Can a diversity statement increase diversity in MOOCs?

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ABSTRACT

Despite the fact that anyone can sign up for open online courses, their enrollment patterns reflect the historical underrepresentation of certain sociodemographic groups (e.g. women in STEM disciplines). We theorize that enrollment choices online are shaped by contextual cues that activate stereotypes about numeric representation and climate in brick-and-mortar institutions. A longitudinal matched-pairs experiment with 14 MOOCs (N=29,000) tested this theory by manipulating the presence of a diversity statement on course pages and measuring effects on who enrolls. We found a 3% increase in the proportion of students with lower socioeconomic status. The effect size varied across courses between -0.5 and 7 percentage points. No significant changes in enrollment patterns by gender, age, and national development level occurred. Implications for the use and content of diversity statements and their alternatives are discussed.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in HCI*; • **Applied computing** → *Education*;

KEYWORDS

Diversity, Inclusion, Equality, Education, Social Psychology

1 INTRODUCTION

Participation in online education continues to accelerate while overall enrollment at US intuitions of higher education declines [57]. Today nearly one in three US college students takes at least one online course during their academic career and 15% are enrolled in entirely online programs [24]. Distance education programs and, more recently, massive open online courses have been cited as a key way to expand access to higher education while also increasing revenue in the face of shrinking budgets and traditional enrollments [16, 21, 64].

However, there is strong evidence that online learning environments can perpetuate historical enrollment and participation gaps for certain sociodemographic groups (e.g., women in STEM disciplines) [5, 25, 28, 32, 34]. Growing empirical evidence attributes this phenomenon to the presence of contextual cues that activate psychological stereotypes and cause certain groups of learners to feel unwelcome in the online environment [7, 33, 45]. Online enrollment portals—which have become ubiquitous on-ramps to both online and face-to-face courses—are a key source of contextual cues and information regarding particular courses and have been shown to significantly affect enrollment behaviors and performance [8, 9]. Thus, there is a pressing need to better understand how visual and verbal cues contained in course enrollment portals affect enrollment behavior, especially for members of sociodemographic groups that have been traditionally underrepresented in STEM disciplines [33].

Diversity statements are increasingly commonplace in a variety of contexts such as on the websites of corporations, non-profit organizations, universities, and in employee training programs [2, 51, 67]. Wilton et al. [68] found that 75% of US higher education institutions reference diversity in their mission statements in 2009. Statements of diversity and inclusion are intended to influence people's perception of the diversity climate, which plays an important role in the persistence and performance of members of stigmatized groups [20, 43]. For example, a number of studies have examined the experiences and coping strategies of women in STEM settings and how attributes of STEM environments shape their perceptions about what it would be like in this environment [9, 33, 38, 58, 61, 66]. While contextual cues can communicate group stereotypes and cause individuals to consider disengaging from an academic domain [47, 62], they can also affirm an organizations commitment to diversity and inclusion, and thereby alleviate concerns about fit and belonging [15, 49, 65]. In fact, a recent study showed that adding a combination of diversity cues to the enrollment page of an online statistics course can encourage more women to enroll [33].

The current study investigates whether a diversity statement that highlights values of educational access, inclusion, and equality can influence enrollment patterns in open online courses on a variety of subjects. We focus on four social groups that have been identified in prior work as underrepresented in massive open online courses: women, people with lower socioeconomic status, people in less developed countries, and older (mid- to late-career) learners [11, 17, 26, 54]. Employing a complex experimental design to obtain precise treatment estimates, we find a positive effect on enrollments from people with lower socioeconomic status but not from other groups. Further, we find substantial course-level variation in the treatment effect. By contributing causal evidence from a real-world context, this research advances our understanding of how affirming

