




Women's Daily Performance, Enjoyment, and Comfort in Male-Dominated Majors: The Role of Social Interactions in Classes

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Received: 7 September 2019 / Published online: 1 September 2020
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Abstract

Women drop out of male-dominated majors (MDMs) at a higher rate than men (Blickenstaff 2005). Research is needed to better understand contextual factors in the major, such as social interactions in major classes, that may increase women's engagement in MDMs and ultimately reduce attrition (Lawson et al. in *Sex Roles* 78:542–560, 2018). The present study examined whether women in MDMs differed from men in MDMs and women in gender-neutral majors (GNMs) in terms of (1) levels of daily student engagement in major classes; and (2) the association between daily social interactions in classes and student engagement. Daily data were collected from 120 students (40 women in MDMs, 40 men in MDMs, 40 women in GNMs) about social interactions (talking to a peer, interacting with a professor one-on-one, and class discussions) and student engagement (perceived performance, enjoyment, and feelings of comfort) in major classes at the end of the day over a two week period. Results indicated that women in MDMs reported lower levels of daily engagement in major classes, relative to their peers. Talking with a peer and class discussions were associated with higher levels of student engagement, but these associations were qualified by group. Overall, the daily association between social experiences and student engagement were stronger for women in MDMs, relative to their peers. Results support the social-contextual model of prejudice (Murphy et al in *Policy Insights Behav Brain Sci* 5:66–74, 2018) in that classroom experiences disadvantaged women in MDMs, but daily social interactions may be particularly beneficial for women in these contexts.

Keywords Women in male-dominated majors · Experience sampling methodology · Student engagement · Classroom experiences · Social interactions

Women drop out of male-dominated fields at various stages of career development at a higher rate than men (e.g., Cech and Blair-Loy 2019; Isphording and Qendria 2019). Male-dominated fields include some fields of science, technology, engineering, and math (STEM), such as computer science, engineering, and physics, and some non-STEM fields

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such as music theory and composition (Cheryan et al. 2017; Meyer et al. 2015). High rates of attrition of women from male-dominated fields has remained a persistent issue in the U.S. and throughout the world (Blickenstaff 2005; Kanny et al. 2014), which contributes to larger societal level problems. For example, high rates of attrition at all stages of career development ultimately result in gendered segregation in the labor market, which is a contributor to the gender wage gap and power inequities in society (Hegewisch and Hartmann 2014; Hultin and Szulkin 2003). In addition, research finds that diversity in classrooms is associated with more cognitive growth and positive learning experiences for students (Bowman 2010; Pascarella et al. 2014), diversity in the workforce is associated with higher levels of productivity, innovation, and creativity (Corbett and Hill 2015), and many male-dominated fields (such as computer science) are growing and will need larger numbers of employees to meet societal demands (Bureau of Labor Statistics 2019). Therefore, it is important to better understand contributors to and buffers of women's attrition from male-dominated fields.

Predictors of student engagement, defined as academic performance, personal, and social factors that have implications for the well-being of a student (London et al. 2011a), may allow for a better understanding of contributors to women's attrition or persistence in male-dominated majors (MDMs). Social experiences in university classrooms, in particular, may have important implications for women's engagement and persistence in MDMs (Kahu 2013). The present study utilizes data collected daily over the course of two weeks during an academic year to examine: (1) whether student engagement (perceived performance, enjoyment, and feelings of comfort) in major classes differ for women in MDMs, relative to men in MDMs and women in gender-neutral majors (GNMs); and (2) whether daily social interactions in classes—namely talking to a peer, interacting with a professor one-on-one, and class discussions—are stronger predictors of daily student engagement in classes for women in MDMs, relative to their peers.

Social-Contextual Model of Prejudice

Although psychological theories and lay beliefs often attribute prejudice to occur within individuals (i.e., some people are more prejudiced than others—referred to as prejudice-in-people models), Murphy et al. (2018) argue that *contexts* are prejudiced when there are “predictable, systematic inequalities in experience and outcomes based on people's social group memberships—advantaging people from some social groups while disadvantaging people from others” (p. 68). The values, norms, behaviors, hierarchies, and models within a context may have negative implications for certain social groups' cognitive functioning, performance, emotions, and physiology—even in the absence of a prejudiced individual. Supporting this idea, research on stereotype threat finds that individuals who experience negative stereotypes about their social group (e.g., the stereotype that women are not good at math) often underperform due to increased stress and pressure to disconfirm the stereotype (Steele et al. 2002). In other words, even though men and women may appear to be engaging in the same behavior when taking an exam in a math class (for example), according to the social-contextual model of prejudice, this would be an example of a prejudiced situation because this test requires more cognitive resources for women, relative to men, due to the negative stereotypes about women's math ability.

Certain components of male-dominated contexts may also have negative implications for women's, but not men's, sense of belonging and interest in the field. For example, using

experimental designs where components of the context were manipulated to determine its effects on women's engagement in computer science, Cheryan et al. (2011, 2013) found that interacting with a stereotypical role model (e.g., hobbies included video games, wore glasses, T-shirt that said "I code therefore I am"), and viewing virtual classrooms with stereotypical objects (e.g., science fiction books, Star Wars items) decreased women's, but not men's, sense of belonging in computer science. This reduced sense of belonging ultimately led to women reporting less interest and anticipated success in computer science, and lower intentions to enroll in computer science classes in the future.

