

Lesbian, Gay, Bisexual, Transgender, and Queer Students' Sense of Belonging in Computing: An Intersectional Approach

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The field of computing is rapidly developing, requiring a strong and diverse labor force. However, the results of two studies indicate that LGBTQ undergraduate and graduate students think about leaving computing degree programs due to a low sense of belonging in the computing community.

Queen Elizabeth II recently pardoned Alan Turing after he had been convicted of “gross indecency” with a man in 1952. A key figure in the development of computer science, Turing died in 1954 at the age of 41; his cause of death is widely believed to have been suicide.¹ This regrettable historic event illustrates untapped potential in the field of computing from an individual in the lesbian, gay, bisexual, transgender, and queer (LGBTQ) community. Six decades later, most cultures no longer publicly persecute individuals due to sexual orientation, as was the case with Turing, but bias against LGBTQ individuals persists. Biases can be subtle (perceptible glances or usage of dysphemisms such as “that’s so gay”) or explicit (heterosexist/homophobic harassment, institutional discrimination, or hate crimes).² In either case, bias is likely to make LGBTQ individuals feel as though they do not “belong” in the social milieu, which can have damaging effects on the self-concept, motivation, and achievement.

The need to belong is widely theorized to be a fundamental necessity for psychological and physical well-being.^{3,4} When individuals do not feel a secure sense of belonging in academic settings, which are the

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milieus of interest in our current work, individuals' motivation, achievement, and persistence tend to suffer.^{5,6} Moreover, LGBTQ students report more instances of harassment than heterosexual students on college campuses,⁷ even though LGBTQ students tend to choose to attend institutions that have reputations for being supportive of the LGBTQ community.⁸ In addition to overall campus climate, some specific academic settings can unintentionally foster a particularly low sense of belonging among LGBTQ students. For instance, computing departments tend to foster a heteronormative social environment, in which heterosexuality is assumed to be the norm, such that institutions and policies are aligned with a heterosexual lifestyle.⁹ Consistent with this, an interview study revealed that LGBTQ faculty members in computing departments perceived that heterosexuality was the assumed norm among colleagues.¹⁰ Thus, existing theory and interview data among individuals in computing suggest that LGBTQ students pursuing postsecondary computing degrees have reason to feel a generally lower sense of belonging in their degree tracks than heterosexual students.

Within computing, women are also considered a marginalized group and are known to feel a lower sense of belonging therein than men.^{11,12} Thus, our expectation was that women in the LGBTQ community would feel a particularly low sense of belonging compared to their peers, given that LGBTQ women belong to two social groups that are underrepresented and even stigmatized in computing. Such a hypothesis is consistent with intersectionality theory, indicating individuals' subjective experiences are subject to multiple (that is, intersecting) social identities.¹³

Importantly, extant theory and research suggest a thwarted sense of belonging among LGBTQ students in computing should increase their inclination to leave a computing career track.^{3,4} Systematic attrition from computing among LGBTQ students is suboptimal for several reasons. For one, a dearth of LGBTQ individuals in computing means that this group of individuals' needs and interests become underrepresented in computing innovations. Moreover,

this group of individuals brings a diverse perspective to the computing enterprise, which is associated with high innovation and productivity.^{14,15} Finally, high dropout rates among whole subgroups of students will result in a low volume of qualified workers, impeding society's ability to build a strong computing labor force.

Assessing Belonging in Computing

Despite the implications of understanding LGBTQ students' sense of belonging in computing settings, to our knowledge, this topic has not yet been formally studied. In this article, we assess LGBTQ versus heterosexual students' sense of belonging in computing and its relation to students' intentions to persist in a computing career track. We also take an intersectional approach in our work by looking at whether and how students' gender interacts with their LGBTQ identity to influence their sense of belonging in computing. We collected data from undergraduate and graduate students, which allowed us to assess whether our findings replicate across two samples and generalize across individuals at different stages of their computing career preparation. We expected that LGBTQ undergraduate and graduate students would show a stronger relationship between thoughts about leaving computing and a low sense of belonging in the computing community than their heterosexual peers.

Study 1

We invited undergraduate computing students to complete an online survey sent to a national sample of colleges and universities during the fall academic semester of 2013.

