

Lesbian, Gay, Bisexual, Transgender, and Queer Students' Sense of Belonging in Computing

Jane G. Stout

Computing Research Association (CRA)
Center for Evaluating the Research Pipeline (CERP)
Washington D.C., U.S.A.
jane@cra.org

Heather M. Wright

Computing Research Association (CRA)
Center for Evaluating the Research Pipeline (CERP)
Washington D.C., U.S.A.
heather@cra.org

Abstract— The field of computing is rapidly developing, requiring a strong and diverse labor force. The current work assessed the relationship between Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ) students' sense of belonging in computing and thoughts about leaving the field. The results of two studies indicated that among undergraduate students (Study 1) and graduate students (Study 2), thoughts about leaving one's computing program were associated with feeling a low sense of belonging in the computing community. These findings suggest that in order to capitalize on talent and perspective offered by the LGBTQ community, the field of computing should make greater strides towards inclusivity.

Keywords—Sexual Orientation; Heteronormativity; Belonging; Retention

I. INTRODUCTION

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 within 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 (e.g., perceptible glances; use of dysphemisms like “that’s so gay”) or explicit (heterosexist/homophobic harassment; institutional discrimination; hate crimes) [2]. In both cases, 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 wellbeing [3,4]. When individuals do not feel a secure sense of belonging in academic settings, which are the milieus of interest in the current work, individuals' motivation, achievement, and

persistence tend to suffer [5,6]. Of relevance, LGBTQ students report more instances of harassment than heterosexual students on college campuses [7], and 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 may unintentionally foster a particularly low sense of belonging among LGBTQ students. For instance, computing departments tend to foster a heteronormative social environment, where 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 lesbian, gay, bisexual, and transgender faculty members in computing departments perceived that heterosexuality was the assumed norm among colleagues [10]. Although existing empirical evidence is limited, theory and interview data among individuals in computing suggest that LGBTQ students pursuing postsecondary computing degrees have reason to feel a low sense of belonging in their degree track.

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 a number of 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 diversity of perspective to the computing enterprise, which is associated with high innovation and productivity [11,12]. 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.

A. Overview

Despite the implications of understanding LGBTQ students' sense of belonging in computing settings, to our knowledge, this topic has not yet been studied. In the current work, we assessed LGBTQ versus heterosexual students' sense of belonging in computing, and its relation to students' intentions to persist in a computing career track. 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.

II. STUDY 1

A. Method

1) *Participants*. Eight hundred fifty-seven undergraduate students majoring in a computing field¹ were recruited from a sample of computing departments across the U.S. to participate in our study in exchange for being entered in a raffle to win a \$100 gift card². Of those, 86 students self-identified as belonging to the LGBTQ community (n = 9 Lesbian; n = 28 Gay; n = 45 Bisexual; n = 1 Transgender; n = 3 Queer), and 771 students self-identified as heterosexual³.

Of the students in our subsample, 63% of students were attending institutions where the highest computing degree offered in their department was a Ph.D.; 15% where the highest degree available was a Terminal M.S.; 20% where the highest degree available was a Bachelor's; and 2% of students did not provide institution information. Twenty-five percent of our subsample was women, and 75% was men. The racial and ethnic makeup of the sample was 4% African American, 12% Asian American, 61% Caucasian, 9% Latina/o, 12% More Than One Race and 2% Other.

2) *Procedure*. Students were invited to complete an online survey sent to a national sample of colleges and universities during the fall academic semester. Embedded within the survey were questions pertaining to students' thoughts about leaving their academic program and reasons for doing so. Additionally, students were asked to provide their current GPA for their computing major.

3) *Measures*.

a) *Thoughts about leaving*. 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 non-computing major?* Response options were Yes or No.

b) *Reasons for leaving: Low belonging*. Students who had thought about leaving their major were asked: *How much do you disagree or agree with the following statements: I have considered changing to another major because: (1) I do not feel welcomed in the computing community; and (2) 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 ($\alpha = .89$; [13,14]), 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 have considered leaving their program.

c) *Major GPA*. Students were asked to report their current GPA for their computing major using a 4.0 scale, which served as a covariate for analyses that follow.