Similarly, Murphy et al. (2007) found that women, but not men, were less likely to desire to participate in a conference if they viewed a video showing an unbalanced ratio of men to women (3 to 1), versus those who watched a video with a balanced gender ratio (1 to 1). In all of these studies, even though men and women were exposed to the same contexts (interacting with role models, virtual classrooms, and a video of a conference), the impact of these experiences were not the same, hindering women's engagement in computer science. Thus, according to the social-contextual model of prejudice, these *contexts* are prejudiced (Murphy et al. 2018). Given the evidence that the contexts in male-dominated fields may have negative implications for women's engagement in MDMs, it is predicted that:

Hypothesis 1 On days students reported attending a major class, women in MDMs will report they performed more poorly in class, enjoyed the class less, and felt less comfortable in class, relative to men in MDMs and women in GNMs.

Daily Social Experiences in Classrooms and Student Engagement

Although the contexts of MDMs have the potential to be prejudiced, there may be components of these contexts that are beneficial for women's engagement. Kahu's (2013) model of student engagement attempts to combine commonly used research perspectives on student engagement by emphasizing how sociocultural (e.g., gender roles), structural (e.g., university culture), and psychosocial (e.g., relationships) factors all interact to influence student engagement. This model acknowledges that social integration and relationships—such as faculty-student and peer relationships—are important contributing factors to student engagement. In line with this model, research finds that social interactions and relationships with faculty and peers predict higher levels of student engagement, such as positive perceptions of the environment, student performance and learning, and social development and feelings of belonging (e.g., Delgado et al. 2016; Furrer et al. 2014; Lundberg and Schreiner 2004; McFaul 2016; Shook and Keup 2012; Umbach and Wawrzynski 2005).

Although a majority of this research focuses on overall experiences within a major (e.g., overall, do students who interact more with professors and peers also report higher levels of student engagement; also referred to as between-person associations), it is possible that the benefits of social interactions may occur at a smaller level: the daily level. For example, on a day when a woman in a MDM talks one-on-one with a professor in class, does she also report enjoying the class more than usual? To examine daily associations between social classroom experiences and student engagement, the present study utilizes experience sampling methodology (ESM). ESM requires participants to report on their contexts, feelings, thoughts, and activities repeatedly as they live their daily lives. Researchers argue that ESM is an underutilized, yet promising method for better understanding how contexts, such

as classrooms, shape the daily lived experiences of students, including women in MDMs (London et al. 2011a; Zirkel et al. 2015). In addition, daily associations have been found to be powerful predictors of well-being—above and beyond the typical between-person associations often found in research (Almeida et al. 2016; Charles et al. 2013).

Little research has utilized this methodology to examine women's engagement in MDM classrooms. This research, however, supports the idea that student engagement is not static, but rather changes across days (London et al. 2011b; Zirkel et al. 2015). Given Kahu's (2013) model of student engagement predicts that social integration has positive implications for students' engagement, and that research has found students who are more socially integrated often report higher levels of student engagement (e.g., Delgado et al. 2016; Furrer et al. 2014; Lundberg and Schreiner 2004; McFaul 2016; Shook and Keup 2012; Umbach and Wawrzynski 2005), it is predicted that:

Hypothesis 2: On days students attended a major class, talking with a peer, one-on-one discussions with a professor, and class discussions will be associated with higher levels of student engagement (perceptions of performance, enjoyment, and feelings of comfort in the class).

The Importance of Social Interactions for Women in MDMs

Whereas past research has often viewed the sociocultural environment as the start of a chain of processes that lead to student engagement, Kahu's (2013) student engagement model emphasizes how the entire process of student engagement is embedded within a larger sociocultural environment. This means that psychosocial factors, such as faculty-student and peer relationships within majors, are embedded within a sociocultural context that includes values, stereotypes, unequal distributions of power between genders, and gendered roles in society. Thus, the development and implications of faculty and peer relationships for student engagement may differ for women in MDMs, relative to men in MDMs and women in GNMs, due to these sociocultural factors. Stereotypes that women will not possess the skills necessary for male-dominated fields, such as the stereotype that women are not good at math, lack of female role models in male-dominated fields, and unequal distributions of power in society by gender may already put women in MDMs at risk for lower levels of student engagement, such as perceptions of performance, enjoyment, and comfort in the major (Casad et al. 2019). Relationships with faculty and peers, then, may be particularly important for women in MDMs.

Research finds social interactions and relationships may be lacking for women in MDMs. Qualitative research finds that women in male-dominated fields commonly report feelings of isolation because it can be difficult to interact and network with their male colleagues, there are few women to interact with in their field, some women report a workplace culture that discourages women's solidarity, and they feel alienated from other women who do not work in their field (Apfelbaum 1993; Kemelgor and Etzkowitz 2001; Smith 2014; Wright 2016).

Supporting Kahu's (2013) model of student engagement, past research has also found that social experiences have positive implications for women's engagement in MDMs. Results of Lawson et al. (2018)'s qualitative research suggest that women in MDMs find socially interactive classroom techniques (e.g., classroom discussions) helpful because they help them form connections with both peers and professors. As a result, women reported

these classroom techniques ultimately increased their sense of belonging in the major and the number of peers and professors that serve as informational resources. In addition, ESM research has found that daily social support has positive implications for women's engagement in MDMs. Using reports of STEM engagement on days when women attended a STEM class, London et al. (2011b) found that greater perceived support from others predicted greater sense of belonging in a STEM major and greater motivation as a woman STEM student.

There is also research showing that social interactions may actually be *more important* for underrepresented groups, relative to majority groups. For example, using survey methodology, research has found that overall levels of faculty-student interactions predicted student engagement and learning for all students, but this association was stronger for Students of Color, relative to White students (Kim and Sax 2009; Lundberg and Schreiner 2004). Similarly, due to higher levels of social isolation (Smith 2014; Wright 2016), it may be that social experiences in major classes—such as talking to a peer, interacting with a professor one-on-one, and class discussions—are particularly important for women's engagement in MDMs. Therefore, it was predicted that:

Hypothesis 3 The association between social classroom experiences and student engagement will be stronger for women in MDMs, relative to men in MDMs and women in GNMs.