WELCOME TO THIS COURSE

This is an equal opportunity course that offers you a supportive and inclusive space to learn. Everyone, no matter their age, gender, race, or nationality, can be successful in this course. People like you are joining from all over the world and we value this diversity. We hope you enjoy learning about topics that are important to you.
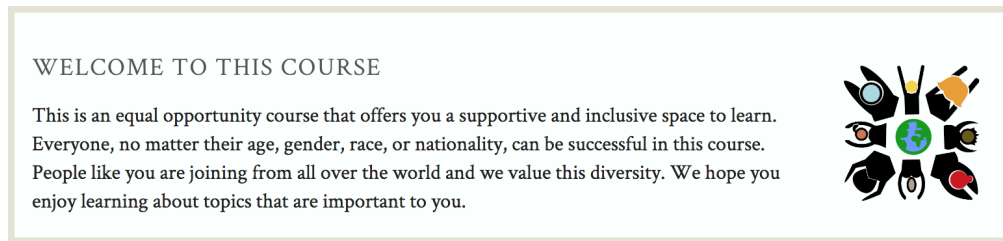
Figure 1: Diversity statement displayed prominently on the course enrollment page during treatment periods.

a commitment to diversity and inclusion in a learning environment influences the academic choices of underrepresented groups.

2 RELATED WORK

2.1 Social Identity and Psychological Cues

Membership in social groups constitutes a fundamental part of people's identities (e.g., gender, race, ethnicity, nationality) and they strive to maintain a positive perception of their social identities [4, 63]. It is therefore plausible that psychological processes pertaining to social identity and belonging matter not only in face-to-face but also computer-mediated environments [30]. How multimedia cues raise identity-based concerns and influence anticipated belonging has been studied in a number of settings: gender-stereotypic TV commercials [14, 15], promotional videos for STEM events [46], physical and virtual-reality computer science (CS) classrooms [9, 10, 42], and websites for a CS course [45]. These studies confirm that stereotypical cues can shape perceptions about diversity climate and reduce anticipated belonging, even when communicated through media. Accordingly, psychologically inclusive cues can be added strategically to affirm a diversity climate [7, 33, 48]. For example, in an online data science course, Brooks et al. [7] found that the gender of people in the background of lecture videos and of guest lecturers influenced participation in online discussions: women posted more in the female cue condition and vice versa.

Diversity statements are essentially verbal cues to allay identity-based concerns. They can be accompanied by photos that communicate numeric representation or a welcoming climate, which can increase the persuasiveness of the statement [33]. These cues aim to assure people that they will be respected for who they are as individuals and that their social identity does not pose a barrier in the environment. In particular, adding an explicit "identity-safe sentence" refuting the presence of gender-based differences in performance has been shown to reduce women's concerns [15, 49, 65]. Several studies found positive effects of reducing uncertainty by assuring women that everyone is welcome, respected, and treated fairly [9, 44]. Even subtle changes in diction, such as presenting tests as "puzzles", can diffuse apprehension about evaluations [6, 36, 60]. In the following section, we review literature on how the content of diversity statements can differentially influence social groups.

2.2 Diversity Statement Content

A diversity statement lays out the philosophy or approach to diversity in an environment. While the content of diversity statements varies across institutions and domains, two broad categories have been identified. First, there are statements that highlight equality in treatment and opportunities such that one's group membership does not act as an obstacle in the environment [52] and everyone is judged fairly based on effort, skills, and qualifications. This approach is referred to as color blindness in the context of race and ethnicity [39]. Second, there are statements that highlight the value of social group differences and a commitment to raising awareness about these differences and the ways in which they contribute. This approach sometimes referred to as multiculturalism. The nature and consequences of these two approaches to diversity is the subject of substantial research [1, 2, 29, 35, 39, 50, 52].

Apfelbaum et al. [2] argues that diversity statements should be tailored to the level of representation of social groups. Being a small minority in an environment can raise concerns about standing in as a representative or token member of one's group [12]. Thus, when group representation is very low, a statement that focuses on equality is more likely to reduce representation-based concerns than one that highlights uniqueness. In contrast, when a stigmatized group is moderately represented and therefore protected from representation-based concerns, a statement that highlights the value of differences is more likely to have group members feel comfortable and appreciated [22, 52]. Although this theory aims to abstract from particular social groups to their numeric representation, the empirical evidence in these studies is confounded with race (the underrepresented group) and gender (the moderately represented group). Martin [40] also argues for tailoring diversity messages, but in the opposite direction. In the context of gender, they find that downplaying gender differences rather than emphasizing them raised women's workplace confidence and encouraged actions to reduce disparities [41]; the opposite was the case for racial differences. Khan et al. [29] conducted a study to disentangle the statement content (equality vs. difference) and group representation (women in psychology vs. CS) in the context of judging graduate programs. Consistent with [2]'s theory, women's perceptions were more positive about CS with a statement highlighting equality yet more positive about psychology with a statement highlighting differences.