B. Results

1) *Thoughts about leaving*. We first assessed whether LGBTQ students were more likely to think about leaving their major than heterosexual students. We found that 16% of LGBTQ students versus 11% of heterosexual students had seriously considered changing to a non-computing major. Although this pattern of results was in the expected direction, a Pearson Chi-Square test of significance indicated that this difference was not statistically significant, $\chi^2(1,857) = 1.86, p = .17^4$.

2) *Reasons for leaving*. 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. A one-way Analysis of Variance (ANOVA) indicated that among students who had considered leaving their major, LGBTQ students were more likely to do so because they felt as though they did not belong in the computing community to a greater degree than heterosexual students (LGBTQ: *Mean (M)* = 3.46, *Standard Error (SE)* = .32; Heterosexual: *M* = 2.47, *SE* = .13), $F(1, 99) = 8.12, p < .01^5$.

C. Discussion

Study 1 provided empirical support for our hypothesis that LGBTQ students' thoughts about leaving are more strongly related to a low sense of "fit" in computing than heterosexual students. 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 deeper into the computing career pipeline and note whether and to what degree LGBTQ graduate students might "leak" out of the pipeline relative to heterosexual students.

¹ We define "computing field" as either computer science, computing engineering or electrical and computer engineer, computing information systems, or another computing-related field including interdisciplinary fields with a strong computing component (e.g., computational biology or digital media).

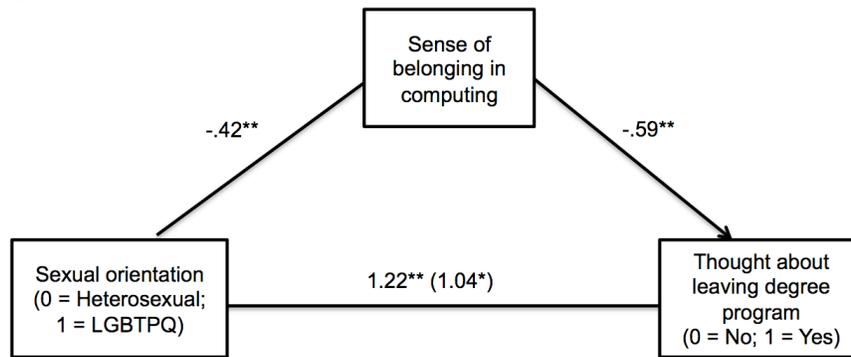
² Visit www.cra.org/cerp for more information on this data collection initiative.

³ In Studies 1 and 2, students indicated their sexual orientation at the end of a survey that is described in the Measures section.

⁴ We used a cutoff of $p \leq .05$ to indicate statistical significance throughout the paper.

⁵ Because students' undergraduate GPA tends to be positively related to sense of belonging in achievement settings [5], we ran this same analysis statistically controlling for students' reported major GPA. Doing so did not change the results; LGBTQ students' reasons for leaving were more strongly related to a low sense of belonging than heterosexual students, controlling for students' major GPA, $F(2, 98) = 8.40, p < .01$.

Fig 1. Indirect Effect of Belonging on LGBTQ Versus Heterosexual Graduate Students' Greater Tendency to Think about Leaving their Degree Program.



Note. Regression coefficients are unstandardized. Coefficient in parentheses is the effect of Sexual Orientation on Thoughts about Leaving, controlling for belonging. * $p < .01$; ** $p < .001$

III. STUDY 2

A. Method

1) *Participants.* Forty-five LGBTQ (n = 5 Lesbian; n = 12 Gay; n = 25 Bisexual; n = 3 Queer) and 899 heterosexual graduate students pursuing either an M.S. or a Ph.D. in a computing field were recruited from a sample of computing departments across the U.S. to participate in our study 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% of students were attending institutions where the highest computing degree offered in their department was a Ph.D.; 8% where a Terminal M.S. was the highest degree offered; and 7% of students did not report institution information. Fifty-eight percent of our sample was in Terminal Masters programs, and 42% was in Ph.D. programs. Thirty-eight percent of the sample was women, 61% was men and 1% did not specify their gender. The racial and ethnic makeup of the sample was 3% African American, 48% Asian American, 38% Caucasian, 3% Latina/o, 5% More Than One Race, and 3% Other.

