Unveiling Concealable Stigmatized Identities in Class: The Impact of an Instructor Revealing Her LGBTQ+ Identity to Students in a Large-Enrollment Biology Course

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ABSTRACT

Sharing personal information can help instructors build relationships with students, and instructors revealing concealable stigmatized identities (CSIs) may be particularly impactful. One CSI is the LGBTQ+ identity, but there has been no research on the student-perceived impact of an instructor revealing this identity. In this exploratory study conducted at an institution in the U.S. Southwest, an instructor revealed that she identifies as LGBTQ+ to her undergraduate biology course in less than 3 seconds. We surveyed students (*n* = 475) after 8 weeks to assess whether they remembered this, and if so, how they perceived it affected them. We used regression models to assess whether students with different identities perceived a disproportionate impact of the reveal. Most students perceived the instructor revealing her LGBTQ+ identity positively impacted them; regression results showed LGBTQ+ students and women perceived greater increased sense of belonging and confidence to pursue a science career. Students overwhelmingly agreed that instructors revealing their LGBTQ+ identities to students is appropriate. This study is the first to indicate the perceived impact of an instructor revealing her LGBTQ+ identity to students in the United States and suggests that a brief intervention could positively affect students.

INTRODUCTION

Academic science has been identified as an unwelcoming space for members of the lesbian, gay, bisexual, transgender, and queer (LGBTQ+[1]) community (Cech and Pham, 2017; Cech and Waidzunas, 2021; Vaccaro *et al.*, 2021), and LGBTQ+ undergraduates are less likely to graduate with science, technology, engineering, and math (STEM) degrees compared with their straight and cisgender peers (Hughes, 2018; Maloy *et al.*, 2022). Additionally, undergraduates in the sciences report knowing few LGBTQ+ academics (Vacarro, 2012; Cooper and Brownell, 2016; Linley *et al.*, 2016; Barres *et al.*, 2017; Garvey *et al.*, 2017). Revealing one's LGBTQ+ identity can be complicated, namely because it is considered to be a concealable stigmatized identity (CSI); individuals often have to "come out" in order for others to know that they identify this way, and sharing the identity can result in loss of status and discrimination (Link and Phelan, 2001; Quinn, 2006; Arena and Jones, 2017). Despite not knowing

[1]In this study, we use "LGBTQ+" as an umbrella acronym to include all minority gender identities and sexual orientations. Although it explicitly refers to lesbian, gay, bisexual, transgender, and queer identities, it is meant to be inclusive of any individual who does not identify as either straight or cisgender. Other studies have used variations on this acronym, and in referencing prior findings, we retained the acronym used in the original text. We intentionally do not use the term "sexual minority" or "sexual orientation" throughout the study because of critique from the LGBTQ+ community of these terms due to the emphasis on sex (Mizzi and Walton, 2020).

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many LGBTQ+ academics, undergraduates highlight that science faculty or instructors who have the same CSI as them could positively affect them, primarily by providing a role model of a successful scientist with the identity (Cooper and Brownell, 2016; Cooper *et al.*, 2020c; Barnes *et al.*, 2021a). In this exploratory study, we examine students' perceived impact of an instructor who identifies as gay revealing her identity to undergraduate biology students in less than 3 seconds. We assess how the instructor revealing her LGBTQ+ identity affects not only the perceptions of LGBTQ+ students, but those of all students in the course.

The Experience of LGBTQ+ Individuals in STEM

STEM fields have been described as hetero- and cisnormative and are perceived to be generally unwelcoming to LGBTQ+ individuals (Bilimoria and Stewart, 2009; Cech and Waidzunas, 2011; Atherton *et al.*, 2016; Fidas and Cooper, 2018). Specifically, the prevalence of binary thinking in STEM, or classifications with only two options (e.g., male/female, positive/negative; Faulkner, 2007), delegitimizes individuals who identify as gender nonbinary and perpetuates a heteronormative culture (Cech and Waidzunas, 2021). Additionally, the "depoliticization" of STEM, or the removal of social or political issues from day-to-day STEM work in order to retain the perception that science is objective, can contribute to the sterile environment of STEM disciplines that deems personal information unnecessary and encourages LGBTQ+ individuals to keep their identities private (Bilimoria and Stewart, 2009; Cech, 2013; Cech and Waidzunas, 2021; Mattheis *et al.*, 2020). Indeed, LGBTQ+ employees in STEM fields, including research scientists, postdoctoral scholars, and academic faculty, report needing to conceal their LGBTQ+ identities at work (Atherton *et al.*, 2016) and to be less obviously gay in order to navigate their work environments, including dressing in a more conservative and gender-normative way and not bringing partners to departmental events (Bilimoria and Stewart, 2009; Mattheis *et al.*, 2020). Moreover, LGBTQ+ STEM professionals report more negative and hostile workplaces and perceive fewer opportunities to develop their skills compared with non-LGBTQ+ colleagues (Cech and Pham, 2017; Cech and Waidzunas, 2021), which can result in them considering leaving their jobs (Dyer *et al.*, 2019). Whether individuals perceived their STEM workplaces to be safe is associated with how open LGBTQ+ individuals are with colleagues and, in academia, students (Yoder and Mattheis, 2016), highlighting the importance of LGBTQ+ individuals feeling protected at work.

Academic STEM environments in particular present unique challenges for LGBTQ+ faculty and students. Faculty have reported hesitancy in revealing their LGBQ identities, because some of their colleagues' attitudes toward them have become more negative after learning of their identities (Patridge *et al.*, 2014) and out of concern that students may discriminate against them or that they could lose their jobs (Cooper *et al.*, 2019). Undergraduate students also perceive a stigma surrounding the LGBTQ+ identity in academic STEM. LGBTQ+ undergraduates have described biology as an unwelcoming place for their identities (Cooper and Brownell, 2016), and undergraduate and graduate students have reported facing greater sex-based and gender-based discrimination in the larger STEM community compared with social science and humanities disciplines, which they found more welcoming and accepting (Linley *et al.*, 2018). Undergraduate students have also described the prevalence of "dude culture" in STEM as a factor that treats their LGBTQIA+ identities as inferior (Miller *et al.*, 2020) and reported lower sense of belonging than their straight peers (Yang *et al.*, 2021). Together, these studies highlight that academic STEM can be uniquely difficult to navigate for LGBTQ+ individuals.

The generally unwelcoming nature of academic STEM has presumably resulted in higher attrition of LGBTQ+ students. A national longitudinal study found that LGB students were 7% less likely than their peers who identify as straight to be retained in STEM majors (Hughes, 2018), and a similar pattern has been found for transgender students (Maloy *et al.*, 2022). Further, in interviews with queer individuals in STEM, two transgender graduate students who transitioned during graduate programs in the same state had very different experiences: one experienced an unwelcoming departmental climate, while the other received support, and each student attributed their departmental climate to their future plans to leave the field and to pursue a career in STEM, respectively (Mattheis *et al.*, 2020). As such, making academic STEM more inclusive for LGBTQ+ individuals may be a key step in retaining LGBTQ+ individuals (Cooper *et al.*, 2020a). Increasing retention of LGBTQ+ individuals in STEM is important in undoing the systemic exclusion of LGBTQ+ individuals from science and fostering research teams with more diverse views and experiences, which in turn can improve the quality of the work they are able to produce and increase the objectivity of that work by counteracting stereotypes or biases that individual researchers may have (Harding, 1992; Intemann, 2009).

Making STEM More Inclusive through Instructor LGBTQ+ Representation

Notably, there are increasing efforts to transform academic STEM into a more welcoming space for LGBTQ+ individuals. For example, the American Physical Society published an LGBT climate report in 2016 that included a set of recommendations to make academic physics more inclusive (Atherton *et al.*, 2016). More recently, LGBTQ+ engineers and allies published a set of recommendations to make academic chemical engineering more inclusive for LGBTQ+ individuals (Butterfield *et al.*, 2018), and a group of LGBTQ+ biologists and allies published a specific set of recommendations for academic biology (Cooper *et al.*, 2020a). All of these documents highlight the importance of increased representation of LGBTQ+ individuals in academic STEM, namely because representation in a field has been shown to help develop a sense of belonging among underrepresented individuals (Rosenthal *et al.*, 2013; Linley *et al.*, 2016; Harmsen, 2018; Rainey *et al.*, 2018). In STEM, instructors have been identified as particularly influential potential role models for students (Rask and Bailey, 2002; Cotner *et al.*, 2011). Studies have found that women having a STEM instructor of the same gender can positively affect engagement (Crombie *et al.*, 2003; Solanki and Xu, 2018), self-efficacy (Cotner *et al.*, 2011; Stout *et al.*, 2011), and sense of belonging (Harmsen, 2018), while persons excluded because of their ethnicity or race (PEERs; Asai, 2020) who have instructors with the same race/ethnicity show improved persistence in the major (Rask and Bailey, 2002) and self-efficacy (Shin *et al.*, 2016).

Studies examining the impact of instructors sharing identities with their students have focused on identities that tend to be more visible, such as gender and race/ethnicity.[2] However, less is known about the impact of instructors sharing CSIs, including the LGBTQ+ identity, with students. CSIs are identities that can be hidden, but when revealed, can result in loss of status or discrimination for that individual (Link and Phelan, 2001; Quinn, 2006). As such, the decision to reveal a CSI, particularly in the context of an undergraduate science classroom, is complex.

Prior studies of LGBTQ+ individuals revealing their identities have primarily focused on the impact on the instructors. For example, in interviews, lesbian and queer women professors in the humanities, nursing, and athletic therapy reported that coming out to their students allowed them to live more authentically (Nielsen and Alderson, 2014), which was echoed by LGBQ instructors who chose to reveal their identities in college biology classrooms (Cooper *et al.*, 2019). While some instructors have identified potential benefits of coming out, LGBTQ+ instructors also noted that there are risks to coming out to students; they could be disrespected, criticized, or experience professional repercussions for sharing this identity (Cooper *et al.*, 2019). Studies have also examined how students perceive an instructor who comes out and have resulted in varied findings. For example, a study conducted nearly 20 years ago in an introductory college communication course determined that students found the instructor less credible, perceived that they learned less, and were more likely to make negative comments on the course evaluation when the instructor came out as gay during the lecture compared with when the instructor did not come out (Russ *et al.*, 2002). There have since been two replication studies of the 2002 study that presented conflicting results (Boren and McPherson, 2018; De Souza, 2018). One study, conducted in 2018 at the same university as the original study by Russ and colleagues (2002), found that introductory psychology students consistently rated the instructor more virtuous, honest, pleasant, unselfish, reliable, and qualified when he did not come out than when he did come out and although the instructor received more negative comments on the evaluation when students perceived him as gay, students wrote a similar proportion of positive comments in both conditions (De Souza, 2018). However, another replication study in 2018 at a different institution found that students in a basic communication course did not rate the instructor as being less credible when he came out than when he did not and perceived that they learned to the same extent in both conditions (Boren and McPherson, 2018). One additional study examined the student evaluations of three LGBTQ+ university humanities faculty and found no difference between sections where the instructors revealed their LGBTQ+ identities and other sections of the same course where they kept their LGBTQ+ identities concealed (Jennings, 2010). In sum, the effect that coming out can have on instructors in the present day may be highly variable, likely dependent on other social identities and geographic context (Duran, 2019; Whitehead, 2019), but additional research is needed.