Multiple studies have suggested that tailoring the diversity statement to different social groups is important. However, in an environment that seeks to attract a wide variety of people, a choice needs to be made. In many online learning environments, (prospective) participants do not know their group's representation. We theorize that individuals rely on beliefs and knowledge about climate and numeric representation in brick-and-mortar institutions in their judgment of online courses. Contextual cues on the online

course page, such as a diversity statement, can activate or alleviate representation-based concerns. Building on the research findings reviewed here, we created a diversity statement (Fig. 1) that focuses on equality, highlighting that group membership is not a barrier to success, but at the same time emphasizing that diversity is present, welcome, and valued. We hypothesize that our diversity statement impacts enrollment of multiple groups.

H1 A diversity statement increases the proportion of female enrollments.

H2 A diversity statement increases the proportion of enrollments from older people.

H3 A diversity statement increases the proportion of enrollments from lower-SES people.

H4 A diversity statement increases the proportion of enrollments from people in less developed countries.

Each course page contains somewhat different contextual cues and activates subject-specific beliefs about numeric representation. Thus, although the diversity statement is held constant, the context changes and this may give rise to heterogeneity in the treatment effect. We therefore pose the following research question:

RQ1 How does the effect of the diversity statement vary across courses?

3 METHOD

3.1 Study design

We conducted a longitudinal matched-pairs randomized field experiment to test the effect of a diversity statement on enrollment diversity in MOOCs. The study was run on an institutional instance of the OpenEdX platform that has hosted hundreds of courses and enrolled millions of learners since 2013. We began by considering all 93 online courses offered on the platform at the time and retained courses with sufficiently high enrollment rates (>70 per week and >100 in the last month). We also excluded courses that were explicitly tied together in a sequence and courses with female enrollments above 40%. The latter exclusion was motivated by an interest in reducing female underrepresentation.

We used threshold blocking [27] to identify pairs of courses with similar enrollment patterns. Specifically, we block on the following enrollment characteristics with a caliper of 0.25 (i.e. excluding matches with a distance of over 0.25 SD): proportion of females (ever enrolled), proportion females (last month), proportion with college degree, and proportion located in a less developed country (adopting the following definition from prior work [34]: UN Human Development Index, HDI < 0.7). This resulted in seven matched pairs of courses (Table 1). Most of the courses are about Science, Technology, Engineering and Mathematics (STEM) topics: Economics, Physics, Earth Sciences, Renewable Energy, Professional Development, Science Writing, Computer Science, Statistics, Optimization, Data Mining, Machine Learning, Algorithms, Compilers, Networking.

Within each pair, we randomly assigned one course to be treated during the first period. Treated courses displayed a diversity statement prominently on the course enrollment page (Fig. 1). No change was made to the control course. There were six treatment periods

Table 1: Descriptive statistics for course enrollments during the twelve-week study period: number of enrollments, percentage female, mean age, percentage with lower SES, and percentage in less developed country.

Course Topic	N	Female	Age	Lower SES	Less Dev. Country
Intro CS	9,060	28.3	28.2	76.1	20.3
Machine Learning	4,813	22.2	29.3	54.3	25.9
Networking	2,895	17.0	27.6	75.7	33.0
Algorithms	2,712	17.5	27.6	73.2	31.8
Physics	1,829	16.6	30.8	63.9	32.4
Science Writing	1,471	42.3	30.0	53.2	26.9
Compilers	1,397	12.0	26.8	75.1	29.7
Data Mining	1,362	16.8	29.6	57.6	30.4
Optimization	1,316	14.1	27.4	53.8	20.7
Statistics	868	28.6	29.6	62.2	34.6
Professional Dev.	788	45.8	31.0	63.3	24.6
Economics	648	24.5	28.4	66.9	25.1
Earth Sciences	293	23.3	28.8	61.5	28.0
Energy	248	18.6	29.3	70.1	45.0
Total	29,700	23.6	28.6	67.4	27.0

that were each two weeks long (beginning and ending on a Saturday). The treatment and control assignment alternated across periods. Thus, 14 courses were observed for 3 times 2 weeks in the treatment and in the control. The study ran between 3 November 2018 and 26 January 2019, recording 29,700 enrollments (25,017 unique hashed IDs).