Method

Participants

Data were collected as part of a larger study designed to better understand the daily experiences of women in MDMs (data is available upon request). Participants included 120 students from a midsize, Midwestern University. This sample included 40 women and 40 men from MDMs—defined as any major where at least 2/3 of students are men at both the university and nationally—and 40 women from GNMs—defined as any major where 40–60% of students are women at both the university and nationally. Defining the gender typicality of a major based on the percent of men and women in these majors is commonly used in past research (e.g., Mastekaasa and Smeby 2008; Lawson et al. 2018). The sample (see Table 1 for demographics) included freshmen through seniors and a majority of the sample identified as White. Computer Science and Finance (20 students in each major) were the most common MDMs and Business Administration, Criminal Justice Criminology, and Exercise Science (8, 6, and 6 students, respectively) were the most common GNMs. Chi-square analyses found that the groups did not significantly differ in terms of student year in school, $\chi^2(6, 120) = 10.49, p = 0.11$, Cramer's $V = 0.21$, or race/ethnicity, $\chi^2(10, 120) = 13.80, p = 0.18$, Cramer's $V = 0.24$.

Procedure

A multi-faceted approach was used to recruit participants; participants were sent targeted emails (obtained based on participants' reported gender and major listings), campus-wide emails sent through the University's Communication Center, flyers, and in-class presentations. Recruitment materials stated that the research focused on the daily experiences of

Table 1 Participant demographics

	Total sample (N = 120)	Women in MDMs (N = 40)	Men in MDMs (N = 40)	Women in GINMs (N = 40)
Year in school				
Freshman	29 (24.17%)	4 (10.00%)	11 (27.50%)	14 (35.00%)
Sophomore	25 (30.83%)	7 (17.50%)	11 (27.50%)	7 (17.50%)
Junior	36 (30.00%)	17 (42.50%)	9 (22.50%)	10 (25.00%)
Senior	30 (25.00%)	12 (30.00%)	9 (22.50%)	9 (22.50%)
Race/ethnicity				
White	95 (79.83%)	29 (72.50%)	37 (92.50%)	29 (74.36%)
Black	14 (11.76%)	7 (17.50%)	0 (0.00%)	7 (17.95%)
Hispanic	4 (3.36%)	2 (5.00%)	1 (2.50%)	1 (2.56%)
Asian	3 (2.52%)	1 (2.50%)	0 (0.00%)	2 (5.13%)
Mixed race	2 (1.68%)	1 (2.50%)	1 (2.50%)	0 (0.00%)
Other	1 (0.84%)	0 (0.00%)	1 (2.50%)	0 (0.00%)
Male-dominated majors (% female at university)				
Computer Information Systems (24%)	8 (6.67%)	3 (7.50%)	5 (12.50%)	
Computer Science (14%)	20 (16.67%)	8 (20.00%)	12 (30.00%)	
Computer Technology (10%)	6 (5.00%)	2 (5.00%)	4 (10.00%)	
Construction Management (12%)	6 (5.00%)	2 (5.00%)	4 (10.00%)	
Economics (16%)	6 (5.00%)	3 (7.50%)	3 (7.50%)	
Finance (20%)	20 (16.67%)	12 (30.00%)	8 (20.00%)	
Industry and Technology (15%)	1 (0.83%)	1 (2.50%)	0 (0.00%)	
Logistics Supply Chain Management (25%)	1 (0.83%)	1 (2.50%)	0 (0.00%)	
Music Media Production (18%)	5 (4.17%)	2 (5.00%)	3 (7.50%)	
Physics (20%)	2 (1.67%)	1 (2.50%)	1 (2.50%)	
Sport Administration (21%)	5 (4.17%)	5 (12.50%)	0 (0.00%)	

Table 1 (continued)

	Total sample (N= 120)	Women in MDMs (N=40)	Men in MDMs (N= 40)	Women in GNMNs (N=40)
Gender-Neutral Majors (% female at university)				
Architecture (47%)	1 (0.83%)			1 (2.50%)
Business Administration (46%)	8 (6.67%)			8 (20.00%)
Chemistry (58%)	1 (0.83%)			1 (2.50%)
Criminal Justice Criminology (49%)	6 (5.00%)			6 (15.00%)
Exercise Science (57%)	6 (5.00%)			6 (15.00%)
History (47%)	2 (1.67%)			2 (5.00%)
International business (54%)	1 (0.83%)			1 (2.50%)
Landscape architecture (53%)	2 (1.67%)			2 (5.00%)
Marketing (45%)	4 (3.33%)			4 (10.00%)
Natural resources environmental management (47%)	1 (0.83%)			1 (2.50%)
Political science (51%)	1 (0.83%)			1 (2.50%)
Pre dental preparation (57%)	1 (0.83%)			1 (2.50%)
Teaching major in social studies (42%)	3 (2.50%)			3 (7.50%)
Teaching major music education: voice and general (60%)	3 (2.50%)			3 (7.50%)

* Frequencies (percent of the sample described in the column) reported. Results of chi-square analyses indicate that groups do not significantly differ in year in school or race/ethnicity. This demographic table is also published in Lawson (2020)

college students, including classroom experiences, stressors, positive experiences, departmental contexts, and career aspirations. Interested participants were directed to email the study coordinator to verify eligibility (at least 18 years old, man/woman in MDM or woman in GNM, access to a smartphone). Sixteen interested individuals were not eligible for the study due to the gender/major combination.