Method

We recruited 857 undergraduate students majoring in a computing field from a sample of computing departments across the US to complete an online survey in exchange for being entered in a raffle to win a US\$100 gift card. We define "computing field" as computer science, computing engineering or electrical and computer engineering, computing information systems, or

another computing-related field including interdisciplinary fields with a strong computing component (such as computational biology or digital media). At the end of the survey, we asked students to provide demographic information such as sexual orientation, race, and gender. Eighty-six students self-identified as LGBTQ ($n = 9$ lesbian; $n = 28$ gay; $n = 45$ bisexual; $n = 1$ transgender; $n = 3$ queer), and 771 students self-identified as heterosexual.

Of the students in our sample, 63 percent attended institutions where the highest computing degree offered in their department was a PhD, 15 percent where the highest degree available was a terminal MS, and 20 percent where the highest degree available was a BS; 2 percent of students did not provide institution information. Twenty-five percent of our sample was women and 75 percent was men. The racial and ethnic makeup of the sample was 4 percent African-American, 12 percent Asian-American, 61 percent Caucasian, 9 percent Latina/Latino, 12 percent more than one race, and 2 percent other.

Students completed an online survey that included questions pertaining to students' thoughts about leaving their academic program and reasons for doing so. The following item assessed students' thoughts about leaving their major: "Since declaring or planning to declare your computing major, have you seriously considered changing to a noncomputing major?" Response options were yes or no.

Students who had thought about leaving their major were asked the following two follow-up questions: "How much do you disagree or agree with the following statements: I have considered

changing to another major because "... I do not feel welcomed in the computing community"; "I do not feel like I 'fit' in the computing community," using a scale ranging from 1 (strongly disagree) to 5 (strongly agree). Items had good internal reliability ($\alpha = .89$),^{16,17} so we created an average score of the two items and used this composite variable to assess students' endorsement of low belonging as an explanation for why they've considered leaving their program.

Finally, we asked students to report their current GPAs for their computing majors using a 4.0 scale, which served as a covariate in the following analyses.

Results

Regarding students' thoughts about leaving, we first assessed whether LGBTQ students were more likely to think about leaving their major than heterosexual students and whether thoughts about leaving were particularly high among LGBTQ women. To do this, we ran a multiple logistic regression in which we regressed whether students had thought about changing to a noncomputing major (0 = no; 1 = yes) on LGBTQ (−1 = heterosexual students; 1 = LGBTQ students), gender (−1 = women; 1 = men), and their interaction term (LGBTQ \times gender). We found that LGBTQ group identification, gender, and students' interaction terms were not significant predictors of students' thoughts about changing their major, $ps > .23$ (see Figure 1).

Although LGBTQ students did not consider leaving their program to a stronger degree than heterosexual students, we expected that among students who did consider leaving ($n = 101$), LGBTQ students would be more likely than heterosexual students to indicate that their reason for doing so was due to a low sense of belonging in the computing community. Moreover, we expected that female LGBTQ students would be particularly likely to report having thought about leaving due to a low sense of belonging.

To test these hypotheses, we ran a LGBTQ \times gender analysis of variance (ANOVA) on the degree to which students' thoughts about leaving were related to a low sense of belonging in computing. We found that, indeed, LGBTQ students were more likely to have thought about leaving their major due to a low sense of belonging in computing than heterosexual students, $F(1, 97) = 6.85$, $p < .05$. Furthermore, a main effect of gender indicated that women who had considered leaving their major were more likely to do so than men due

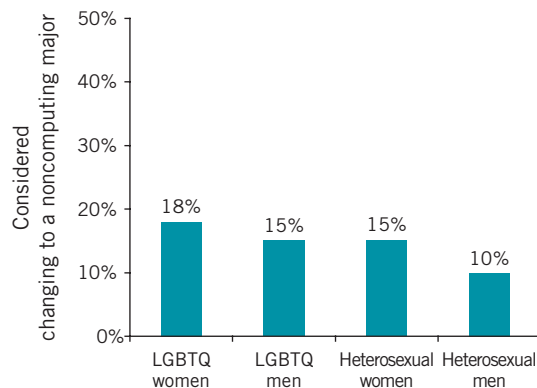


Figure 1. Percent of undergraduate students who thought about changing to a noncomputing major: LGBTQ \times gender.