3.2 Materials

The study manipulation is the presence of a diversity statement above the "fold" on the enrollment page with an icon showing diverse people, conveyed by body shape and hair color, around a globe (Fig. 1). We adopted the text of the diversity statement from one that was successfully tested in prior research in the same learning environment [33] and made minor modifications in line with recommendations from the literature on diversity statements reviewed above. The text states:

> WELCOME TO THIS COURSE
> This is an equal opportunity course that offers you a supportive and inclusive space to learn. Everyone, no matter their age, gender, or nationality, can be successful in this course. People like you are joining from all over the world and we value this diversity. We hope you enjoy learning about topics that are important to you.

3.3 Measures

We collected individual course enrollments with self-reported age, gender, and highest achieved education level (pre-college, college, master, doctorate, other). Formal education level is a frequently used indicator of socioeconomic status (SES) because it is strongly determined by parental characteristics [3, 13, 37]. In their analysis of 68 MOOCs, Hansen and Reich [26] used parental educational attainment as a measure of SES and found that individuals with lower
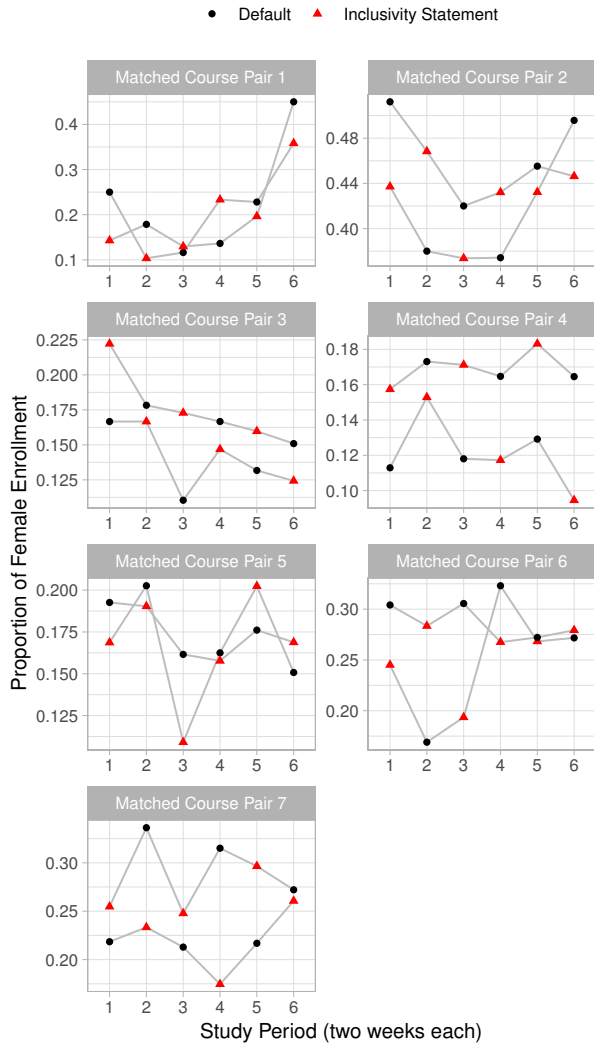
Figure 2: The proportion of female course enrollments for all courses and periods grouped by matched pairs. Each connected line represents one course over time.

SES were less likely to enroll than those with higher SES. They used parental educational attainment because their study focuses on adolescent MOOC learners. We use educational attainment of the learners themselves as a measure of SES because our study sample is older and the influence of parental SES is more distal, but still highly correlated with child's SES and educational attainment throughout the lifespan [18, 59]. Given that 34% of learners in our sample hold a masters' or doctorate degree, we define individuals who have completed up to a college degree as having lower SES in relative (not absolute) terms. In addition to the survey measures, the platform infers country-level location based on a user's IP address and we look up the United Nations Human Development Index (HDI) for each country. In keeping with prior research, we categorize countries with an HDI below 0.7 as less developed. Missing

values were ignored after confirming that the treatment had no significant effect on data reporting: 23.5% missing for age, 18.4% for gender, 20.9% for education, and 50.9% for HDI. Table 1 provides descriptive statistics on how many learners enrolled in each of the 14 courses during the study period and the sociodemographic makeup of the sample.