Few studies have examined the impact of an instructor coming out in class on students' experiences in the course. However, two studies have shown that LGBQ instructors perceive that revealing this identity may have a positive impact on students, particularly LGBTQ+ students. Lesbian and queer women professors reported that coming out to their students helped them relate to their students, demonstrate their support for social justice issues, and model authenticity for their students (Nielsen and Alderson, 2014). Additionally, LGBQ life sciences instructors reported that revealing their identities may positively impact students, because they could serve as an example of a member of the LGBQ community to all students, a mentor to LGBQ students specifically, a known supporter of the LGBTQ+ community, and they could increase the extent to which students relate to them and students' comfort in class (Cooper *et al.*, 2019). However, instructors' predictions of how revealing their LGBTQ+ identities in class affects students have not been empirically studied by asking the students themselves.

In addition to the positive impact that an LGBTQ+ instructor may have on LGBTQ+ students, coming out may also have a disproportionately positive impact on students with other marginalized identities, including marginalized gender, religious, racial/ethnic, and mental health identities. Previous studies suggest that individuals with marginalized identities feel greater empathy toward one another (Wade and Brittan-Powell, 2001; Spanierman *et al.*, 2012; Cooper *et al.*, 2020c), which may result in students with marginalized identities feeling connected to the instructor and more comfortable in the course following disclosure of the instructor's CSI (even if they have a different stigmatized identity). An instructor revealing their LGBTQ+ identity may also challenge the chilly environment that women often describe experiencing in STEM disciplines (Seymour and Hewitt, 1997; Seymour and Hunter, 2019; Christe, 2013). However, talking about LGBTQ+ status in the workplace can be perceived as unprofessional for LGBTQ+ individuals due to the emphasis on "sex" (McKenna-Buchanan *et al.*, 2015; Fidas and Cooper, 2018), even though it is perceived as appropriate for those who are straight and cisgender to share information about their romantic partners (Russ *et al.*, 2002; Cooper and Brownell, 2016). Further, students who are evangelical Christians (Woodford *et al.*, 2012; Worthen *et al.*, 2017; Wilcox, 2020), Muslims (Abraham, 2010; Habib, 2010; Human Rights Campaign, 2021), and those who are politically conservative (Woodford *et al.*, 2012; Worthen *et al.*, 2017) historically tend to hold opposing LGBTQ+ views,[3] although this assumption is not true of everyone who identifies this way (Barnes *et al.*, 2021a). Considering the stigma associated with the LGBTQ+ identity, it is important to examine the impact of an instructor revealing this identity on all students, not just LGBTQ+ students.

Current Study

Given the extant research, we predict that an instructor revealing their LGBTQ+ identity will be associated with disproportionately positive effects on LGBTQ+ undergraduates and may also be associated with positive effects on students with other marginalized identities in STEM. However, revealing one's LGBTQ+ identity may be perceived as inappropriate by students

[2]Although they are largely considered visible, we recognize that gender and race/ethnicity identities are not inherently apparent based on appearance.

[3]"Opposing LGBTQ+ views" is an umbrella term to include individuals who perceive being a member of the LGBTQ+ community to be "wrong" and those who actively deny LGBTQ+ people rights and resources.

(Russ *et al.*, 2002; Anderson and Kanner, 2011) and may be associated with negative effects on students associated with groups that have opposing LGBTQ+ views.

In this study, we examined how students perceive they are impacted by an instructor revealing her LGBTQ+ identity in the context of a large-enrollment upper-level biology course at a research-intensive institution in Arizona.

Our specific research questions were:

1. To what extent do students remember an instructor revealing her LGBTQ+ identity in less than 3 seconds at the beginning of the semester?
2. To what extent do students perceive that the instructor revealing her LGBTQ+ identity impacted their experiences in the course negatively, positively, or not at all?
3. To what extent do students perceive that the instructor revealing her LGBTQ+ identity increased their willingness to approach the instructor for mentorship or guidance, feelings of connectedness to the instructor, confidence in their ability to pursue a career in science, sense of belonging in the course, and sense of belonging in the scientific community?
4. In general, how appropriate do students think it is for an instructor to reveal their LGBTQ+ identity and why do they perceive it as appropriate or inappropriate?

For each question, we also examined to what extent students' identities, including LGBTQ+ status, gender, religion, race/ethnicity, and history of anxiety and/or depression, predicted their responses. Although previous work indicates that LGBTQ+ students predict that they would benefit from knowing an LGBTQ+ instructor, this has not been systematically assessed in the context of a specific course. The current study serves as an exploratory study to begin to unpack the potential impact on all students in the course of an instructor revealing her LGBTQ+ identity to serve as a foundation for future studies that could quantify these impacts to understand potential causality.

METHODS

This study was approved by the Arizona State University Institutional Review Board (protocol no. 00011085).

Study Context

To investigate the extent to which an instructor revealing her LGBTQ+ identity in class impacts students, we conducted a study in the context of a large-enrollment upper-level biology course at a large public research-intensive (R1) institution in Arizona during two semesters.

Because stigma is contextually determined (Barreto *et al.*, 2006; Newheiser *et al.*, 2017), considering the location and institution where the study took place is pertinent to this research. Arizona ranks low relative to other states in their overall policy of equality for LGBTQ+ people (Movement Advancement Project, 2021). However, the metropolitan areas surrounding the campus where this study was conducted earned perfect scores on the Human Rights Campaign Foundation's annual Municipality Equality Index and are considered among the best places in Arizona for LGBT families (MacDonald-Evoy, 2017; Woods, 2021). The institution is neither listed on Princeton Review's top 20 list of LGBTQ-friendly colleges nor on their top 20 list of LGBTQ-unfriendly colleges (Princeton Review, 2021a,b). Together, this suggests that the institution is neither particularly friendly nor hostile to LGBTQ+ individuals and is in a geographic region that is tolerant of but not entirely welcoming to LGBTQ+ people.

We chose to collect data over two semesters to increase our sample size and to ensure that students' perceptions of the instructor were not unique to a specific course offering. At this institution, the biology course was taught to 288 students in person during Fall 2019 and to 307 students asynchronously online in Fall 2020 because of the COVID-19 pandemic. Besides the change in modality, the content of the course and learning materials provided to students were the same in both semesters. The course was co-taught by two instructors; one instructor, who identifies as a member of the LGBTQ+ community, taught the first 8 weeks of the course, and then the other instructor, who does not identify as a member of the LGBTQ+ community, taught the remaining 8 weeks. At the beginning of each term, the first instructor revealed her LGBTQ+ identity to her students using a single PowerPoint slide. On the slide, she shared personal information about herself, including her interests, hobbies, favorite movie, and that she is "a proud member of the LGBTQ+ community" (Figure 1). Revealing her LGBTQ+ identity took no more than 3 seconds, and she did not mention her LGBTQ+ identity to the class at any other point during the term.

At the midpoint of each semester, just after the LGBTQ+ instructor stopped teaching, students were invited to participate in a survey about their experiences in their biology course in exchange for a small number of extra-credit points. Students were told that the survey would ask them about their experiences in the course, that their responses were confidential, and that that the instructor of the course would never see their specific answers. In Fall 2019, 221 students (77%) completed the survey, and in Fall 2020, 254 students (83%) completed the survey.

Survey

We developed a survey with closed-ended and open-ended questions to assess student outcomes that prior research suggested may be affected by the instructor revealing her

FIGURE 1. Introductory PowerPoint slide used by the instructor to reveal her LGBTQ+ identity to her students during class in less than 3 seconds.

LGBTQ+ identity to the class. Specifically, we were interested in the effects of the instructor revealing her LGBTQ+ identity on students' willingness to approach the instructor (Stout *et al.*, 2011; Nielsen and Alderson, 2014; Cooper and Brownell, 2016; Cooper *et al.*, 2019), the extent to which students felt connected to the instructor (Stout *et al.*, 2011; Nielsen and Alderson, 2014; Cooper and Brownell, 2016; Cooper *et al.*, 2019), students' confidence to pursue a science career (Cotner *et al.*, 2011; Stout *et al.*, 2011; Cooper and Brownell, 2016; Cooper *et al.*, 2019), and their sense of belonging in the course and science community (Stout *et al.*, 2011; Cooper and Brownell, 2016; Cooper *et al.*, 2019; Nielsen and Alderson, 2014; Linley *et al.*, 2016). We were also interested in students' perceptions of whether or not an instructor revealing their LGBTQ+ identity in the context of a class was appropriate (Nielsen and Alderson, 2014; Cooper and Brownell, 2016; Cooper *et al.*, 2019; Arena and Jones, 2017). The questions assessing these constructs in the survey are described in sections *Student Outcomes Hypothesized to Be Influenced by the Instructor Revealing Her LGBTQ+ Identity* and *Appropriateness of an Instructor Revealing Their LGBTQ+ Identity*.

To establish cognitive validity of the survey questions, we conducted individual think-aloud interviews with a total of seven undergraduate students to ensure that the students understood what each question was asking (Trenor *et al.*, 2011). Four of these undergraduates had experienced an instructor revealing their LGBTQ+ identity during a course, and all were enrolled in upper-level life sciences courses and were majoring in the life sciences. The survey was iteratively revised after each think-aloud interview until we perceived that no question needed to be revised. One survey item that was not on the Fall 2019 version of the survey was added to the Fall 2020 version to assess the overall impact students perceived that the instructor coming out had on their general experience in the course. A copy of the analyzed survey questions can be found in the Supplemental Material.