to a low sense of belonging, $F(1, 97) = 13.60, p < .001$. We did not find a significant LGBTQ \times gender interaction, $F(1, 97) = 2.89, p = .093$, but we suspected that this lack of an interaction was due to few LGBTQ women and men in this particular analysis ($n = 7$ women; $n = 7$ men), resulting in low statistical power to detect this specific effect. Although this interaction effect was not significant, we opted to test our a priori hypothesis that LGBTQ women would be more likely than their peers to think about leaving their computing major due to low belonging in computing by way of a series of post hoc Dunnett t-tests, where we compared LGBTQ women's responses to those of the remaining three student groups. In doing so, we found that, indeed, LGBTQ women were significantly more likely than their peers to report thinking about leaving their major due to a low sense of belonging in computing, $ps < .05$ (see Figure 2).

Because students' undergraduate GPA tends to be positively related to sense of belonging in achievement settings,⁵ we reran our analysis, this time statistically controlling for students' reported major GPAs. Doing so did not change our results.

Discussion

Study 1 provided empirical support for our hypothesis that LGBTQ students' thoughts about leaving are more strongly related to a lower sense of "fit" in computing compared to heterosexual students. Furthermore, this explanation for wanting to leave their major was most prevalent among female LGBTQ students who belong to two minority groups within computing. In a second study, we sought to conceptually replicate these findings among graduate students in computing using a slightly modified analytic design. An added benefit of focusing on graduate students in study 2 was that we could observe belonging and persistence intentions further into the computing career pipeline and note whether and to what degree LGBTQ graduate students might "leak" out of the academic pipeline relative to heterosexual students.

Study 2

We invited graduate students in computing programs to complete an online survey sent to a national sample of universities during the fall academic semester of 2013.

Method

We asked 45 LGBTQ ($n = 5$ lesbian; $n = 12$ gay; $n = 25$ bisexual; $n = 3$ queer) and 899 heterosexual

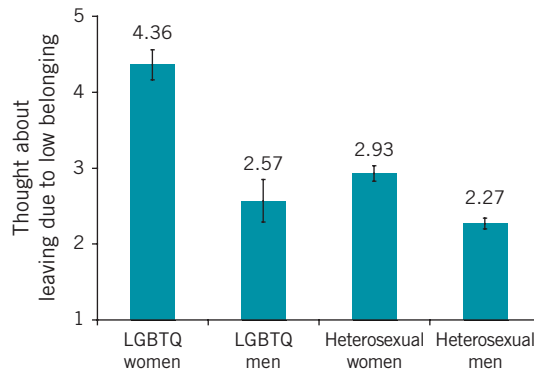


Figure 2. Undergraduate students' indication that thoughts about changing to a noncomputing major were due to a low sense of belonging in computing: LGBTQ \times gender. Bars indicate mean responses for each group. Group means are displayed above each bar, and standard errors are displayed at the top of each bar.

graduate students pursuing either an MS or a PhD in a computing field from a sample of computing departments across the US to complete an online survey in exchange for being entered in a raffle to win a \$100 gift card. The total number of students in this sample was 944.

Of the students in our sample, 85 percent attended institutions where the highest computing degree offered in their department was a PhD and 8 percent where a terminal MS was the highest degree offered; 7 percent of students did not report institution information. Fifty-eight percent of our sample was in terminal MS programs and 42 percent was in PhD programs. Thirty-eight percent of the sample was women, 61 percent was men, and 1 percent did not specify gender. The racial and ethnic makeup of the sample was 3 percent African-American, 48 percent Asian-American, 38 percent Caucasian, 3 percent Latina/Latino, 5 percent more than one race, and 3 percent other.

Students completed a survey containing questions pertaining to students' sense of belonging in the computing community and thoughts about leaving their graduate degree programs. The following question assessed students' thoughts about leaving their degree programs: "During your academic career, have you ever seriously considered leaving your graduate program?" Response options were "I have never seriously considered leaving" and "I have seriously considered leaving." Four questions assessed students' sense of belonging in computing: "I feel like I belong in computing," "I feel like an outsider in the computing community"

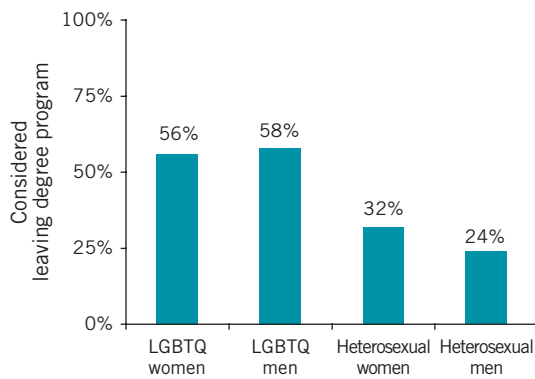


Figure 3. Percent of graduate students who thought about leaving their degree program: LGBTQ \times gender.