Eligible participants were scheduled to meet in person with research personnel to (1) give informed consent; (2) complete a Qualtrics survey to report demographics, attitudes, experiences as a student in their major at the university, health, and career aspirations, and (3) register their smartphones to receive text messages to complete ESM assessments for two weeks (including weekends). After completing the in-person assessment, students received \$10 compensation.

ESM assessments started the day after the in-person assessment. This methodology allows for an examination of both between-person (e.g., do students who interact with professors more also report higher levels of student engagement) and within-person associations (e.g., on a day when a student talks one-on-one with a professor in class, does he/she also report higher levels of student engagement than usual). Within-person associations allow researchers to rule out the possibility of potential stable personality factors contributing as third variable confounds (e.g., a motivated student may be likely to both seek out interactions with professors and report higher levels of student engagement; Almeida 2005). This methodology, however, can be more time-consuming for participants, as it requires participants to fill out multiple surveys a day. Thus, surveys are often shorter than traditional, one-time assessment surveys.

In this study, participants were signaled via text message to complete 5 short assessments a day through the program SurveySignal (Hofmann and Patel 2014). The first four signals (hourly signals) included questions about sexism (e.g., During the past hour, did you hear traditional negative beliefs that your gender is not able to do things as well as the other gender) and positive experiences related to their major in the previous hour (e.g., During the past hour, did you have an experience related to your major that was particularly positive?) and occurred at random times within four time frames: 9:00am-11:30am, 11:30am-2:00 pm, 2:00 pm-4:30 pm, and 4:30 pm-7:00 pm. These hourly signals were designed for other research questions examining sexism and positive experiences, and therefore were not used in the current study (see Lawson 2020, and Lawson, in press, for further information on studies using this data).

The final signal (end of day signal) occurred at 9:00 pm and asked students to report sexist experiences and positive major-related experiences not captured with the hourly signals. In addition, and relevant to the current study, participants also reported whether they attended a class from their major, and if so, their engagement in the course(s) (perceived class performance, enjoyment of class, comfort in class) and class experiences (talked to a peer, one-on-one with professor, class discussion). On average, it took participants approximately 5–6 min to complete the end of day assessment.

After the two-week period, participants were compensated \$40 if they completed over half of the ESM signals ($n=112$, 93.33%) and \$20 if they completed less than half of the signals ($n=8$, 6.67%). All ESM assessments occurred from the third to the thirteenth weeks of the fall or spring semester in the same academic year. Study procedures were approved by the University's IRB. On average, participants completed 11.61 ($SD=2.86$) out of 14 end of day signals. Overall, participants missed 261 out of 1680 end of day signals, resulting in an 84.46% (1419/1680) end of day completion rate. This completion rate is comparable to ESM studies examining social-psychological topics that also collected data via Survey Signal (77%; Hofmann and Patel 2014).

Measures

During the end of day assessment, if students reported attending at least one major class, they also were prompted to report engagement in the class and classroom experiences. If students attended more than one major class, they reported their overall levels of engagement and experiences in the classes.

Student Engagement

Three items were used to assess students' daily engagement in major courses. *Perceptions of class performance* was assessed using one item from London et al. (2011b) past research: "How well do you think that you did in your major class(es) today?" Participants responded to the item using a 7 point numerical rating scale ($1 = \text{Very Poorly}$, $7 = \text{Very Well}$). One item was created for this study to assess students' *enjoyment of class* ("How much did you enjoy your major class(es) today") and one item to assess students' *comfort in class* ("How comfortable did you feel in your major class(es) today?"). Participants responded using a 7-point numerical rating scale ($1 = \text{Not at all}$, $7 = \text{Very Much}$).

Classroom Experiences

Participants were given a checklist of classroom experiences, including social experiences: talked to a peer in class, spoke with the professor one-on-one, and had a class discussion. Participants were asked to check all experiences that occurred during their major class that day.

Results

Out of the 1419 completed end of day surveys, participants attended a major class on 593 of these days ($593/1419 = 41.79\%$). Descriptive statistics for all study variables can be seen in Table 2. For all class engagement and experience variables, between 47.18% and 80.03% of the variance occurred at the daily level, supporting the use of a daily diary design.

Hypothesis 1: Group Differences in Student Engagement

Results of ANOVAs indicated that the average daily student classroom engagement scores differed between groups (class performance: $F(2, 590) = 15.54$, $p < 0.001$; enjoyment of class: $F(2, 587) = 14.44$, $p < 0.001$; comfort in class: $F(2, 587) = 26.18$, $p < 0.001$). Tukey's post hoc test indicated that, compared to men in MDMs and women in GNMs, women in MDMs reported they felt they did less well in major classes, enjoyed the classes less, and felt less comfortable in major classes—supporting hypothesis 1.

Hypotheses 2 and 3: Social Classroom Experiences and Student Engagement

Preliminary descriptive analyses found that students reported talking to a peer over one-half of days they reported attending a major class, had a class discussion less than

Table 2 Descriptive statistics for daily student engagement and classroom experiences