Memory of Instructor Revealing Her LGBTQ+ Identity. The first survey question prompted students: "On a slide at the beginning of the semester, your instructor revealed that she is a member of the LGBTQ+ community. To what extent do you remember this?" Students selected from (1) do not remember at all, (2) remember somewhat clearly, and (3) remember very clearly. Student responses to all questions were only included in the analyses if they indicated that they either somewhat clearly or very clearly remembered the instructor revealing her LGBTQ+ identity, except for the question about the appropriateness of an instructor revealing their LGBTQ+ identity, as this was not specific to the instructor of the course revealing her LGBTQ+ identity. This question about whether students remembered the instructor revealing her identity was included on both the 2019 and 2020 surveys.

Overall Impact of Instructor Revealing Her LGBTQ+ Identity on Students. To investigate the impact on students' overall experiences in the course, students indicated the impact that their instructor revealing her LGBTQ+ identity had on their experience in the course from (1) very negative impact to (7) very positive impact, with the option of selecting (4) no impact. Students were then asked to explain why having their instructor reveal her LGBTQ+ identity had a positive, negative, or no impact on their experience in the course. These questions were only included on the 2020 survey.

Student Outcomes Hypothesized to Be Influenced by the Instructor Revealing Her LGBTQ+ Identity. To assess the impact of the instructor revealing her LGBTQ+ identity on students' willingness to approach the instructor for mentorship or guidance, feeling connected to the instructor, confidence in their ability to pursue a career in science, sense of belonging in the course, and sense of belonging in the scientific community, we developed a single item to measure each of the constructs, because no items or scales had been previously developed to assess such outcomes in this unique context. The purpose of this study was to understand the student-perceived impact of the instructor revealing her LGBTQ+ identity on these affective measures of their course experience. Therefore, we asked students to consider whether they perceived an increase in each of the outcomes due to the instructor disclosing her LGBTQ+ identity. Students indicated the extent to which they agreed with the following five statements using a Likert scale ranging from (1) strongly disagree to (6) strongly agree: "My instructor revealing her LGBTQ+ identity in this course increased my likelihood of approaching her for mentorship or guidance," "My instructor revealing her LGBTQ+ identity in this course increased my confidence in my ability to pursue a career in science," "My instructor revealing her LGBTQ+ identity in this course made me feel more connected to her," "My instructor revealing her LGBTQ+ identity in this course increased my sense of belonging in this course," and "My instructor revealing her LGBTQ+ identity in this course increased my sense of belonging in the science community." These questions were included on both the 2019 and 2020 surveys.

Appropriateness of an Instructor Revealing Their LGBTQ+ Identity. To assess students' perceptions of how appropriate it is to reveal one's LGBTQ+ identity in class, students indicated the extent to which they agreed with the following statement using a Likert scale from (1) strongly disagree to (6) strongly agree: "I think it is completely appropriate for STEM instructors to reveal that they are a member of the LGBTQ+ community." Students were then asked to explain why they thought it was appropriate or inappropriate for STEM instructors to reveal that they are members of the LGBTQ+ community in a course. These questions were included on both the 2019 and 2020 surveys.

Demographics. At the end of the survey, we collected student demographic information, including LGBTQ+ status, gender, religious identity, race/ethnicity, if they currently have or previously had anxiety or an anxiety disorder, and if they currently have or previously had depression or a depressive disorder. These questions were included on both the 2019 and 2020 surveys.

Analyses

Regression Analyses Performed. To address our research questions, we used logistic and ordinal regression modeling in R (R Core Team, 2021) using the stats and MASS (Venables and Ripley, 2002) packages, respectively. In each of our models described in the following four sections, we included LGBTQ+

status[4] (yes/no), gender[5] (man/woman), religious identity[6] (Christian, Muslim, other, not religious), race/ethnicity (white, Asian,[7] PEER[8]), and history of anxiety and/or depression[9] (yes/no). These predictor variables have been previously found to affect students' perceptions of their instructors and experiences in biology learning environments (Eddy *et al.*, 2014; Cooper and Brownell, 2016; Cooper *et al.*, 2020c,d; Grunspan *et al.*, 2016; England *et al.*, 2017; Theobald *et al.*, 2017; Meaders *et al.*, 2019, 2020); further justification for including these predictor variables in the regression models is provided in the Supplemental Material. In our models, we also controlled for semester of enrollment (Fall 2019/Fall 2020) to account for any differences in students' responses due to the change in modality and year. Considering the racial disparities in discrimination against LGBTQ+ individuals (Whitfield *et al.*, 2014), investigating the intersectionality of systems of oppression faced by individuals who are LGBTQ+ is important. However, all regression analyses in this study are additive and do not consider interactions between gender identity and LGBTQ+ status and/or racial identity and LGBTQ+ status due to the low number of individuals with each of these identities in this study. This approach was used in all analyses, but differences are highlighted in the following sections for each research question.

For all logistic regressions, we checked the adequacy of the model fit by plotting the residuals against the fitted linear predictors and fitting a LOWESS smoothed curve to the data; the LOWESS curves were all approximately horizontal, indicating the logistic regression models are adequate (Kutner *et al.*, 2003; Fox and Weisberg, 2018). For all ordinal regressions, proportional odds assumptions were checked and met. For all models, we checked for multicollinearity among the predictors by examining the variance inflation factor (VIF) values using the car package in R (Fox and Weisberg, 2018). The VIF values indicated there was no issue with multicollinearity.

To What Extent Do Students Recall the Instructor Revealing Her LGBTQ+ Identity? We calculated the percent of students who remembered or did not remember the instructor revealing her LGBTQ+ identity during class. We grouped students who selected "remember very clearly" and "remember somewhat clearly" into one group of students who remembered. We used logistic regression to determine whether there were demographic differences in who remembered (yes or no). Model: remember (yes or no) ~ LGBTQ+ status + gender + religion + race/ethnicity + anxiety/depression + semester.

To What Extent Did the Instructor Revealing Her LGBTQ+ Identity Impact Students' Experiences in the Course Negatively, Positively, or Not at All and Why? We calculated the percent of students who reported that the instructor had a positive impact on their experience in class, had no impact on their experience in class, and had a negative impact on their experience in class. To assess the extent to which student identities predicted the impact that students perceived the instructor revealing her LGBTQ+ identity had on their experience in the course, we used logistic regression (positive impact or nonpositive impact). Due to the small number of students who selected negative impact (n = 7), we combined students who selected negative impact with those who selected no impact. Additionally, this question was only included on the 2020 version of the survey, so we did not include semester of enrollment in the regression. Model: impact (positive or nonpositive) ~ LGBTQ+ status + gender + religion + race/ethnicity + anxiety/depression.

We then examined students' respective open-ended responses explaining why they felt that the instructor revealing her LGBTQ+ identity had a positive, negative, or no impact on their experience in the course. One researcher (C.A.B.) reviewed all student responses of why the instructor revealing her LGBTQ+ identity had either a positive impact or no impact on the students' experiences in the course. There were too few students (n = 2) who provided open-ended responses about why the instructor revealing her LGBTQ+ identity had a negative impact on them to go through a formal coding process. The researcher (C.A.B.) used open-coding methods to develop a codebook describing each theme that emerged from students' responses of why the instructor revealing her LGBTQ+ identity had a positive impact or no impact on their experience in the course. The researcher (C.A.B.) used constant comparative methods to develop the codebook (Glesne and Peshkin, 1992). Responses were continuously compared to ensure that each theme adequately represented each quote and that quotes were not sufficiently different to warrant creating a new theme. A second researcher used the final rubric to review and code a randomly selected set of 15% of each response set (positive impact or no impact). The researchers compared their codes

[4]We grouped LGBTQ+ individuals because there were too few individuals in each category (e.g., gay, bisexual, transgender) to disaggregate and they have a shared lived experience of not being straight or cisgender. We acknowledge that the experiences of individuals in each category are different, particularly the experiences of transgender and intersex individuals (Atherton *et al.*, 2016).

[5]We recognize that not all students identify as gender binary (man or woman; Cooper *et al.*, 2020a); however, there were too few individuals who identified as gender nonbinary to include this category in the analyses.

[6]We acknowledge that religious affiliation does not dictate one's view of the LGBTQ+ community. However, we felt that religion was important to control for given the other identities we were examining. We grouped Catholic, Latter-day Saint (LDS), and Protestant students with those who described their religion as Christian, nondenominational Christian, or another denomination of Christianity (e.g., Lutheran) into one group of "Christian students." We grouped students who selected a religion other than a denomination of Christianity and Muslim (e.g., Hindu, Buddhist, Jewish) into an "other" category, because these groups had too few students to group separately, but they all identify as religious, yet their affiliations are not currently considered to be actively anti-LGBTQ+ (Human Rights Campaign, 2021). Students who identify as atheist, agnostic, or no religion were grouped into "not religious."

[7]We acknowledge students grouped under the term "Asian" represent various ethnic groups and that grouping individuals in this way minimizes the differences in privilege afforded to these diverse groups and perpetuates the model minority myth (Museus and Kiang, 2009). While Asian people are not numerically underrepresented in STEM, they do experience racial discrimination in the United States (Kuo, 1995; Wei *et al.*, 2010).

[8]Persons excluded due to ethnicity or race (PEER) refers to students who identify as Black, Latinx, American Indian, Alaska Native, Native Hawaiian, or Pacific Islander. We recognize that the experiences of students from these groups will differ; however, due to low sample size of Black, American Indian, Alaska Native, Native Hawaiian, and Pacific Islander students, we have grouped them together with Latinx students because of their shared experience of identifying as a race/ethnicity that has been systematically excluded from STEM in the United States. (Asai, 2020).

[9]Anxiety and depression often occur as comorbid illness (Pollack, 2005), and students with anxiety and depression report similar experiences in academic settings (Quinn *et al.*, 2004). As such, we chose to group students with a history of anxiety and/or depression.

and their Cohen's κ interrater score was at an acceptable level for why there was a positive impact (κ = 0.89) or no impact (κ = 1.00; Landis and Koch, 1997). One researcher (C.A.B.) then coded all remaining responses. Each theme is mutually exclusive; an excerpt of text could only be coded as one theme, but students' full responses could include multiple themes. In rare cases (n = 3), a student's response to the open-ended question contradicted their response to the closed-ended question. For example, a student who reported that the instructor coming out negatively affected them wrote about why the instructor coming out positively affected them. Any students whose responses to the open-ended question contradicted the response from the preceding closed-ended question were excluded from analyses regarding the impact of the instructor revealing her LGTBQ+ identity. A copy of the final coding rubrics are provided in Supplemental Tables S1 and S2.

