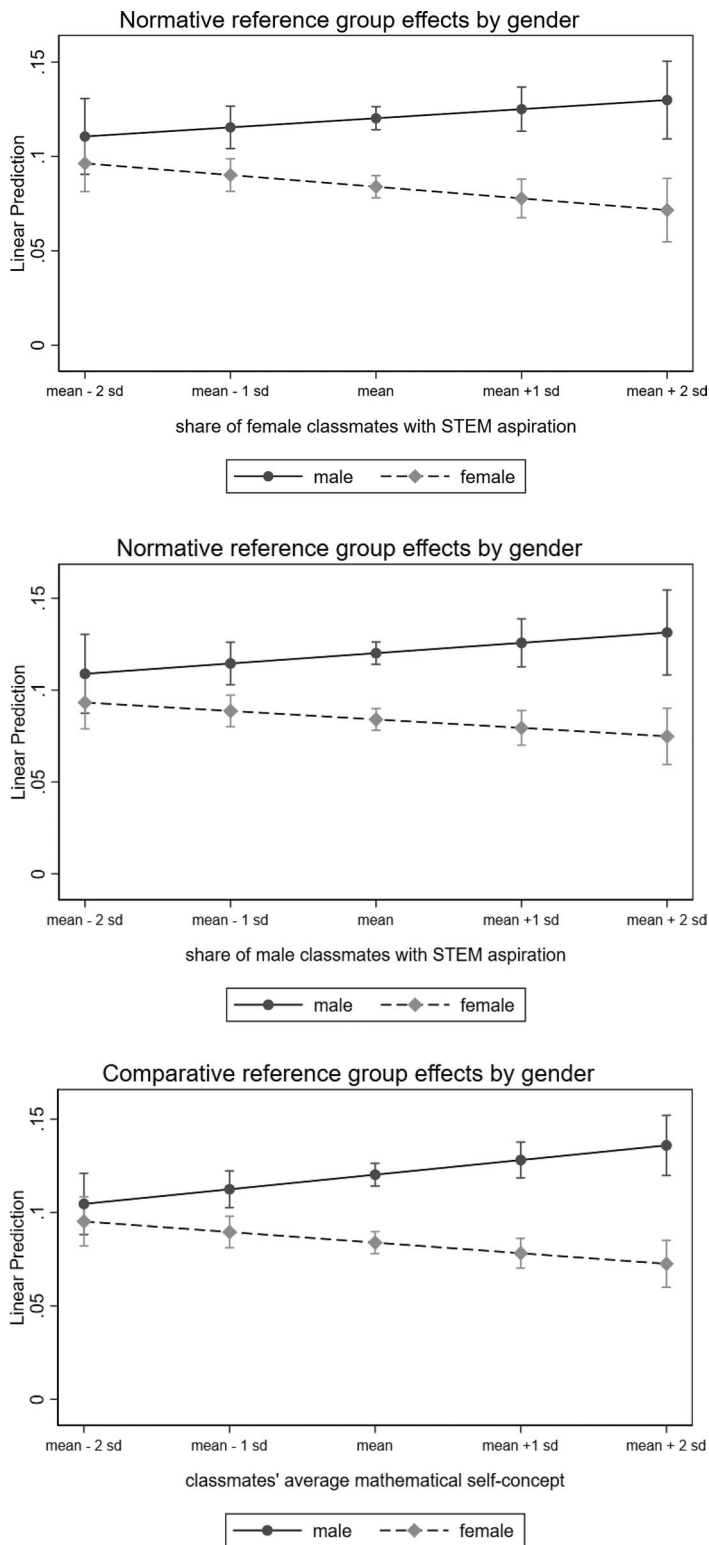


Figure 1. Normative and comparative classroom effects by gender. Results from Table 3, Model 4.

expectations, the goal of this study was to explore how two aspects of a STEM-related classroom climate are associated with the gender gap in occupational expectations. Specifically, this study considered the potential effect of same-sex classmates' STEM aspirations (normative reference group effects) and classmates' confidence in mathematics (comparative reference group effects). The results of this study reconfirm that females are less likely than males to expect to work in STEM occupations, even when they have comparable abilities and aspirations. Multivariate analyses of a representative sample of 9th graders in Germany suggest that classmates are important sources of both normative and comparative reference group effects. To recapitulate, I found that both classroom environments were associated with the gender gap in STEM expectations. In the presence of mathematically confident and STEM-aspiring classmates, male students were generally more likely to express a STEM expectation, while female students had lower STEM expectations. As an overall result, the gender gap in STEM expectations is most pronounced in classrooms with an overall STEM-oriented climate.

The results of this study are robust to the inclusion of an important number of individual, family and classroom covariates, which might bias the association studied. Importantly, by applying school fixed effects models, I was able to take into account (unobserved) school characteristics, which previous studies dealing with the impact of school effects on occupational expectations did not consider. Thereby, I strengthen the robustness of previous findings relying on between-school effects (e.g. Mann, Legewie, and DiPrete 2015).