	Women in MDMs		Men in MDMs		Women in GNMs		% of Variance at the Person Level	% of Variance at the Daily Level
	Mean (SE)	N (% of major classes)	Mean (SE)	N (% of major classes)	Mean (SE)	N (% of major classes)		
Class engagement								
How well do you think that you did in your major class(es) today?	4.96 (1.56) ^a	4.96 (1.56) ^a	5.73 (1.32) ^b	5.73 (1.32) ^b	5.55 (1.24) ^b	5.55 (1.24) ^b	47.63%	52.37%
How much did you enjoy your major class(es) today?	4.44 (1.84) ^a	4.44 (1.84) ^a	5.28 (1.48) ^b	5.28 (1.48) ^b	5.13 (1.47) ^b	5.13 (1.47) ^b	40.78%	59.22%
How comfortable did you feel in your major class(es) today?	4.91 (1.65) ^a	4.91 (1.65) ^a	5.88 (1.13) ^b	5.88 (1.13) ^b	5.69 (1.28) ^b	5.69 (1.28) ^b	52.82%	47.18%
Class experiences								
Talked to a peer in class	88 (57.89%)	88 (57.89%)	101 (53.16%)	101 (53.16%)	123 (58.02%)	123 (58.02%)	31.94%	68.06%
Spoke with a professor one-on-one in class	27 (18.49%)	27 (18.49%)	38 (20.32%)	38 (20.32%)	41 (19.52%)	41 (19.52%)	19.97%	80.03%
Class discussion	81 (53.29%) ^a	81 (53.29%) ^a	67 (35.64%) ^b	67 (35.64%) ^b	83 (39.34%) ^b	83 (39.34%) ^b	44.43%	55.57%

Significant group differences are indicated by superscript letters

half of class days, and spoke with a professor one-on-one approximately one-fifth of major class days (see Table 2). Preliminary chi-square analyses were conducted to see if classroom experiences differed by groups. Groups did not report significant differences in the number of classes where they talked to a peer, $\chi^2(2, 2216) = 0.10, p = 0.10$, Cramer’s $V = 0.05$, or one-on-one with the professor, $\chi^2(2, 2172) = 0.70, p = 0.71$, Cramer’s $V = 0.02$. There were, however, significant group differences in the number of classes students reported having class discussions, $\chi^2(2, 2204) = 46.78, p < 0.001$, Cramer’s $V = 0.15$. Post hoc analyses conducted via SPSS based off of Sharpe’s (2015) recommendations indicated that the proportion of major classes that women in MDMs reported having class discussions was higher, relative to the proportions reported by men in MDMs and women in GNM.

To test hypotheses 2 and 3, in order to account for the nested structure of the data (days nested within people), multilevel models (MLM) were conducted using SAS Proc Mixed (Version 9.4). Classroom experience (0 = did not experience in a major class today, 1 = experienced in a major class today; talked to a peer, talked one-on-one with a professor, and class discussion were entered in separate models), group status (2 dummy variables were created so that women in MDMs were the reference group: man in MDM (0 = no, 1 = yes) and woman in GNM (0 = no, 1 = yes)), and the interaction between class experiences and the group status variables were entered as predictors of class engagement (perceptions of class performance, enjoyment of class, comfort in class; separate models conducted for each outcome). Analyses were conducted twice: with and without year in school as a covariate. Because the conclusions were the same in both sets of analyses, results are reported from the simpler model that did not include year in school as a covariate.

Results of MLMs can be viewed in Tables 3–5. Each table summarizes the results for the three student engagement outcomes (Table 3: perceived class performance; Table 4: enjoyment of class; Table 5: comfort in class). Within each table, the three models show the results for each class experience (model 1: talked to a peer; model 2: spoke to

Table 3 Multilevel model results examining classroom experiences as predictors of perceived class performance

	Moderators (Classroom Experiences)		
	Talked to a peer (Model 1)	Spoke 1-on-1 with professor (Model 2)	Class discussion (Model 3)
Fixed effects			
Intercept	4.84 (.21)***	5.08 (.19)***	4.86 (.21)***
Classroom experience	.32 (.20)	– .10 (.26)	.37 (.20) †
Man in MDM	.98 (.28)***	.68 (.25)**	.85 (.28)**
Woman in GNM	.64 (.28)*	.57 (.25)*	.73 (.27)**
Classroom experience*man in MDM	– .39 (.27)	.09 (.33)	– .26 (.28)
Classroom experience*woman in GNM	– .05 (.25)	.10 (.32)	– .21 (.27)
Random effects			
Intercept	.72 (.13)***	.74 (.13)***	.74 (.13)***
Residual	.92 (.06)***	.95 (.06)***	.89 (.06)***

Betas (standard errors) from multilevel models reported. Man in MDM coded 0=no, 1=yes. Woman in GNM coded 0=no, 1=yes. Reference group= women in MDMs

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4 Multilevel model results examining classroom experiences as predictors of students’ enjoyment of major class

	Moderators (classroom experiences)		
	Talked to a peer (Model 1)	Spoke 1-on-1 with Professor (Model 2)	Class discussion (Model 3)
Fixed effects			
Intercept	4.11 (.25)***	4.39 (.22)***	3.83 (.25)***
Classroom experience	.52 (.24)*	.01 (.32)	1.13 (.25)***
Man in MDM	1.30 (.33)***	.96 (.29)**	1.43 (.31)***
Woman in GNM	.85 (.33)**	.77 (.29)**	1.37 (.31)***
Classroom experience*man in MDM	– .67 (.33)*	– .24 (.41)	– .95 (.35)**
Classroom experience*woman in GNM	– .01 (.32)	.30 (.40)	– 1.04 (.34)**
Random effects			
Intercept	.88 (.17)***	.91 (.17)***	.83 (.16)***
Residual	1.45 (.10)***	1.51 (.10)***	1.46 (.10)***

Betas (standard errors) from multilevel models reported. Man in MDM coded 0=no, 1=yes. Woman in GNM coded 0=no, 1=yes. Reference group= women in MDMs

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 5 Multilevel model results examining classroom experiences as predictors of student comfort in major class