3.4 Analysis

The analysis approach follows directly from the study design. There are $2^7 = 128$ ways the seven matched pairs could have been assigned to control and treatment in the first period. As assignment in the first period determines all subsequent assignments, the total number of possible permutations is 128. We can therefore list all permutations and conduct an exact permutation test. Note that the smallest possible p-value we can achieve is 2/128=0.0156 (the numerator is 2 due to symmetry). We use the difference in means estimator, assigning equal weight to all courses. In the matched-pairs design, we can compute an efficient standard error based on the within pair average treatment effect (ATE) and overall ATE [23].

4 RESULTS

Figure 2 visualizes a descriptive account of the study results for one enrollment diversity outcome, the proportion of female enrollments. The graphs show the proportion for each course from two-week period to two-week period, which highlights the fact that enrollment trends are subject to substantial variation over time. If there were a strong treatment effect, we would expect red triangles (outcomes under treatment) to fall above black circles (outcomes under control).

We estimate the ATE, standard error, and p-value for the four enrollment diversity outcomes following the analytic approach described above. The results in Table 2 show that, on average, the diversity statement encouraged 3.14% more lower-SES students to enroll, a 2.12 percentage point increase. However, the statement did not significantly increase the proportion of women (-4.06%) or individuals in less developed countries (1.62%), or increase the average age of students who enroll (-0.17%). These effects are estimated with high precision and statistical power.

Figure 3 illustrates the null distribution and observed estimate for the four permutation tests. Panel (d) shows the significant positive effect on lower-SES enrollments. In fact, the observed effect is the most extreme value that can be observed conditional on the study design. In contrast, panel (a) shows that the observed effect on female enrollment is negative and approaching the tail of the distribution, and thus $p = 0.141$.

Table 2: Average treatment effects for different outcomes using a difference in means estimator, matched-pairs standard error, and exact p-value from a permutation test.

Outcome	ATE	Std. Error	p-value
Proportion female	-0.0096	0.00576	0.141
Average age	-0.0474	0.162	0.766
Proportion lower SES	0.0212	0.00519	0.0156
Prop. less developed country	0.00439	0.0094	0.656

4.1 Effect Heterogeneity

To investigate course-level heterogeneity, we estimate the within-course effect of the diversity statement: the difference between outcomes in the three treatment and three control periods for each course. Figure 4 shows these effects for the four subgroups of learners under investigation, showing substantial levels of heterogeneity. For lower-SES learners, the effect was positive for all but one course (-0.5pp) and that treatment effect varied. While three courses saw average increases between 5-7 percentage points, most effects were smaller. The largest effect was in the economics course, where the 7.1 percentage points increase corresponds to a 10.6% increase in lower-SES enrollments (given the 66.9% baseline from Table 1)

We observe course-level effects centered around zero for the three other learner subgroups for which we observed no significant average treatment effects. The effect in the Energy course appears to be an outlier for both the proportion of female (extremely negative) and proportion in less developed countries (extremely positive); however, this course also has the lowest enrollment in the sample and therefore has high variance in estimate.

Given the significant effect of the diversity statement on lower-SES enrollments, which is measured in terms of learners' education level, we explored how the effect changes with a more conservative definitions of SES. We found that the diversity statement did not increase overall enrollment from learners without a college degree (ATE=-0.0012, SE=0.0067, $p = 0.891$), with course-level effects varying between -6 and +10 percentage points. The overall effect on the proportion of enrollments with college degrees was positive and significant on its own (ATE=0.0223, SE=0.00765, $p = 0.0469$).