To What Extent Did the Instructor Coming Out Impact Specific Outcomes? We calculated the percent of students who agreed that the instructor coming out positively affected each of the five outcomes: 1) willingness to approach the instructor for mentorship, 2) feelings of connectedness with the instructor, 3) confidence in their ability to pursue a career in science, 4) sense of belonging in the course, and 5) sense of belonging within the scientific community.

To assess the extent to which student identities predicted whether they agreed that the instructor coming out affected each of the five primary outcomes of interest, we conducted five ordinal regressions. For each regression, we regressed student identities on each of the five outcome variables (measured on a Likert scale ranging from 1 to 6; example model: outcome ~ LGBTQ+ status + gender + religion + race/ethnicity + anxiety/depression + semester).

To What Extent Do Students Perceive That It Is Appropriate for an Instructor to Reveal Their LGBTQ+ Identity and Why? We calculated the percent of students who agreed that it was appropriate for STEM instructors to reveal their LGBTQ+ identities.

One researcher (C.A.B.) reviewed all student responses to why an instructor revealing their LGBTQ+ identity was appropriate or inappropriate and used the same process as described earlier to create codebooks for each set of responses. The Cohen's κ interrater scores were at an acceptable level for the responses for why it is appropriate (κ = 0.87) or inappropriate (κ = 0.91; Landis and Koch, 1997). Any students whose responses to the open-ended question contradicted the response from the preceding closed-ended question were excluded from analyses involving appropriateness (n = 9). Although students' full responses could include multiple themes, each excerpt of text could only be coded as one theme. A copy of the final coding rubrics is provided in Supplemental Tables S3 and S4.

To assess the extent to which student identities predicted how appropriate they perceived an instructor revealing their LGBTQ+ identity to be, we conducted an ordinal regression. The outcome variable was the student response to the survey item about the appropriateness of a STEM instructor revealing their LGBTQ+ identity (measured on a Likert scale ranging from 1 to 6; model: appropriateness ~ LGBTQ+ status + gender + religion + race/ethnicity + anxiety/depression + semester).

Interpretation of Analyses

Whether the result of a statistical test is significant or not is continuous rather than dichotomous based on the p value (Wasserstein *et al.*, 2019). However, we report the results based on the standard of $p \leq 0.05$ for simplicity. We acknowledge that p values greater than 0.05 can be scientifically meaningful, depending on the coefficient of the variable, so we report out all results of statistical tests in the Supplemental Material for the reader's further interpretation. Results of logistic regressions are described using language such as "LGBTQ+ students had 2.3× higher odds of selecting a particular response compared with non-LGBTQ+ students." The number (e.g., 2.3) is the natural exponential of the estimated coefficient for the predictor variable (e.g., LGBTQ+ vs. non-LGBTQ+) in the logistic regression model to predict whether the student selected a particular response. This number is called the "odds ratio" and is a standardized effect size statistic in logistic regressions (Deeks, 1998; Agresti and Franklin, 2018). Further, we refer to the percent of students who agreed with a particular item on the survey, which was calculated based on the total number of students who selected somewhat agree, agree, or strongly agree (4–6 on the Likert scale) out of the total number of students who answered the question. With the exception of the question assessing the overall impact of the instructor coming out, the Likert-style questions were on scales from 1 to 6 and did not have a neutral option.

Positionality

All four of the authors identify as LGBTQ+ cisgender women. Given the focus of the study and analyses on students' perceptions of their instructor revealing her LGBTQ+ identity, it is important to acknowledge that our own LGBTQ+ identities may have affected the interpretation of results and likely made them more thorough (Day, 2012; Jacobson and Mustafa, 2019). Although students knew that their instructor identified as LGBTQ+, they did not know that the research team responsible for administering the survey or analyzing and interpreting the data also identified as members of the LGBTQ+ community.

RESULTS

Finding 1: Most Students Recall the Instructor Revealing Her LGBTQ+ Identity

Student demographics for all 475 students who completed the survey are reported in Table 1; a breakdown of student demographics by semester of enrollment is available in Supplemental Table S5.

Just over 90% (90.5%) of students who completed the survey reported that they remembered the instructor revealing her LGBTQ+ identity, even though it was only done once in less than 3 seconds. We predicted that different demographic groups of students would remember the instructor revealing her LGBTQ+ identity disproportionately, but student LGBTQ+ identity, gender, religion, race/ethnicity, history of anxiety and/or depression, and semester of enrollment were not significantly associated with remembering the instructor revealing her LGBTQ+ identity. The extent to which different groups of students remembered the instructor revealing her identity and the full result of the binary logistic regression are included in Supplemental Tables S6 and S7.

TABLE 1. Demographics of students who completed the survey in Fall 2019 or Fall 2020 (*N* = 475)

	% (*n*)		% (*n*)
LGBTQ+ status		Race/ethnicity	
Yes	14.9 (71)	American Indian or Alaska Native	0.2 (1)
No	76.6 (364)	Asian or Asian American	19.4 (92)
Decline to state	8.4 (40)	Black or African American	3.2 (15)
Gender identity		Hispanic or Latinx	13.7 (65)
Man	31.4 (149)	Native Hawaiian or Pacific Islander	0.2 (1)
Woman	62.5 (297)	White	41.5 (197)
Nonbinary	0.4 (2)	More than one race/ethnicity	9.3 (44)
Decline to state	5.7 (27)	Other	5.5 (26)
Religious identity		Decline to state	7.2 (34)
Christian–Catholic	16.2 (77)	History of anxiety and/or depression	
Christian–Protestant	5.9 (28)	Now or previously	61.3 (291)
Latter-day Saint	1.5 (7)	Never	27.6 (131)
Christian (nondenominational or other denomination)	7.2 (34)	Decline to state	11.2 (53)
Muslim	4.8 (23)	Semester of enrollment	
Hindu	3.4 (16)	Fall 2019	46.5 (221)
Buddhist	1.3 (6)	Fall 2020	53.5 (254)
Jewish	1.1 (5)		
Other	6.7 (32)		
Agnostic	22.1 (105)		
Atheist	10.5 (50)		
Not religious	10.7 (51)		
Decline to state	8.6 (41)		

Finding 2: Most Students Perceive That the Instructor Revealing Her LGBTQ+ Identity Had a Positive Impact on Their Overall Experience in the Course

Nearly two-thirds of students (65.6%) who remembered the instructor revealing her LGBTQ+ identity reported that it had a positive impact on their overall experience in the course. Nearly one-third of students (31.3%) perceived that the instructor revealing her LGBTQ+ identity had no impact on their overall experience in the course. Only seven students (3.1%) who remembered their instructor coming out reported that their instructor revealing her LGBTQ+ identity had a negative impact on their overall experience in the course.

Comparing whether students reported that the instructor revealing her LGBTQ+ identity had a positive impact or neutral to negative impact on their experience, we found that LGBTQ+ status, gender, and history of anxiety and/or depression were significantly associated with students' responses. Students who identify as LGBTQ+ had 15.8× higher odds of reporting a positive impact than non-LGBTQ+ students (p = 0.01). However, most non-LGBTQ+ students (61.4%) reported a positive impact on their overall course experience, so the positive impact was not limited to LGBTQ+ students. Women had 2.5× higher odds of reporting a positive impact than men (p = 0.03), while 55.7% of men reported a positive impact. Students with a history of anxiety and/or depression had 2.7× higher odds of reporting a positive impact than students without a history of anxiety and/or depression (p = 0.01), although a substantial proportion of those students without a history of anxiety and/or depression (46.3%) also reported a positive impact. Religion and race/ethnicity were not associated with a significant effect on the impact of the reveal on students' overall course experience. The full result of the regression is reported in Table 2.

When examining open-ended responses as to why students reported that the instructor revealing her LGBTQ+ identity had a positive impact on their experience in the course, students commonly reported that it increased their feelings of connectedness and relatability toward the instructor (45.6%) and helped to foster an inclusive and welcoming environment in the course (25.7%). Students also cited the instructor revealing her LGBTQ+ identity as a means of normalizing LGBTQ+ identities in the course (18.4%). Additionally, students (13.2%) noted the instructor's impact on the representation of LGBTQ+ individuals in science, often highlighting that none of their previous instructors have revealed a similar identity.

The most common reason (60.9%) students cited for the instructor coming out having no impact on their course experience was that their view of the instructor's ability to teach or their capacity to learn was not impacted. Students also cited that LGBTQ+ identities are normal and not a reason to judge an instructor (21.9%). Table 3 includes themes that were included in at least 5% of student responses, theme descriptions, and example student quotes; quotes are designated as from an LGBTQ+ student or a non-LGBTQ+ student to provide greater context of the students' background, because whether the student also identifies as LGBTQ+ often influenced students' rationale for the positive impact.

Of the seven students who reported that the instructor revealing her LGBTQ+ identity negatively impacted their experience in the course, only two provided open-ended explanations. One student said, "There was a short period of time where I felt slightly uncomfortable thinking of my instructor in that regard." The other student said, "It was information that distracted from the course material."

TABLE 2. Summary of logistic regression model of the relationship between students' perceived impact on the overall course experience (positive or nonpositive) and their LGBTQ+ status, gender, religion, race/ethnicity, and history of anxiety/depression[a]

Variable	B	SE B	β	*p*	OR	Significant OR interpretation[b]
Intercept	−0.23	0.46	1.11	0.62	0.80	
LGBTQ+ (yes)	2.76	1.07	1.07	0.01	15.77	LGBTQ+ students had 15.8× higher odds of reporting a positive impact than non-LGBTQ+ students.
Gender (woman)	0.93	0.42	0.42	0.03	2.54	Women had 2.5× higher odds of reporting a positive impact than men.
Religion (Christian)	−0.75	0.45	−0.35	0.09	0.47	
Religion (Muslim)	−0.67	0.90	−0.15	0.44	0.50	
Religion (other)	−0.25	0.63	−0.09	0.69	0.78	
Race/ethnicity (Asian)	−0.27	0.50	−0.12	0.59	0.76	
Race/ethnicity (PEER)	−0.47	0.49	−0.20	0.33	0.62	
Anxiety/depression (yes)	0.98	0.40	0.46	0.01	2.66	Students with a history of anxiety and/or depression had 2.7× higher odds of reporting a positive impact than students without anxiety or depression.