The results of the present study are of theoretical importance, because they show that the formation of occupational expectations operates not only at the individual level, but also depends on the classroom context. Findings confirm the relevance of comparative reference group effects for occupational decisions (Jonsson and Mood 2008) and emphasize their gender-specific structure. Regarding normative influences, this study contradicts previous findings on the counter-stereotypical influence of female role models (e.g. Raabe, Boda, and Stadtfeld 2019; Riegle-Crumb and Morton 2017). Instead, a higher share of female classmates who show an aspiration to STEM depress female students' expectation to work in STEM. Furthermore, normative effects were not limited to same-sex influences, as suggested by social homophily theory (McPherson, Smith-Lovin, and Cook 2001). Rather, females' (males') STEM expectations were depressed (enhanced) by their same-sex and opposite-sex classmates' to a comparable extent.

Limitations and future research

This study is not without limitations. First, results could be biased in case of selection effects across classrooms. The results of Lorenz et al. (2020) increase confidence that influence effects usually play a greater role than selection processes when considering peer influences in relation to educational and occupational aspirations. Second, social comparison processes might not only manifest themselves at the classroom level, but also at more fine-grained levels of social interaction, e.g. regarding friendship groups and close friends (Lomi et al., 2011). Future research is needed to unravel how close friends and the broader classroom context jointly influence the career decision-making process of adolescents. For example, although classmates' mathematical confidence on average depresses females' STEM expectations, as found in the present study, the positive influence of close friends could counteract this negative impact. Ultimately, better understanding the micro-channels generating the gender-specific influence

processes found here would be a promising avenue for future research. Third, in the present study, I investigated social comparison effects in the domain of mathematics. Since mathematics is viewed as a stereotypical masculine domain, female students might attach greater importance to comparisons with their peers in female-typed subjects, such as languages. Future research is needed to investigate whether the associations found here can be generalized across different disciplines. Finally, the findings from this study are limited by their cross-sectional nature, making it difficult to interpret the effects as causal. Future research should replicate these findings from a longitudinal perspective to better understand how the associations found in this study unfold over time. To achieve this research aim, more longitudinal data about the evolution of classroom climate and students' occupational plans is needed.

Notes

1. Studies concerned with the BFLPE have traditionally focused on classmates' achievement as measured by standardized test scores. In the present study, I instead use classmates' mathematical self-concept, which captures how classmates express their confidence about their mathematical abilities and thus provides a more relevant social comparison standard. For example, it has been shown that students interpret the same individual academic performance differently (Möller and Pohlmann 2010). Thus, using test scores as a contextual measure does not capture the subjective importance students attach to their abilities which they will ultimately convey to their classmates.
2. Research has shown that students with an immigration background are more likely to pursue STEM careers, reflecting a comparative disadvantage in native language skills (Rangel and Shi, 2019).
3. A linear probability model (LPM) is a linear regression model where the outcome variable is a binary variable: $Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + u_i$ coefficients. β_j can be interpreted as conditional probabilities, i.e. the change in the probability that $Y_i = 1$, holding constant the other $k - 1$ regressors.

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No potential conflict of interest was reported by the author(s).

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Appendix

Table A1. Classification of STEM occupations (based on ISCO-08).

Occupation	STEM hard	STEM soft	STEM health
<i>2 Professionals</i>			
211 Physical and Earth Science Professionals			
212 Mathematicians, Actuaries and Statisticians			
213 Life Science Professionals			
214 Engineering Professionals (excluding Electrotechnology)			
215 Electrotechnology Engineers			
216 Architects, Planners, Surveyors and Designers			
221 Medical Doctors			
222 Nursing and Midwifery Professionals			
223 Traditional and Complementary Medicine Professionals			
224 Paramedical Practitioners			
225 Veterinarians			
226 Other Health Professionals			
251 Software and Applications Developers and Analysts			
252 Database and Network Professionals			
<i>3 Technicians and Associate Professionals</i>			
311 Physical and Engineering Science Technicians			
312 Mining, Manufacturing and Construction Supervisors			
313 Process Control Technicians			
314 Life Science Technicians and Related Associate Professionals			
315 Ship and Aircraft Controllers and Technicians			
321 Medical and Pharmaceutical Technicians			
322 Nursing and Midwifery Associate Professionals			
323 Traditional and Complementary Medicine Associate Professionals			
324 Veterinary Technicians and Assistants			
325 Other Health Associate Professionals			
351 Information and Communications Technology Operations and User Support Technicians			
352 Telecommunications and Broadcasting Technicians			

Table A2. Results from linear probability models with school fixed effects. (Replication of [Table 2](#) for different STEM definitions.)

[illegible]

Table A3. Results from linear probability models with school fixed effects, interaction between gender and classroom context. (Replication of [Table 3](#) for different STEM definitions.)

[illegible]