5 DISCUSSION

Diversity statements are commonplace in many online contexts and are intended to allay identity-based concerns and promote participation and success among members of stigmatized groups. Recent empirical work has instrumented online learning contexts in an attempt to ameliorate psychological stereotypes and help certain stigmatized groups of learners to feel welcome [7, 31, 33, 34]. Online enrollment portals have become ubiquitous on-ramps to both online and face-to-face courses and are a key source of contextual cues and information about particular courses. We are aware of only one published study to show that implementing diversity cues on the enrollment page of an online course can raise the enrollment of marginalized students; in this case, women in a STEM course [33]. The research presented herein advances our understanding of how a diversity statement that highlights values of educational access, inclusion, and diversity affects enrollment patterns in online courses on various topics. This study expands on previous work by simultaneously investigating four social groups that have been identified as underrepresented: women, people with lower socioeconomic status, people in less developed countries, and older (mid- to late-career) learners.

The results show that the diversity statement had a positive impact on lower-SES enrollment (H3). This suggests that cues in the online enrollment pages discouraged lower-SES learners from enrolling. Two possible (and likely related) explanations are that
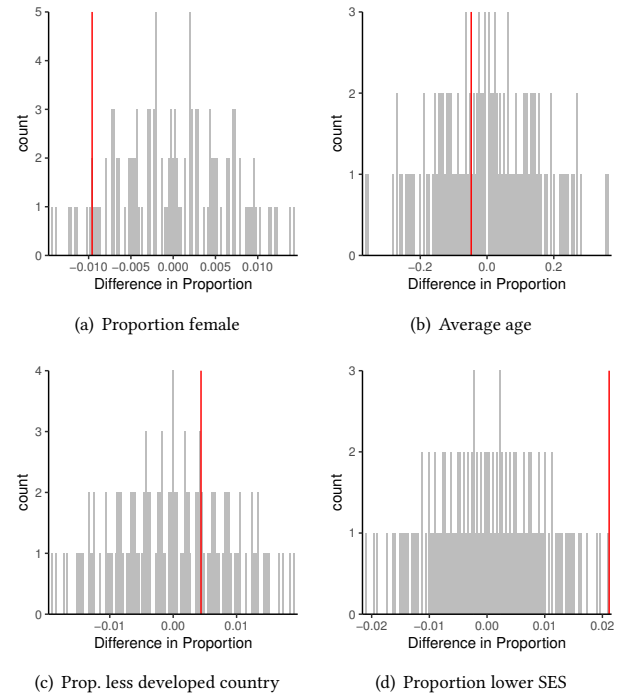

(a) Proportion female
(b) Average age
(c) Prop. less developed country
(d) Proportion lower SES

Figure 3: Null distribution (grey) and actual estimate (red) for different outcomes used in exact permutation test.

the contextual cues on the enrollment pages raised (a) identity-based concerns and reduced anticipated belonging among lower-SES learners, and (b) instrumental concerns regarding prior academic preparation. This is consistent with research on motivation that posits that both intrinsic factors (e.g., identity-based beliefs and values) and extrinsic factors (e.g., instrumental expectancies) influence engagement in educational contexts [19, 56]. Thus, it is plausible that the diversity statement helped allay both identity- and preparation-based concerns for lower-SES learners. Further research is needed to disentangle this effect, especially as our subsequent exploratory analysis revealed that the effects was present for enrollments from college degree holders but those with lower education levels. On the one hand, college-educated people may be more concerned about meeting course requirements because they have experience with the concept from taking college courses in the past; on the other hand, people with low levels of education may be especially intimidated by college courses. Prior work shows that unrealistic expectations and an overemphasis on extrinsic factors undermine sustained commitment in educational pursuits [53], especially for students entering novel learning situations [55].