[a]B represents unstandardized coefficients. OR represents the odds ratio (calculated as e^B). β represents standardized coefficients. Focus categories are provided in parentheses in column 1. Semester of enrollment was not included in this model because this survey item was only included on the 2020 survey. Reference groups are non-LGBTQ+, men, not religious, white, and no history of anxiety or depression.

[b]We provide OR interpretations only for the variables that are significant at $p \leq 0.05$.

Finding 3: Instructor Revealing LGBTQ+ Identity Is Associated with Multiple Student Benefits

The majority of all students agreed that they perceived that the instructor revealing her LGBTQ+ identity increased their willingness to approach her for mentorship (71.0%), their feelings of connectedness with the instructor (77.2%), their confidence in their ability to pursue a career in science (53.3%), their sense of belonging in the course (63.7%), and their sense of belonging within the scientific community (57.1%). Student responses to each of the five outcomes are summarized in Figure 2 and disaggregated by demographic groups in Supplemental Figure S1.

Student identities were significantly associated with the extent to which students perceived the instructor coming out had a positive impact on each outcome. LGBTQ+ status was significantly associated with the extent to which students agreed with the statements that the instructor coming out increased their 1) willingness to approach the instructor for mentorship, 2) feelings of connectedness with the instructor, 3) confidence in their ability to pursue a career in science, 4) sense of belonging in the course, and 5) sense of belonging within the scientific community. That is, LGBTQ+ students were more likely to strongly agree with each statement than their non-LGTBQ+ peers when controlling for gender, religion, race/ethnicity, history of anxiety and/or depression, and semester of enrollment. Student gender was significantly associated with students' responses for three of the five outcomes. Women were more likely to agree with the statements of increased confidence in their ability to pursue a scientific career, sense of belonging in the course, and sense of belonging in the scientific community than men. Religion was associated with students' responses for four of these outcomes. Christian students were less likely to agree with the statements that the instructor coming out increased their feelings of connection with the instructor, confidence in pursuing a science career, sense of belonging in the course, and sense of belonging in the scientific community compared with their peers who do not identify as religious, while Muslim students were more likely to agree with the statements regarding increased willingness to approach the instructor, confidence to pursue a career in science, sense of belonging in the course, and sense of belonging in the scientific community due to the instructor coming out during class compared with their peers who do not identify as religious. Semester of enrollment was associated with all outcomes with students in the 2020 online semester more likely to agree with all five of the statements compared with students in the 2019 in-person semester. Race/ethnicity and history of anxiety and/or depression were not significantly associated any of the outcome variables (Supplemental Table S8). The effect sizes for all predictors, including LGBTQ+ status (yes), gender (woman), religion (Christian, Muslim, other religion), race/ethnicity (Asian, PEER), and history of anxiety/depression (yes), are presented in Figure 3.

Although LGBTQ+ students and women expressed higher levels of agreement than non-LGBTQ+ students and men that they perceived that the instructor coming out increased particular outcomes, we were curious whether non-LGBTQ+ students and men perceived that they were positively impacted by their instructor revealing her LGBTQ+ identity. Similarly, although Christian students were less likely to strongly agree with the statements that the instructor revealing her LGBTQ+ identity increased these outcomes, we were still interested in the extent to which they agreed that the gesture did increase these outcomes. More than half of the non-LGBTQ+ students agreed with the statement that their instructor revealing her LGBTQ+ identity increased their willingness to approach her for mentorship (67.0%), feelings of connectedness (73.2%), sense of belonging in the course (57.2%), and sense of belonging in the scientific community (50.9%; Figure 4a, $n = 328$). The majority of men agreed with the statement that their instructor revealing her LGBTQ+ identity increased their willingness to approach their instructor for mentorship (58.9%), feelings of connectedness (71.9%), and sense of belonging in the course (52.0%; Figure 4b, $n = 129$). Most Christian students agreed with the statement that their instructor coming out increased their willingness to approach the instructor for mentorship (61.9%), feelings of connectedness (65.7%), and sense of belonging in the course (52.6%; Figure 4c, $n = 134$).

TABLE 3. Themes that emerged from the student responses for why the instructor revealing her LGBTQ+ identity had a positive impact or no impact on their overall course experience

Theme	Description of theme	% (*n*)	Student quote 1	Student quote 2
		Positive impact ($N = 136$)		
Increases connectedness	Student reports that the instructor revealing her LGBTQ+ identity made her seem more relatable or human or the student is more comfortable approaching the instructor.	45.6 (62)	LGBTQ+ student: "It made me feel more comfortable knowing that I could relate to my professor because I belong to the LGBTQ+ community too. I feel more confident in communicating with [my instructor] as well."	Non-LGBTQ+ student: "Because she felt comfortable sharing that experience, it made me feel more connected to her in a way and made me feel like I could come talk to her about things."
Helps to create an inclusive environment free from judgment	Student reports that the instructor revealing her LGBTQ+ identity made the course community feel more welcoming and accepting. Student feels the instructor would not judge them.	25.7 (35)	LGBTQ+ student: "It made me feel comfortable and accepted in [the course]. It's a reminder that diversity exists in academia and should be embraced."	Non-LGBTQ+ student: "I like knowing a professor is willing to push social norms to create an inclusive environment."
Normalizes LGBTQ+ identities and benefits LGBTQ+ students	Student reports that the instructor revealing her LGBTQ+ identity helps to reduce the stigma around the LGBTQ+ community or likely increases LGBTQ+ student sense of belonging.	18.4 (25)	LGBTQ+ student: "I'm sure that students in the course that are also members of the LGBTQ community really appreciated hearing this coming from a professor in the field they want to be a part of. I think this shows how much she cares and has our interests as students at heart."	Non-LGBTQ+ student: "Even though I'm not part of the LGBTQ+ community I still think it's important that people feel like they are welcomed, accepted, included, and loved. I like that she wasn't afraid to hide such an important part of her life and I am more than sure that people that are also part of the LGBTQ+ community felt closer to her in some way and that alone makes me happy which makes my overall experience more positive."
Impact on the representation of LGBTQ+ individuals in science	Student reports that the instructor revealing her LGBTQ+ identity was a unique experience and few of their previous instructors have shared their LGBTQ+ identities.	13.2 (18)	LGBTQ+ student: "I have never had a professor who openly discussed that they were a part of the LGBTQ+ community and it was nice to see some diversity and representation in academia."	Non-LGBTQ+ student: "I've never had a professor reveal something like that before, and often in the past, I've had teachers that hide that aspect of their lives."
Student is also LGBTQ+	Student reports that the instructor revealing her LGBTQ+ identity positively impacted their overall course experience because they are also a member of the LGBTQ+ community.	10.3 (14)	LGBTQ+ student: "Since I am [LGBTQ+] too I felt it was something I can identify with so it left a positive impression."	LGBTQ+ student: "As a fellow woman in STEM also a part of the LGBTQ+ community, it is very motivating to me [to have my instructor reveal her LGBTQ+ identity]. Representation of people similar to me is motivating and reassuring."

(*Continues*)

TABLE 3. Continued

Theme	Description of theme	% (*n*)	Student quote 1	Student quote 2
		No impact (*N* = 64)		
Does not change student's view of course, the teaching or learning in the course, or is otherwise not related to course content	Student reports that the instructor revealing her LGBTQ+ identity does not change their perception of the course, the material, or the instructor's teaching ability.	60.9 (39)	LGBTQ+ student: "Sexuality has nothing to do with the ability for someone to educate me. It's cool and all, but it didn't really alter my perception of her as my professor."	Non-LGBTQ+ student: "It had no impact because it had nothing to do with the class or my grades."
LGBTQ+ identities are normal and no cause for judgment	Student reports that the instructor revealing her LGBTQ+ identity did not impact them because they do not judge others based on their LGBTQ+ identities or do not see LGBTQ+ identities as noteworthy.	21.9 (14)	Non-LGBTQ+ student: "I mean no impact in a positive way. It's something I automatically accept and don't question. My best friend is gay and it has never affected me/I've never thought twice about accepting her. I do like that [the instructor] is comfortable and proud to have that in her bio."	Non-LGBTQ+ student: "I support the LGBTQ+ community and didn't really believe it had an impact on me. Since I consider it in the norm and a part of daily life, I don't think that I really had a reaction. A lot of my friends are a part of the LGBTQ+ community I am well versed in knowledge about it and it doesn't really impact me."
No impact personally, but mentions the potential positive impact for other students	Student reports that the instructor revealing her LGBTQ+ identity did not impact them personally, but they acknowledge that other students (primarily LGBTQ+ students) may benefit or have a positive impact from the instructor revealing her LGBTQ+ identity.	6.3 (4)	Non-LGBTQ+ student: "I don't feel positively or negatively impacted by having this information revealed. However, I can appreciate how knowing this information would make LGBTQ+ students feel more welcome and included where in similar situations their identity could make them feel isolated when attempting to connect with faculty/utilize school resources/feel a part of the community."	Non-LGBTQ+ student: "It made no impact because I'm not in the community, but I'm sure that made others [feel] more included in the course when she revealed that."

Finding 4: Students Overwhelmingly Agree That It Is Appropriate for an Instructor to Reveal Their LGBTQ+ Identity

Over 96% of students agreed that they thought that it is appropriate for an instructor to reveal their LGBTQ+ identity (Figure 5a). Nearly all LGBTQ+ students (97.1%) agreed that it was appropriate for a STEM instructor to reveal their LGBTQ+ identity, while nearly 95% of their non-LGBTQ+ peers agreed.

LGBTQ+ status and religion were significantly associated with students' perception that it is appropriate for a STEM instructor to reveal their LGBTQ+ identity. LGBTQ+ students had 4.0× higher odds ($p < 0.001$) of agreeing more strongly that it is appropriate for an instructor to reveal their LGBTQ+ identity than non-LGBTQ+ students. Nonreligious students had 2.2× higher odds ($p = 0.002$) of reporting higher levels of agreement on the measure of appropriateness than Christian students, although 93.1% of Christian students still thought that it was appropriate for a STEM instructor to reveal their LGBTQ+ identity. Muslim students had 1.4× higher odds ($p < 0.001$) and students in 2020 had 1.1× higher odds ($p < 0.001$) of reporting higher levels of agreement that it would be appropriate for an instructor to reveal their LGBTQ+ identity compared with not religious students and students in 2019, respectively. Gender, race/ethnicity, and history of anxiety and/or depression did not have a significant effect on the perceived level of appropriateness (Supplemental Table S9). The effect sizes for all predictors, including LGBTQ+ (yes), gender (woman), religion (Christian, Muslim, other religion), race/ethnicity (Asian, PEER), and history of anxiety/depression (yes), are presented in Figure 5b. Additionally, very few students reported knowing other LGBTQ+ instructors in STEM and non-STEM disciplines (Supplemental Table S10).