	Moderators (classroom experiences)		
	Talked to a peer (Model 1)	Spoke 1-on-1 with professor (Model 2)	Class discussion (Model 3)
Fixed effects			
Intercept	4.77 (.22)***	4.95 (.19)***	4.66 (.22)***
Classroom experience	.28 (.18)	– .06 (.24)	.59 (.20)**
Man in MDM	1.09 (.28)***	.96 (.26)***	1.21 (.28)***
Woman in GNM	.91 (.28)**	.79 (.26)**	1.06 (.28)***
Classroom experience*man in MDM	– .17 (.25)	– .05 (.31)	– .50 (.27) †
Classroom experience*woman in GNM	– .14 (.24)	.11 (.30)	– .43 (.26) †
Random effects			
Intercept	.84 (.14)***	.86 (.14)***	.82 (.14)***
Residual	.78 (.05)***	.80 (.05)***	.80 (.05)***

Betas (standard errors) from multilevel models reported. Man in MDM coded 0=no, 1=yes. Woman in GNM coded 0=no, 1=yes. Reference group= women in MDMs

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

a professor one-on-one; model 3: class discussion)—resulting in a total of 9 models. For categorical variables, Cohen *d*s were calculated by dividing the gamma coefficient by the standard deviation of the outcome, then converting *d* into β .

Perceived Class Performance

The three classroom experiences (talking to a peer, speaking one-on-one with a professor, and having a class discussion) did not significantly predict students' perceptions of daily class performance in a major class, failing to support hypothesis 2. In addition, group status did not moderate an association between class experiences and perceived performance—failing to support hypothesis 3.

Enjoyment of Class

Two out of the three classroom experiences predicted higher levels of enjoyment for students—partially supporting hypothesis 2. More specifically, on days when students reported talking to a peer or engaging in a class discussion, they also reported enjoying the major class more (relative to days where these events did not occur). This main effect for talking to a peer, however, was qualified by a significant interaction with group status. Model 1 indicates that the association between talking to a peer and enjoyment of class differs significantly for women in MDMs, relative to men in MDMs. As can be seen in Fig. 1a, for women in MDMs (but not men in MDMs), talking to a peer in class was significantly associated with higher levels of enjoyment of the class, $B=0.52$, $SE=0.24$, $p=0.03$, effect size=0.16, 95% CI [0.04, 1.00]. This association did not significantly differ between women in MDMs and women in GNMs. These results partially support hypothesis 3.

The main effect of class discussion was also qualified by a significant interaction with group status. As can be seen in Model 3, the association between having a class discussion and enjoyment of class significantly differed between women in MDMs and men in MDMs, and women in MDMs and women in GNMs. More specifically, having a class discussion was associated with more enjoyment of a major class, but only for women in MDMs, $B=1.13$, $SE=0.25$, $p<0.001$, effect size=0.33, 95% CI [0.63, 1.63], not for men in MDMs, $B=0.06$, $SE=0.24$, $p=0.45$, effect size=0.18, 95% CI [-0.28, 0.64], or women in GNMs, $B=0.10$, $SE=0.22$, $p=0.66$, effect size=0.03, 95% CI [-0.34, 0.53] (see Fig. 1b). These results supported hypothesis 3.

Comfort in Class

One out of the three classroom experiences (class discussion) significantly predicted students' comfort in class—partially supporting hypothesis 2. More specifically, on days when a class discussion occurred, students felt more comfortable in the class (relative to days where a class discussion did not occur). This result, however, was qualified by trend-level interactions with group status. Simple slope analyses supported hypothesis 3 in that class discussions were associated with feeling more comfortable in class, but only for women in MDMs, $B=0.59$, $SE=0.20$, $p=0.003$, effect size=0.21, 95% CI [0.20, 0.97], not for men in MDMs, $B=0.09$, $SE=0.18$, $p=0.63$, effect size=0.03, 95% CI [-0.27, 0.44], or women in GNMs, $B=0.15$, $SE=0.17$, $p=0.36$, effect size=0.06, 95% CI [-0.18, 0.49] (see Fig. 1c).