2) *Procedure.* Students were invited to complete an online survey sent to a national sample of universities during the fall academic semester. Embedded within the survey were questions pertaining to students' sense of belonging in the computing community and students' thoughts about leaving their graduate degree program.

3) Measures.

a) *Belonging.* Four items assessed students' sense of belonging in computing: *I feel like I 'belong' in computing*; *I feel like an outsider in the computing community* (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.

b) *Thoughts about leaving.* The following item assessed students' thoughts about leaving their degree program: *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*.

B. Results

1) *Sense of belonging.* As expected and conceptually consistent with the findings from Study 1, LGBTQ students indicated that they felt a lower sense of belonging in the computing community than heterosexual students ($M = 3.34$, $SE = .12$; $M = 3.75$, $SE = .03$, respectively), $F(1, 942) = 11.27$, $p < .01$.

2) *Thoughts about leaving.* We next assessed whether LGBTQ students thought about leaving their degree program during their graduate career. Indeed, LGBTQ graduate students were significantly more likely to have thought about leaving their graduate program (56%) compared to heterosexual students (27%), $\chi^2(1,944) = 17.33$, $p < .001$ ⁶.

3) *Do Group Disparities in Belonging Explain Group Disparities in Thoughts about Leaving?* Extant research and theory have found that feeling a secure sense of belonging in academic settings is associated with persistence therein (for a review, see [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

⁶ Because Terminal M.S. versus Ph.D. programs have important experiential differences (e.g., given their shorter duration, M.S. programs offer less time to think about leaving), we re-ran the analysis analytically controlling for the type of degree program in which students were enrolled to test for sexual orientation disparities in thoughts about leaving. A multiple logistic regression analysis indicated that, even after controlling for whether they were enrolled in a Terminal M.S. program or Ph.D. program, LGBTQ students had thought about leaving more than their heterosexual counterparts, $B = 1.10$, $SE = .32$, $\chi^2(1,939) = 11.80$, $p < .01$.

(a) LGBTQ graduate students felt a lower sense of belonging in computing than their heterosexual peers and (b) feeling a secure sense of belonging in computing is associated with a lower tendency to think about leaving one's degree program, we tested whether LGBTQ students' lower sense of belonging might partially explain their comparatively greater tendency to think about leaving their degree program than heterosexual students. Indeed, the original group disparity in thoughts about leaving one's 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, $SE = .08, p < .01$ [15], 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 heterosexual students (see Figure 1 for a spatial representation of this relationship).

IV. GENERAL DISCUSSION

The current work suggests that LGBTQ undergraduate and graduate students alike are more likely to think about leaving computing because they feel a lower sense of belonging compared to heterosexual students. Of interest, ancillary analyses indicated that this trend appears to be particularly strong among LGBTQ women. 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. That is, among undergraduate students who had considered leaving their major, LGBTQ women were more likely than heterosexual men and women, and LGBTQ men to indicate that they had thought about leaving their major due to a low sense of belonging, *Dunnett ps* < .05. Similarly, among graduate students, LGBTQ women reported the lowest sense of belonging in the computing community compared to their peers, *Dunnett ps* < .05. We urge the reader to interpret this finding with caution, given low sample sizes for these analyses for LGBTQ women ($n = 7$ undergraduates; $n=18$ graduate students) and LGBTQ men ($n = 7$ undergraduates; $n=24$ graduate students) in these analyses. Nonetheless, our data suggest that whereas all members of the LGBTQ community are at higher risk of leaving computing compared to heterosexually identified 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 as follows: 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. This lack of replication may have been due to a floor effect in Study 1. That is, whereas only approximately 12% of all undergraduate students indicated that they had considered leaving their major, 28% of all graduate students considered leaving their graduate degree. Greater variability in graduate students' thoughts about leaving may 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 the current 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 (e.g., 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 also does not pinpoint the *vehicle(s)* behind LGBTQ students' low sense of belonging 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 but one possible 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 for 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 experience and perspective 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 will be free to pursue a career in a financially and personally rewarding field of computing.

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