Students cited a variety of reasons that it would be appropriate for a STEM instructor to reveal their LGBTQ+ identity

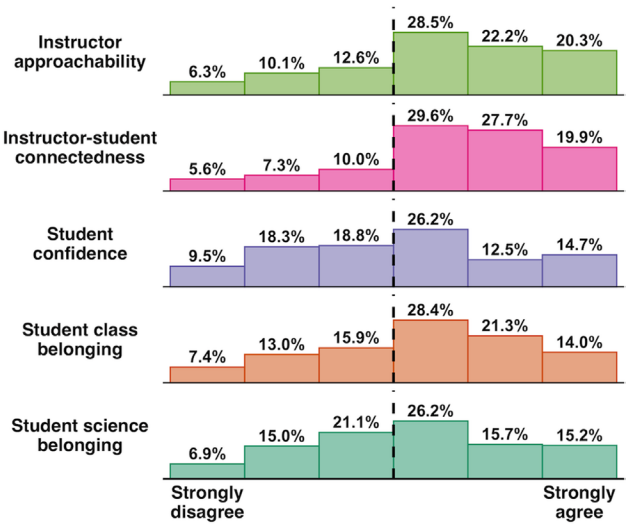

FIGURE 2. Student responses for each of the five outcomes: 1) instructor approachability: willingness to approach the instructor for mentorship or guidance, 2) instructor–student connectedness: feeling connected to the instructor, 3) student confidence: confidence in their ability to pursue a career in science, 4) student class belonging: sense of belonging in the course, 5) student science belonging: sense of belonging in the scientific community. Responses to the right of the vertical dashed line indicate agreement with the statement, whereas responses to the left indicate disagreement.

(Table 4). Students largely perceived that it would normalize LGBTQ+ identities and benefit LGBTQ+ students in particular (28.9%). Many students (27.5%) also noted an increase in their ability to connect with and relate to an instructor who revealed their LGBTQ+ identity and that it helps to promote the community values of trust and inclusion in the classroom (13.2%). Finally, 9.3% of students noted that it would be appropriate for instructors to share other details about their lives and sharing an LGBTQ+ identity is not different from other personal details.

Fewer than 10% of students reported that a STEM instructor revealing their LGBTQ+ identity would be inappropriate. The primary reason cited was that their instructor's sexuality is not relevant to course material (65.0%; Table 4). Students also expressed discomfort or concern on behalf of other students who may feel uncomfortable if an instructor chose to reveal their LGBTQ+ identity (25.0%). Table 4 includes themes that were included in at least 5% of responses for why it is appropriate and 10% of responses for why it is not appropriate, descriptions of those themes, and example student quotes. Each quote is attributed to an LGBTQ+ student or a non-LGBTQ+ student, because whether the student also identifies as LGBTQ+ often influenced students' rationale for why they perceived an instructor revealing their LGBTQ+ identify as appropriate or not.

DISCUSSION

An instructor revealing her LGBTQ+ identity in less than 3 seconds at the beginning of a course was impactful enough for nearly 91% of students to report remembering this event 8 weeks later. One common concern of LGBTQ+ instructors is that revealing their LGBTQ+ identities in class will take up class time that could be spent teaching biology (Cooper *et al.*, 2019). However, this is not necessarily the case; introducing this information in the context of an introductory "Who I Am" slide at the beginning of the semester provides instructors with a natural opportunity to reveal their LGBTQ+ identities quickly and in a way that does not seem out of context in the course. There are a number of reasons why this information may be memorable for students. For LGBTQ+ students, the emotion of learning about a shared CSI with their instructor may make the experience memorable (Erk *et al.*, 2003; Talarico *et al.*, 2009). For non-LGBTQ+ students, this intervention may be an example of expectancy violations theory, because they are not accustomed to instructors revealing their LGBTQ+ identities to students (Burgoon, 2015). Further, instances that violate culturally based expectations (i.e., an instructor revealing their LGBTQ+ identity) have been shown to be especially memorable (Porubanova *et al.*, 2014). Indeed, many students in this study mentioned that an instructor revealing their LGBTQ+ identity is rare; the instructor of this course doing so likely challenged students' expectations and thus made the moment more memorable despite its short duration.

Our findings suggest that nearly all students perceive that the instructor revealing her LGBTQ+ identity during class had a widespread positive impact on them, regardless of whether they identified as members of the LGBTQ+ community. LGBTQ+ students reported perceiving a more positive impact compared with their non-LGBTQ+ peers, which aligns with previous literature that suggests that LGBTQ+ students having instructor role models would be helpful to them (Cooper and Brownell, 2016; Linley *et al.*, 2016). Additionally, women perceived a more positive impact compared with men. This may be due to straight women having more positive attitudes toward LGBT individuals than straight men (Woodford *et al.*, 2012), and/or because having an instructor who was a woman sharing personal information could make the sometimes chilly STEM climate more welcoming for women (Seymour and Hewitt, 1997; Christe, 2013; Seymour and Hunter, 2019). Further, students with a history of anxiety and/or depression perceived a more positive impact compared with students with no history of anxiety or depression, which may be attributable to a sense of connection formed from students to the instructor based on the commonality of having a CSI and dealing with the challenges of experiencing stigma, bias, and discrimination (Quinn and Earnshaw, 2011; Cooper *et al.*, 2020b). Prior research has shown that undergraduates with anxiety and depression hesitate to share these concerns with faculty (Cooper *et al.*, 2020b,c; Mohammed *et al.*, 2021); students report that they try to look for clues as to whether a faculty member would be receptive of a mental health concern, and being a member of the LGBTQ+ community may indicate that an individual is more understanding of an aspect of one's identity that is stigmatized (Cooper *et al.*, 2020b,c; Mohammed *et al.*, 2021).

Additionally, we examined the association between the impact students perceived of the instructor coming out and five specific outcomes. These outcomes included students' perceptions of changes in their 1) willingness to approach the instructor for mentorship, 2) feeling connected to the instructor, 3) confidence in their ability to pursue a career in science, 4) sense of belonging in the course, and 5) sense of belonging in the scientific community. LGBTQ+ students and women

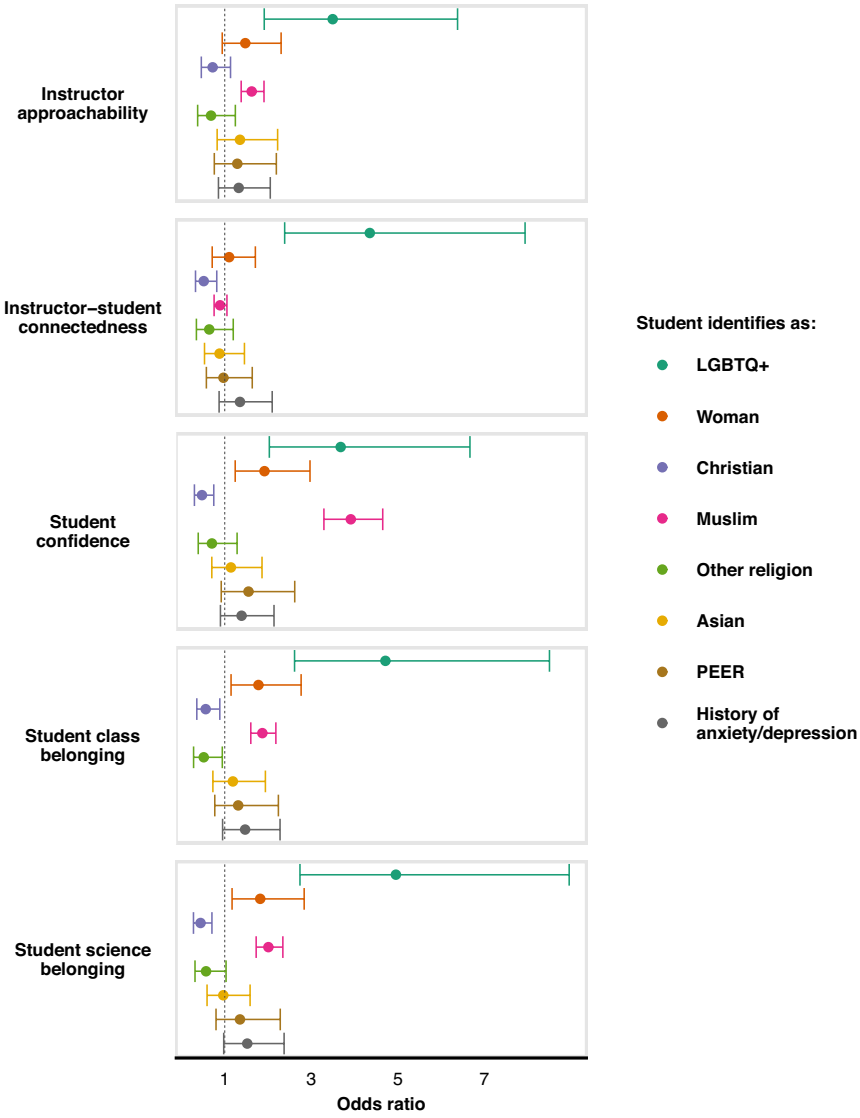

FIGURE 3. Odds ratios and estimated confidence intervals (natural exponential of beta ± 1.96 × SE) for LGBTQ+ students, women, Christian students, Muslim students, students of other religions, Asian students, PEER students, and students with a history of anxiety and/or depression for all five outcomes. Estimated confidence intervals that do *not* cross the dashed gray line at $x = 1$ are statistically significant. Reference groups are non-LGBTQ+, men, not religious, white, and no history of anxiety and/or depression. Outcomes are: 1) instructor approachability: willingness to approach the instructor for mentorship or guidance, 2) instructor–student connectedness: feeling connected to the instructor, 3) student confidence: confidence in their ability to pursue a career in science, 4) student class belonging: sense of belonging in the course, 5) student science belonging: sense of belonging in the scientific community.