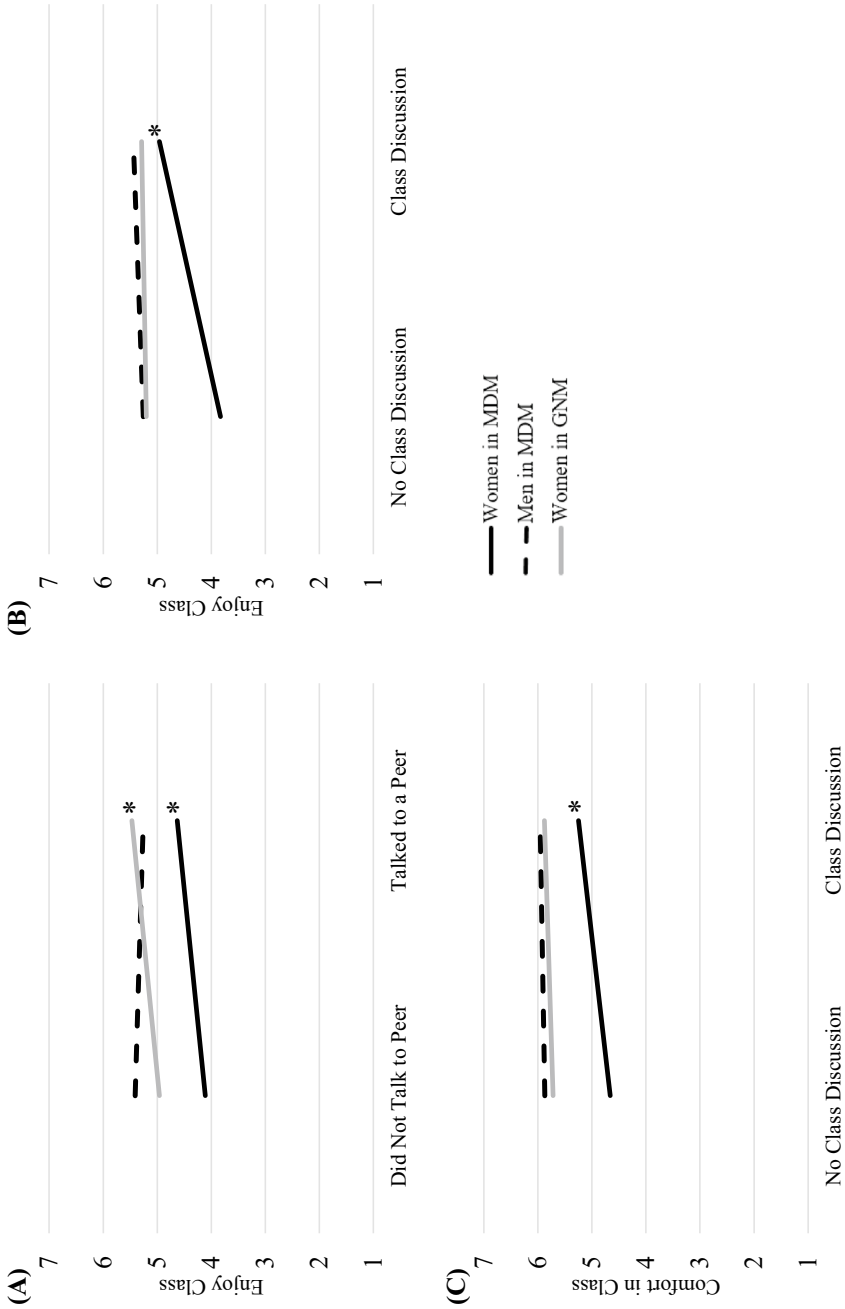


Fig. 1 Association between class experience and student engagement by group

Discussion

The present study utilized experience sampling methodology to better understand the unique association between daily social classroom experiences and women's engagement in male-dominated majors. Overall, the results support the tenets of the social-contextual model of prejudice (Murphy et al. 2018) in that male-dominated classes appeared to disadvantage women, illustrated by lower levels of class engagement. In addition, the results support Kahu's (2013) model of student engagement in that social relationships were associated with higher levels of student engagement, but a more nuanced understanding of classroom social experiences illustrated that these associations are best understood when considering the context in which students are embedded. Women in MDMs, in particular, live in a sociocultural context that may send messages, both subtle and direct, that have the potential to reduce social belonging and student engagement. Daily social interactions in classes, however, have the potential to buffer women from the negative effects of these prejudiced contexts.

Social-Contextual Model of Prejudice

The social-contextual model of prejudice asserts that contexts are prejudiced when there are “predictable, systematic inequalities in experience and outcomes based on people's social group memberships—advantaging people from some social groups while disadvantaging people from others” (Murphy et al. 2018, p. 68). The results of the present study support the idea that the classroom contexts of MDMs may be prejudiced, given that women in these majors reported lower perceptions of academic performance, enjoyment of classes, and feelings of comfort in major classes, relative to their peers in MDMs who identified as men. In other words, the majority (men) and minority (women) groups experienced the environment in different ways, resulting in poorer outcomes for women. The fact that women in MDMs also reported lower levels of student engagement than women in GNMs provides further evidence that the classroom context may be prejudiced, as opposed to the results being explained by women's lower level of engagement overall, compared to men.

Fortunately, on average, women in MDMs still reported high levels of daily class engagement, with average scores above the midpoint on a 7-point scale. This indicates that women are viewing their class performance, enjoyment, and levels of comfort positively overall—just not as positively as their peers. Unfortunately, these small daily differences in class engagement have the potential to accumulate over time and have long-lasting effects on women's achievement and desire to remain in male-dominated fields (Cortina and Landis 2009), and thus it is important to better understand contextual factors that may play a role in these differences.

Daily Social Experiences in Classrooms and Student Engagement

Supporting Kahu's model of student engagement (2013), the present study found evidence that social integration is important for affective components of student engagement—enjoyment of class and feelings of comfort in the class—but not perceptions of academic performance in the class. The results, however, indicated that the importance of social interactions was stronger for women in MDMs. In fact, having a class discussion was only found to predict enjoyment and comfort in class for women in MDMs (not their peers), and

interactions with peers predicted enjoyment in the class for women in MDMs, but not men in MDMs. These results also support the tenets of Kahu's model of student engagement (2018) in that it indicates it is important to consider the context when examining the associations between social interactions and student engagement. Women in MDMs were not experiencing fewer social interactions, which past research has found sometimes occurs for women in male-dominated fields (Apfelbaum 1993; Kemelgor and Etzkowitz 2001; Wright 2016). Rather, these social experiences were more important for affectual components of women's engagement in MDMs.

These results support past research that found social experiences and support predict higher levels of student engagement for women in MDMs (Lawson et al. 2018; London et al. 2011b), but extends it by showing that the importance is stronger for women in MDMs relative to their peers—and thus it is important to consider the context when examining student engagement. Women in MDMs are embedded in a larger societal-level context containing stereotypes that women are not skilled in and/or should not pursue male-dominated fields (Casad et al. 2019). In addition, more immediate contexts often send the message they do not belong in their majors, such as stereotypical objects found in classrooms (Cheryan et al. 2011). Thus, it is not surprising that relatively small, social interactions such as talking with a peer before class on a given day have the potential to send a powerful message to women—resulting in higher levels of enjoyment and comfort in the class, relative to days where they did not talk to a peer.