(reverse scored), “I feel welcomed in the computing community,” and “I do not have much in common with the other students in my computing classes” (reverse scored), each using a scale ranging from 1 (strongly disagree) to 5 (strongly agree). These four items have good internal reliability ($\alpha = .73$), so we aggregated them and used their average as an index of belonging in the computing community.

Results

We first assessed whether LGBTQ students were more likely to think about leaving their graduate program than heterosexual students. Then we assessed whether thoughts about leaving were particularly high among LGBTQ women. We regressed whether students had thought leaving their degree program (0 = no; 1 = yes) on LGBTQ group (-1 = heterosexual students; 1 = LGBTQ students), gender (-1 = women; 1 = men), and their interaction term (LGBTQ \times gender) via multiple logistic regression. We found that LGBTQ students were significantly more likely to have thought about leaving their degree program than heterosexual students, $B = .62$, $SE = .16$, $\chi^2(1,944) = 14.65$, $p < .001$. However, neither gender nor the LGBTQ \times gender interaction were significant predictors of thoughts about leaving a degree program, $ps > .41$ (see Figure 3).

Because terminal MS programs versus PhD programs have important experiential differences (for example, given their shorter duration, MS programs offer less time to think about leaving), we reran our analysis, this time controlling for the type of degree program in which students were enrolled. The pattern of results did not change.

We next ran an LGBTQ \times gender ANOVA on students' sense of belonging in computing and found that LGBTQ students reported a lower sense

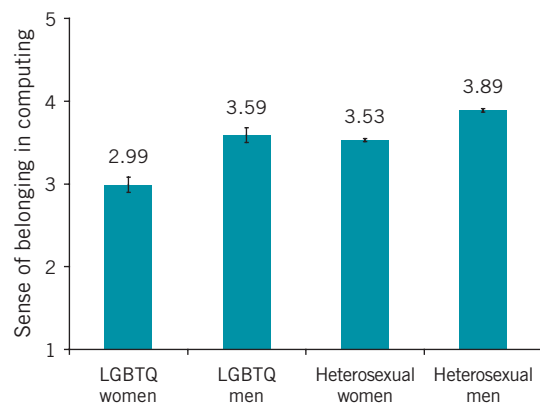


Figure 4. Graduate students' sense of belonging in computing: LGBTQ \times gender. Bars indicate mean responses for each group. Group means are displayed above each bar, and standard errors are displayed at the top of each bar.

of belonging than heterosexual students, $F(1, 935) = 11.16$, $p < .01$. We also found that women reported a lower sense of belonging than men, $F(1, 935) = 14.56$, $p < .001$. Although there was not a significant LGBTQ \times gender interaction, $p = .31$, we ran follow up Dunnett t-tests comparing LGBTQ women's sense of belonging to that of each of the three remaining student groups. Consistent with our a priori prediction, LGBTQ women reported a lower sense of belonging than LGBTQ men, $p < .05$, heterosexual women, $p < .05$, and heterosexual men, $p < .05$ (see Figure 4).

We next explored a possible explanation for LGBTQ students' greater tendency to think about leaving their degree program than heterosexual students: low belonging. Extant research and theory have found that feeling a secure sense of belonging in academic settings is associated with persistence therein.⁵ We found that this was also the case in our data: students who felt a stronger sense of belonging were less likely to think about leaving their degree program, $B = -.59$, $SE = .09$, $\chi^2(1,944) = 41.49$, $p < .001$.