reported perceiving more positive impacts on many of these outcomes compared with non-LGBTQ+ students and men, while Christian students agreed less strongly than not religious students. Given that LGBTQ+ students have been historically marginalized in STEM (Hughes, 2018; Cech and Waidzunas, 2021), are less likely to persist in STEM (Hughes, 2018; Maloy *et al.*, 2022), and report knowing few LGBTQ+ scientists (Cooper and Brownell, 2016), learning of a shared identity with their instructor was expected to have a notable impact on LGBTQ+ students (Shin *et al.*, 2016; Rask and Bailey, 2002). For women, the chilly climate of STEM disciplines has been found to affect persistence in STEM majors and attitudes toward the field (Seymour and Hewitt, 1997; Seymour and Hunter, 2019; Christe, 2013; Simon *et al.*, 2017; Jensen and Deemer, 2019), so learning of their instructor's LGBTQ+ identity likely provided a counterexample to the unwelcoming climate of STEM and resulted in them perceiving a greater increase in their confidence in pursuing a career in science, sense of belonging in the course, and sense of belonging in the scientific community. Christian students were consistently associated with lower perceived effects than their not religious peers, potentially due to the traditionally opposing LGTBQ+ views held by Christians (Woodford *et al.*, 2012; Worthen *et al.*, 2017; Wilcox, 2020), although it is important to note that not all Christians hold these views (Barnes *et al.*, 2021a). However, the majority of Christian students still reported that they perceived the instructor coming out positively impacted these outcomes. Researchers have argued that being a Christian can be a CSI in the context of academic STEM due to Christian graduate students in biology perceiving that the biology community holds strong negative stereotypes against Christians, which results in concealing their religious identity in order to avoid this anticipated stigma (Barnes *et al.*, 2021a). As such, it is possible that some Christian students perceived positive impacts because they also identified with having an identity that is not always welcomed in science (Barnes *et al.*, 2017, 2020; Barnes *et al.*, 2021a). Interestingly, this trend was not consistent for Muslim students. In fact, Muslim students were more likely to agree that the instructor coming out increased their willingness to approach the instructor, confidence to pursue a career in science, and sense of belonging in both the course and the scientific community. While more research needs to be done to understand this difference, one possible explanation is that the Muslim identity is broadly stigmatized in the United States (Lipka, 2017; Ahmadi *et al.*, 2018) and may also be stigmatized within the context of science (Barnes *et al.*, 2021b).

Despite these demographic differences, it is important to note that the majority of all students agreed that they perceived that the instructor revealing her LGBTQ+ identity increased their willingness to approach her for mentorship, feeling connected to her, confidence in their ability to pursue a career in science, sense of belonging in the course, and sense of

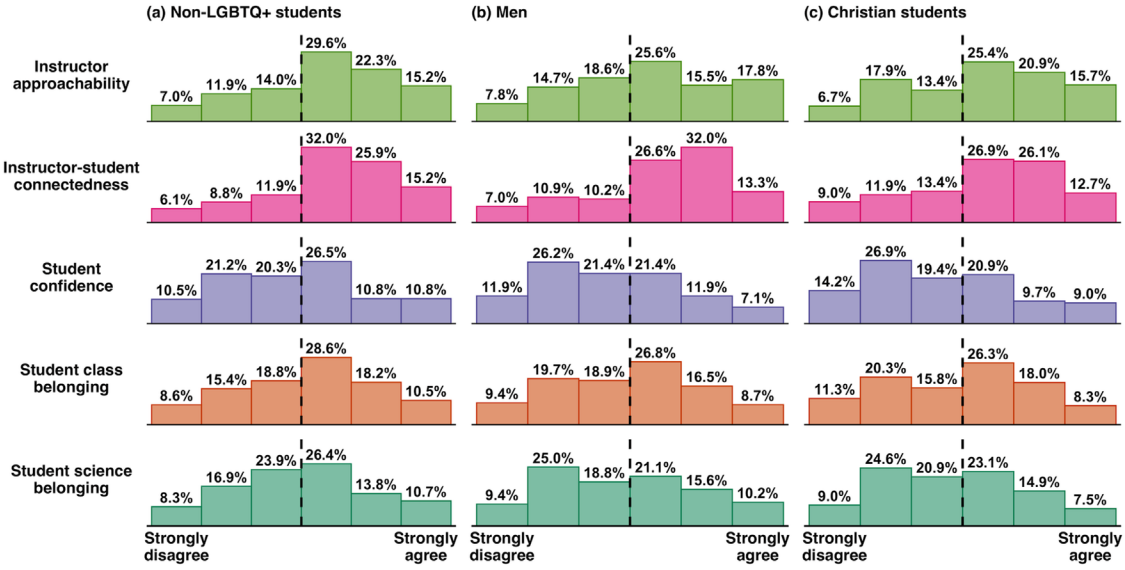

FIGURE 4. Responses for the five outcomes of interest from: (a) non-LGBTQ+ students, (b) men, and (c) Christian students. Outcomes are: 1) instructor approachability: willingness to approach the instructor for mentorship or guidance, 2) instructor–student connectedness: feeling connected to the instructor, 3) student confidence: confidence in their ability to pursue a career in science, 4) student class belonging: sense of belonging in the course, 5) student science belonging: sense of belonging in the scientific community. Responses to the right of the vertical dashed line indicate agreement with the statement, whereas responses to the left indicate disagreement.

belonging to the scientific community. Importantly, irrespective of LGBTQ+ identity, students viewed the instructor's decision to disclose her LGBTQ+ identity as positive because it humanized their instructor and helped students get to know her better (i.e., increased relatability). Most students (77.2%) agreed that they perceived that their instructor coming out increased how connected they felt to the instructor. Students feeling connected to the instructor can enhance the rapport instructors have with their students (Frisby and Housley Gaffney, 2015; Cooper *et al.*, 2018, 2020d), which has been shown to positively influence student participation and learning in the classroom (Frisby and Martin, 2010). Additionally, instructor connectedness has been shown to be related to an increase in student satisfaction (Micari and Pazos, 2016), and the quality of the student–faculty relationship has been found to positively predict student confidence and academic achievement (Micari and Pazos, 2012). Further, for students to feel more connected to their STEM instructors is often considered a way to create a more supportive and warmer learning environment rather than the typical impersonal climate of STEM (Seymour and Hewitt, 1997; Seymour and Hunter, 2019; Christe, 2013). In a study of online students, video introductions were found to be helpful for establishing a sense of connection with the instructor (Martin *et al.*, 2018), so the context of the instructor revealing her LGBTQ+ identity in her self-introduction at the beginning of the semester may contribute to its lasting impact on students.

Finally, the majority (96.1%) of students perceived that it is appropriate for a STEM instructor to reveal their LGBTQ+ identity during a course. LGBTQ+ instructors have expressed concern that revealing their LGBTQ+ identities is not appropriate in the context of STEM or the classroom (Cech and Waidzunas, 2011; Cooper *et al.*, 2019), and a study has previously shown that LGBTQ+ students were worried that their instructor revealing their LGBTQ+ identity may result in negative consequences for the instructor (Cooper and Brownell, 2016). The overwhelming student response that an instructor coming out during class is appropriate challenges these negative assumptions and suggests that current college students may have different perceptions of what is appropriate in the context of undergraduate college science courses. Our findings also provide evidence to counter another common reason instructors list for not revealing their LGBTQ+ identities to their students: that students will perceive them negatively because students have a negative opinion of LGBTQ+ people (Cooper *et al.*, 2019). Students' common perception that the instructor revealing her LGBTQ+ identity was both appropriate and had a positive impact on their overall course experience suggests that perhaps students' views of LGBTQ+ individuals have shifted in parallel with the recent national move toward acceptance of LGBTQ+ individuals (*Obergefell v. Hodges*, 2015; GLAAD, 2017; Goodman, 2018; *Bostock v. Clayton County*, 2020). However, we encourage caution in making generalizations, because our results could be unique to the context and location of this study, as well as this specific instructor.

Limitations and Future Directions

Because of the dearth of research in this area, we chose to conduct an exploratory study to see how a single LGBTQ+ instructor revealing her identity to students during class may affect students. The study design being exploratory in nature, rather than causal, limits the conclusions that can be made. Due to the structure of our survey questions, we were unable to discern whether a student disagreed with an item because they perceived a negative effect or no effect, so we were only able to assess changes the student perceived and attributed to the

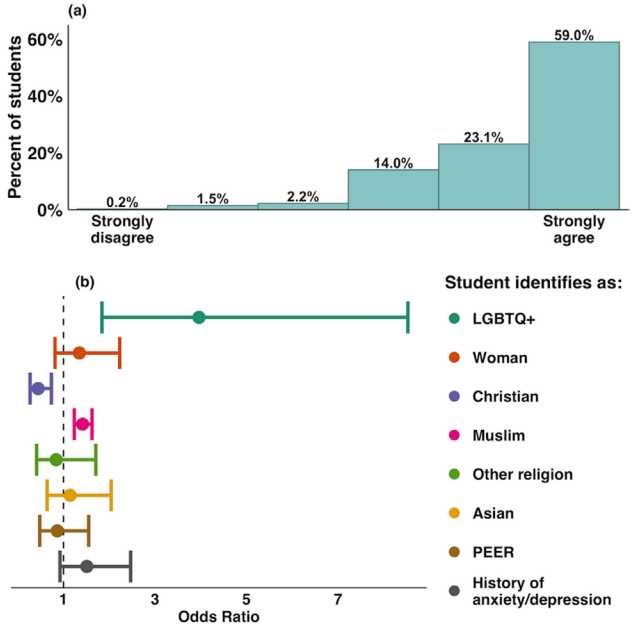

FIGURE 5. (a) Responses from students on whether a STEM instructor revealing their LGBTQ+ identity during class is appropriate. (b) Odds ratios and estimated confidence intervals (natural exponential of beta ± 1.96 × SE) for LGBTQ+ students, women, Christian students, Muslim students, students of other religions, Asian students, PEER students, and students with a history of anxiety and/or depression for the appropriateness model. Estimated confidence intervals that do *not* cross the dashed gray line at $x = 1$ are statistically significant. Reference groups are non-LGBTQ+, men, not religious, white, and no history of anxiety and/or depression.

instructor revealing her LGBTQ+ identity. Measuring constructs with single items limits how generalizable they are, but allowed us to assess a larger number of total outcomes in this exploratory study. The conclusions that we can draw from this study are limited to changes that the undergraduates perceived in these outcomes, as opposed to absolute values of these outcomes or direct measures of some of these outcomes. For example, we measured whether students perceived that they were more willing to approach the instructor for mentorship, but we did not measure changes in actual student behavior. Finally, we did not measure whether these changes were specifically caused by an instructor revealing their LGBTQ+ identity by using a comparison condition in which the same instructor did not reveal this identity. In the future, we plan to build on this exploratory study by conducting a nationwide study of the impact of multiple LGBTQ+ instructors coming out to students in their college biology courses, which will include survey items that distinguish among positive effects, negative effects, and no effects by using a pre–post design to measure our outcomes of interest and comparing outcomes to classes where the same instructors do not reveal their LGBTQ+ identities.