We did not find a significant positive effect of the diversity statement on the enrollment of females (H1), older people (H2), and people from less developed countries (H4), but did observe substantial course-level variation in the treatment effect (RQ1). This is contrary to findings that diversity cues can raise female enrollment [33] and engagement [7] in MOOCs. One possible explanation is that prior work specifically tailored diversity cues to women whereas this study implemented a more general diversity statement and image.
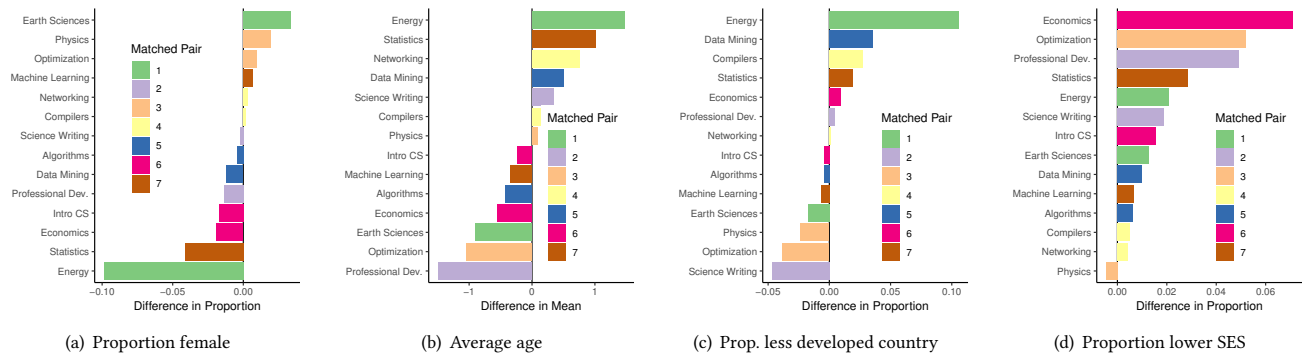
Figure 4: Course-level effects for each learner subgroup showing the mean difference between treatment and control periods. Colors indicate matched course pairs.

Indeed, we reviewed theory and evidence that suggest a need to tailor diversity statements to specific social groups due to differential effects based on whether the statements emphasize equity versus diversity [2, 29, 40]. Since we were investigating an environment that seeks to attract a wide variety of people, we implemented a diversity statement that both focused on equality and the value of diversity. This may have caused large and ultimately attenuating variation in the effects on women, older people, and people from less developed countries, while lower-SES learners interpreted the statement more as a cue about requisite prior knowledge.

According to Apfelbaum et al. [2], diversity statements should be tailored based on the representation of social groups: when a stigmatized group's representation is very low, statements should focus on equality; when representation is moderate, statements should highlight the value of diversity. While it is more difficult to tailor statements in an enrollment portal meant to attract all potential participants, future research should explore varying statements based on group representation. Additionally, researchers should take into account the course content based on our observation of substantial heterogeneity in treatment effects across different courses. The amount of course-level variation in the observed treatment effects suggests that more research is needed to understand how other cues typically present on course enrollment pages interact and affect enrollment behaviors. The effect of a diversity statement may depend on factors such the type of image used to represent the course, description of prerequisites (if any), reviews from previous students. On the one hand, the main image on a course enrollment page may be cold and "techy" (e.g., complex graphs and mathematical functions, which has been shown to decrease female participation [10, 45]. On the other hand, some course pages may display warmer images that depict female role models or more welcoming pictures of nature, which have been shown to increase female participation [33, 45].

5.1 Limitations

We conducted a longitudinal matched-pairs randomized field experiment to test the effect of a diversity statement on enrollment diversity in 14 MOOCs. This complex design offers high statistical power and robust measurement. However, some limitations

to internal validity remain, which are related to trade-offs made to maximize ecological validity. We had little control over other elements on the course enrollment page, which were determined by either the instructor or course marketing team. There was verbal and visual content above, below, and adjacent to the diversity statement that we could not control, such as an automatically-refreshing widget displaying reviews from previous learners in the course. We also had no control over the position of courses on the course portal page, which has implications for course visibility and overall enrollment. However, all of these factors constitute real-world variation and contribute to the ecological validity of our findings.

Another limitation is that we could not directly assess the theorized psychological processes in this research, nor did we evaluate learner performance after enrollment. Ideally, one could examine the entire process in the wild, namely that a diversity statement affects enrollment behaviors by increasing anticipated belonging and reducing identity-based concerns (e.g. [31]). We highlight these as important directions for future research.

6 CONCLUSION

This study is one of the first field experiments to investigate how diversity statements can be implemented to alleviate identity-based concerns and increase the enrollment of underrepresented sociodemographic groups in STEM courses. Our results show that diversity statements can drive changes in enrollment patterns. Yet more work is needed to develop reliably effective diversity statements. Given the rapid expansion of online learning and near ubiquitous use of online course enrollment portals, there is a pressing need to build on this work, advance the science of inclusion and diversity cues in online spaces, and inform evidence-based practice that promotes the success of all learners.

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