Having established that LGBTQ graduate students felt a lower sense of belonging in computing than their heterosexual peers and that feeling a secure sense of belonging in computing is associated with a lower tendency to think about leaving a degree program, we then tested whether LGBTQ students' lower sense of belonging might partially explain their comparatively greater overall tendency to think about leaving their degree programs than heterosexual students. Indeed, the original group disparity in thoughts about leaving a program ($B = 1.22$, $SE = .31$, $\chi^2(1,944) = 15.61$, $p < .001$) decreased in size after statistically controlling for students' sense of

belonging ($B = 1.04$, $SE = .32$, $\chi^2(1,944) = 10.68$, $p < .01$). This indirect effect was significant, Sobel $Z = 3.09$, $SE = .08$, $p < .01$,¹⁸ indicating that LGBTQ students' greater tendency to think about leaving was partially statistically explained by their lower sense of belonging in the computing community than that of heterosexual students (see Figure 5).

General Discussion

Our current work suggests that LGBTQ students are more likely to think about leaving computing because they feel a lower sense of belonging compared to heterosexual students. Although we found that LGBTQ women were no more likely to report thinking about leaving their program than their peers, this group of women showed the lowest sense of belonging in computing compared to other students. Thus, our data suggest that whereas all members of the LGBTQ community might be at higher risk of leaving computing compared to heterosexual-identifying students, women within the LGBTQ community are particularly at risk, perhaps due to the fact that they belong to two marginalized groups: women and non-heterosexual individuals.

One puzzling finding in the current work is that whereas LGBTQ graduate students reported that they had seriously considered leaving their program to a greater degree than heterosexual peers, this pattern did not occur among undergraduate students. Note that while approximately 12 percent of all undergraduate students indicated that they had considered leaving their major, 28 percent of all graduate students considered leaving. Greater variability in graduate students' thoughts about leaving might have revealed sexual orientation disparities that were too difficult to detect in study 1 due to low variability in thoughts about leaving among undergraduate students.

In this work, we focused solely on LGBTQ students' sense of fit and thoughts about leaving within the context of computing. It is possible that LGBTQ students feel a more secure sense of belonging in fields such as the social sciences and humanities, which focus on understanding social issues (sexuality) in the curriculum.⁹ Future work should compare LGBTQ students' sense of belonging and persistence across many different disciplines in order to assess whether LGBTQ students' sense of belonging is localized to specific disciplines or widespread across the academy. Such findings would help administrators and educators target their efforts to create inclusive environments for all students.

Our work does not pinpoint the vehicles behind LGBTQ students' low sense of belonging

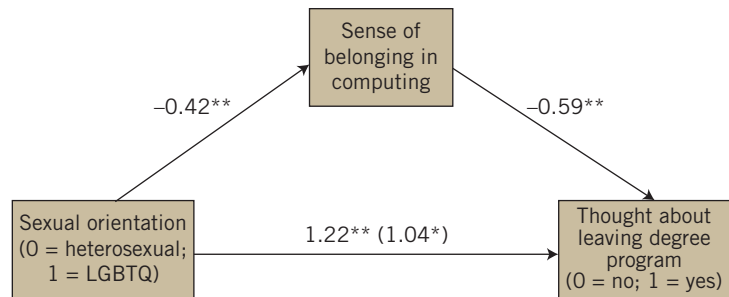


Figure 5. Indirect effect of “belonging” on LGBTQ versus heterosexual students' greater tendency to think about leaving their degree programs. Regression coefficients are unstandardized. Coefficient in parentheses is the effect of sexual orientation on thoughts about leaving, controlling for belonging, where $*p < .01$ and $**p < .001$.

in computing—for example, does the computing culture subtly transmit a blanketed message that the LGBTQ community does not belong in computing via a lack of LGBTQ role models? This is one explanation for women's low sense of belonging in many STEM fields^{19,20} and could be one mechanism behind LGBTQ students' tendency to feel as though they do not “fit” in computing as much as heterosexual students. Future research should explore these and other possible explanations for low belonging among the LGBTQ community in order to develop clear-cut intervention strategies to achieve greater inclusivity in the academy.

It is in the field's best interest to ensure that a broad array of individuals with a diversity of experiences and perspectives contribute to computing. To attract and retain a breadth of talent, computing must foster a safe and inclusive environment for all individuals. In this way, the computing field, and society more generally, can benefit from a sturdy, innovative computing labor force. Equally important, all individuals would be free to pursue a career in the financially and personally rewarding field of computing. ■

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