Given the importance of context when studying the LGBTQ+ identity (Worthen *et al.*, 2017), the geographic context of this research-intensive institution, which is located within an LGBTQ+-friendly municipality of a relatively LGBTQ+-unfriendly state in the United States, limits the generalizability of our findings (Rigel Hines, 2021). We also recognize that revealing an LGBTQ+ identity is a deeply personal decision and not an inherently positive experience for all individuals (Manning, 2015; Ryan *et al.*, 2015). As such, we respect that the decision to come out is not the right one for all individuals. Additionally, because this was one study with one instructor, we were unable to control for how additional characteristics of the instructor, including her gender (cisgender woman), race (white), and personality might impact the students' responses (Bennett, 1982; Glascock and Ruggiero, 2006; Joye and Wilson, 2015). To broaden the generalizability of this research, future studies could expand on these findings and evaluate the impact of instructors disclosing their LGBTQ+ identities on students across multiple courses, instructors, and institutions in different geographic regions.

We chose to approach our research questions quantitatively, as they build on prior qualitative studies conducted by our research teams (Cooper and Brownell, 2016; Cooper *et al.*, 2019). However, one potential source of bias in the students' responses to the survey is social desirability bias, defined as reporting perceived desirable outcomes to please the audience or to maintain a positive self-concept (Paulhus, 1984). Specifically, students may have felt inclined to say that they remembered the instructor revealing her LGBTQ+ identity at the beginning of the survey or to respond positively throughout the survey because the instructor was also part of the research team (as indicated on the signature line of the consent form on the survey). However, we took steps to reduce social desirability bias by ensuring students that the survey was completely anonymous, that there were no right or wrong answers to any of the questions, and that their instructor would not see their specific responses to any of the survey questions. It is also possible that this study was affected by acquiescence bias, defined as the tendency of respondents to select positive response options (Moss, 2016). In an effort to address this potential for bias, we asked students to explain their reasoning as to why they perceived the instructor revealing her LGBTQ+ identity had a particular effect on them. Our intent was that the requirement to explain their reasoning would reduce the chances that they would inadvertently select positive responses to questions (Kam and Meyer, 2015).

Further, the survey may have made students' feelings about the instructor coming out stronger or more salient, given that they were reminded of the event. The impact students attributed to their instructor coming out during class may have instead been caused by the survey itself reminding students of the event. While this exploratory study was designed to probe student perceptions of ways the instructor coming out affected them, future work can empirically test the hypotheses that arose from this study by assessing student outcomes in a quasi-experimental design.

We aggregated students of all LGBTQ+ identities due to the small number of students who identified as a gender outside the binary man/woman, but there are likely differences in the experiences of LGBQ students and those who are gender minorities, because transgender, nonbinary, and intersex individuals face greater discrimination than other members of the LGBTQ+ community (Atherton *et al.*, 2016; Harrison *et al.*, 2012; Maloy *et al.*, 2022). Aggregating students of various racial or ethnic identities as "Asian" or "PEER" may also obscure

TABLE 4. Themes that emerged from the student responses for why a STEM instructor revealing their LGBTQ+ identity would be appropriate or not appropriate

Theme	Description	% (*n*)	Student quote 1	Student quote 2
		Appropriate ($N = 408$)		
Empowers LGBTQ+ community and normalizes LGBTQ+ identities	Student reports that an instructor revealing their LGBTQ+ identity provides a role model for LGBTQ+ students and helps to reduce the stigma around LGBTQ+ identities.	28.9 (118)	LGBTQ+ student: "It allows students to connect, if my instructor is a part of the LGBTQ+ community, with someone who is already in an established career that is impressive."	Non-LGBTQ+ student: "I think it can inspire those in the LGBTQ+ community to see themselves represented in the STEM field."
Increases relatability and connectedness of instructor; helps students get to know them	Student reports that an instructor revealing their LGBTQ+ identity helps them relate to their instructor and makes it easier for them to form a relationship with and feel connected to their instructor.	27.5 (112)	LGBTQ+ student: "I think that this information is very, very personal and sharing this with the class forms a sort of trust between the students and the instructor that wouldn't be present otherwise."	Non-LGBTQ+ student: "It is important to know some personal facts to make the students feel more connected or even relate to the professor. It diminishes the intimidating feeling professors can give off."
It is the instructor's choice to decide what to share and they are free to share what they want	Student reports that an instructor revealing their LGBTQ+ identity is appropriate because the instructor has free speech and the freedom of choice on what information to reveal about themselves.	22.5 (92)	Non-LGTBQ+ student: "It is [the instructor's] choice and freedom to reveal their identity or not, so we should respect their choice."	Non-LGBTQ+ student: "[Instructors] have the right to reveal whatever personal information they'd like, as long as it is appropriate."
It is important to the instructor and who they are	Student reports that an instructor revealing their LGBTQ+ identity is an important part of the instructor's identity and therefore is important and appropriate to share with others.	18.9 (77)	Non-LGBTQ+ student: "It is important for [instructors] to feel comfortable being their authentic self. It is THEIR classroom and they deserve the respect."	Non-LGBTQ+ student: "I think it's a part of [the instructor's] identity and when teachers are introducing themselves to the class this is something they want to share. It's a part of who they are just like everything else."
Builds community and trust in the classroom	Student reports that an instructor revealing their LGBTQ+ identity helps to create an inclusive environment in the classroom and signals to students that all perspectives will be valued.	13.2 (54)	Non-LGBTQ+ student: "It created a more open and accepting environment [in the course]."	Non-LGBTQ+ student: "To know the class is accepting of all sexual orientations and beliefs [helps to] personalize the entire class."
Sharing an LGBTQ+ identity is the same as sharing other information or personal details	Student reports that an instructor revealing their LGBTQ+ identity is appropriate because instructors would share non-LGBTQ+ identities or other personal information without question and sharing an LGBTQ+ identity is no different.	9.3 (38)	Non-LGBTQ+ student: "Many instructors introduce themselves, show photos of their kids, wives or husbands, pets, and random things about themselves. I don't see anything wrong with this being one of those little things that an instructor shares if they so choose."	Non-LGBTQ+ student: "Because many professors will tell you if they are married or with kids or whatever. If the professor was straight nobody would blink an eye."
It does not impact the student's education or the instructor's ability to teach	Student reports that an instructor revealing their LGBTQ+ identity does not impact an instructor's ability to teach or a student's ability to learn in a course.	5.9 (24)	LGBTQ+ student: "As a member of the LGBT community myself, I am happy that the instructors feel comfortable and confident enough to share that about themselves with the class. This doesn't affect my learning in any way, but I appreciate knowing that a faculty member shares my experiences as part of this community."	Non-LGBTQ+ student: "It does not in my opinion add or take anything away from the quality of instruction or my experience/success in the class."

(*Continues*)

TABLE 4. Continued

Theme	Description	% (*n*)	Student quote 1	Student quote 2
		Not appropriate (*N* = 20)		
Not relevant to course material	Student reports that an instructor revealing their LGBTQ+ identity is irrelevant to course content.	65.0 (13)	Non-LGBTQ+ student: "[It is] irrelevant distracting information to the learning objectives of the course, same as if the teacher told everyone they were not a member of the LGBTQ+ community—extraneous."	Non-LGBTQ+ student: "I believe that this is not relevant to [the] course whatsoever. I do not believe anyone's sexual identity, whether it be straight, bisexual, transexual, even asexual, should be the topic in a course."
Makes student uncomfortable or student worries other students would be uncomfortable	Student reports that an instructor revealing their LGBTQ+ identity would make them uncomfortable or might make others in the course feel uncomfortable if their instructor revealed an LGBTQ+ identity.	25.0 (5)	Non-LGBTQ+ student: "It might intimidate students who hold opposing views, as they may think they will be graded harder or treated unequally to the rest of the students."	Non-LGBTQ+ student: "I don't have a problem with it, but it does make me uncomfortable."
Promotes certain beliefs or world views	Student reports that an instructor revealing their LGBTQ+ identity promotes a certain set of beliefs or morals.	10.0 (2)	Non-LGBTQ+ student: "Everyone is entitled to their own opinion and not everyone has the same views."	Non-LGBTQ+ student: "It pushes certain beliefs and other aspects onto the students when it doesn't affect my class at all. I just want to learn about biology, not current day politics."
Student does not care, or it does not matter to them	Student reports that an instructor revealing their LGBTQ+ identity does not matter to students, and they do not care if instructors choose to reveal or not.	10.0 (2)	Student (declined to state LGBTQ+ status): "Rather than being not appropriate, I don't think it matters whether they reveal something like that. […] I don't think it is necessary to reveal such information, but if an instructor does reveal that they are a member of the LGBTQ+ community, then it's fine."	Non-LGBTQ+ student: "I don't think it matters and it is something I don't care to hear about."
Feels forced or asking for attention	Student reports that an instructor revealing their LGBTQ+ identity is forced or unnatural.	10.0 (2)	Non-LGBTQ+ student: "In general, I do feel it was not appropriate to reveal such personal information. It almost felt forced."	Non-LGBTQ+ student: "A privilege I believe associated with the LGBTQ+ community is that no one will know you are a part of it unless it is mentioned. This differs from other marginalized communities. I personally feel that sharing one is a part of the LGBTQ+ community is asking for attention, but at the same time there could be a student in the class that needed to know this information."

some patterns in the data. Further, all of our models were additive, and examining the interactions between gender identity and LGBTQ+ status or racial identity and LGBTQ+ status may have had different effects. Future studies with larger, more diverse samples would likely be able to address these potential limitations and can also probe the student-level factors that are associated with not remembering the instructor revealing their LGBTQ+ status during class.

Finally, across outcomes, we saw that students enrolled in Fall 2020 during the COVID-19 pandemic perceived more positive impacts, which may be because these students experienced a greater benefit from feeling connected to their instructor and a sense of community in the course than they would have outside the context of the pandemic (Lederer *et al.*, 2021; Shim and Lee, 2020; Conklin and Dikkers, 2021; Mooney and Becker, 2021). Repeating this study in additional online and in-person courses will help assess whether this type of intervention is particularly impactful in online courses.

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