Interestingly, speaking with a professor one-on-one around a major class was not associated with student engagement. This finding could be the result of the low frequency these occurred (106 times total across the 3 groups), or the fact that the interactions may not have all been positive (e.g., discussion about a poor grade on an assignment). Because research finds that women in male-dominated fields commonly experience gender bias from faculty (e.g., Moss-Racusin et al. 2012), it is possible that at least some of these one-on-one interactions with professors were not positive. Thus, future ESM research is needed that gives students the opportunity to report social classroom experiences and their perceptions of the experience (e.g., a positive/negative rating dimension), in order to better understand the role of social interactions in classes for student engagement.

The findings also speak to the powerful role of peers when it comes to affective components of student engagement—such as enjoyment of the class and feelings of belonging. Both theory (Kahu 2013) and past research have found that peers play important roles in women's feelings of belonging in MDMs (Leaper 2014). Therefore, when universities and departments consider ways to reduce women's attrition from MDMs, it is important to consider ways to incorporate students who identify as men in the process.

Limitations and Future Research

Limitations in the present study provide avenues for future research aiming to better understand women's engagement in male-dominated fields. First, a majority of the sample identified as White, and thus the results may not be generalizable to all individuals. The experiences of women in male-dominated fields likely differ for women of, for example, differing race/ethnicities. In fact, research finds that the experiences of Women of Color differ from White women pursuing male-dominated fields because race/ethnicity and gender interact to create unique lived experiences for individuals (Espinosa 2011; Ong et al. 2011). Future research is needed with a more representative sample to better understand women's engagement in male-dominated fields.

Future research could also gather more contextual information about the social interactions. For example, asking who the individual spoke to (e.g., man, woman) and topic of discussion (e.g., class related, sharing of major information, social events) could help to better understand what experiences were most useful for women pursuing MDMs. Topics of discussion may not have all been positive, such as a one-on-one discussion with a professor about a poor assignment grade. Thus, future research should also allow students to report on the overall positivity of the encounter using a positive/negative rating dimension.

Future research should also include men and women in female-dominated majors to gain a better understanding of the role of context in student engagement. Do social interactions benefit men in female-dominated majors similarly to women in male-dominated majors? Similarly, the present study grouped all MDMs together, yet the experiences of women may differ depending on whether they are in, for example, computer science or music media production. Therefore, future research is needed that compares the major course experiences and engagement by field type within MDMs. Finally, the present study utilized self-assessment measures. Although research finds that self-assessment measures are of value and show evidence of adequate psychometric properties among students, they only partially correspond to teacher assessments (Ross 2006). Therefore, longitudinal research that includes objective data, such as course grade or later attrition from the major (as opposed to self-assessment), would allow for a better understanding of how smaller, classroom experiences may play a role in more long-term achievement and perseverance in male-dominated fields.

Implications for Policy and Practice

Results of the present study found evidence that classes in MDMs are prejudiced contexts, in that women in MDMs reported lower daily engagement in classes (perceived performance, enjoyment, and comfort), compared to their peers. Thus, the results support policies and practices that can help to reduce contextual values, norms, behaviors, and models that may explicitly or implicitly support the prejudiced context (Murphy et al. 2018). Although the present study did not specifically examine these factors, past research suggests there are a number of activities that can be done to make a context less prejudiced, such as hiring more women faculty and examining symbolic cues in classrooms that may send a non-welcoming message to women (e.g., do textbooks and pictures primarily include men, or do they also include the work of women in the field). By reducing prejudice in a context, it reduces the odds that a prejudice person will act out in the context (because a clear message is sent that this behavior is not tolerated), and it reduces the likelihood that the prejudiced context will create prejudiced individuals (Murphy et al. 2018).

The results of this study also suggest that social interactions may send a message that women belong in male-dominated fields. Class discussions and talking with peers, in particular, were found to predict higher levels of enjoyment and comfort in a major-related class. Thus, it is important to include opportunities for social interactions with peers in classes via mechanisms like class discussions or group activities. Many teaching activities that encourage social interactions are easy to implement and require little class time. For example, ice breakers could be used at the beginning of the semester to encourage student interactions. Professors could ask all students to introduce themselves and share information (e.g., interesting fact about the student; what students hope to learn in the class; career plans) to help create a sense of community among students early in the semester. Although

these types of interactions are more conducive to smaller class sizes, there are additional activities that could encourage social interactions in both smaller and larger classes. For example, think-pair-share is an activity where the professor poses a question to the class for discussion. Students have one minute to write down their response, and then an additional minute to discuss their response with their neighbor in the classroom. Afterwards, the class discusses as a group. These daily social interactions in classrooms may have the potential to accumulate over time and have a large impact on women's career trajectories.

Conclusion

Although psychological theories, research, and lay beliefs often view prejudice as inherent within some individuals (i.e., some people are prejudiced more than others), the results of this study support the tenets of the social-contextual model of prejudice in that some *contexts* may be prejudiced (Murphy et al. 2018). Women in male-dominated majors reported lower levels of student engagement in classes, compared to men in the same major and women in gender-neutral majors. In addition, the results suggest that social integration in classes, namely talking with peers and class discussions, have the potential to have positive implications for women's affectual engagement in male-dominated classes. The present study found that when considering student classroom experiences and engagement, it is important to consider the context in which students are embedded.

Acknowledgements This study was funded by Ball State University's Aspire Internal Grant Program to Katie M. Lawson, principal investigator. The author thanks Rahissa Winningham, Adrianna Caballero, Marcy Beutlich, Charlie Jackson, Kendall Smith, and Krista Kranz for their help with survey testing and data collection.

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