

Christian Student Experiences During Peer Interactions in Undergraduate Biology Courses

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ABSTRACT

The tension between religion and science as a long-standing barrier to science education has led researchers to explore ways of improving the experiences of Christian students in biology who can experience their Christianity as stigmatized in academic biology environments. As undergraduate science classes become student-centered, interactions among students increase, and Christians may feel a need to conceal their religious identities during peer discussions. In this interview study, we used the social psychology framework of concealable stigmatized identities to explore 30 Christian students' experiences during peer interactions in undergraduate biology courses to find potential ways to improve those experiences. We found that students felt their religious identity was salient during peer interactions in biology, and students thought revealing their religious identity to peers in their biology courses could be beneficial, yet few actually did so. Additionally, though most students *anticipated* stigma, comparatively few had *experienced* stigma from other students in their biology courses, despite the prior documented cultural stigma against Christians in biology. These results indicate a need for future studies exploring the impact of learning environments in which students are given the opportunity to share their religious identities with one another, which could reduce their anticipated and perceived stigma.

INTRODUCTION

To improve the long standing tensions between science and religion, science education has aimed to be more inclusive of Christian students who may struggle with perceived conflict between their religious and science identities (Southerland and Scharmann, 2013; Barnes and Brownell, 2017; Lindsay *et al.*, 2019; Tolman *et al.*, 2020). Though Christians are often privileged in the United States broadly, previous studies have asserted that Christianity is a stigmatized identity in the context of academic biology environments (Ecklund and Scheitle, 2007; Barnes *et al.*, 2017b). Specifically, Christianity can be considered a Concealable Stigmatized Identity (CSI) in academic biology (Barnes *et al.*, 2021a) because one's Christian identity is not typically apparent to others. As undergraduate science courses increasingly adopt active learning formats (Freeman *et al.*, 2014; Yannier *et al.*, 2021), student interactions in the classroom often increase in parallel. So, Christian students may increasingly be making decisions about whether to reveal or conceal their religious identity when interacting with their peers, and they may experience psychological distress that can affect their experiences in the classroom when they choose either option (Chadoir and Quinn, 2010; Newheiser and Barreto, 2014; Lynch and Rodell, 2018). Previous studies have indicated that students with anxiety, LGBTQ+ students, and students with disabilities (Eddy *et al.*, 2015; Cooper and Brownell, 2016; Cooper *et al.*, 2018a; Gin *et al.*, 2020) can experience identity-relevant challenges during peer interactions that force them to either reveal or conceal their identities, but little is known about the experiences of

Tati Russo-Tait, *Monitoring Editor*

Submitted Jan 30, 2023; Revised Nov 21, 2023;

Accepted Dec 15, 2023

CBE Life Sci Educ March 1, 2024 23:ar7

DOI:10.1187/cbe.23-01-0020

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Competing Interests: The authors declare they do not have any competing interests.

Funding: Funding for this project was provided by the National Science Foundation (NSF) Grant No. 1818659.

Author's Contributions: All authors contributed to this paper. B.A.E.: conceived and designed research, conducted interviews, analyzed interview data, interpreted results, drafted manuscript, and edited and revised manuscript; C.B.: analyzed interview data; S.E.B. & M.E.B.: conceived and designed research, analyzed interview data, interpreted results, and edited and revised manuscript. All authors read and approved the final manuscript.

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Christian students even though they comprise up to 65% of students in undergraduate biology classes (Barnes *et al.*, 2021c). Thus, in this study, we investigated the experiences of Christian students when they interact with their peers in undergraduate biology courses to better understand how to improve their biology education experiences.

Stigmatized Identities and CSIs

Stigmatized identities are identities that are devalued in specific social contexts, and they are associated with negative stereotypes (Steele *et al.*, 2002; Quinn, 2006). In a given context, individuals can be stigmatized based on various factors such as their physical characteristics, moral behaviors, and community affiliations. For example, individuals from certain racial/ethnic groups, individuals with mental health struggles or physical disabilities, and LGBTQ+ individuals have been shown to be broadly stigmatized in society; people can associate those identities with negative stereotypes and, thus, individuals with those identities often face negative biases and experience negative interactions when engaging with others (Sigelman and Tuch, 1997; Phelan *et al.*, 2000; Oswald, 2007). However, identities that are stigmatized in one country, culture, or social context may not be stigmatized in other countries, cultures, or social contexts; for example, an identity that is stigmatized in one culture may be privileged in another, or a majority-identity in society may be stigmatized in specific social contexts where individuals with that identity are either underrepresented or not in positions of authority and prestige. Further, people can anticipate stigma without actually experiencing that stigma, which is separate from the actual level of cultural stigma that exists within a culture or environment (Quinn and Chadoir, 2009). Although stigmatization can vary across different social environments, the consequences of stigmatization to a person's sense of belonging within that environment is almost always negative, and this negative impact can prime people to hide their stigmatized identities as a mechanism of protecting their sense of belonging within the environment (Bosson *et al.*, 2010; Newheiser and Barreto, 2014; Shalka and Leal, 2022). Though this is not possible for all identities, some identities are more easily concealed than others.

While gender or racial identities are typically visibly apparent during social interactions, other identities may not be obvious from one's physical appearance and are thus considered concealable stigmatized identities, or CSIs. Similar to other stigmatized identities, CSIs are context-dependent (Ikizer *et al.*, 2018); for instance, addiction is a CSI but affords less stigmatization in rehabilitation support groups than in broader society (Romo and Obiol, 2023). However, the concealable nature of CSIs makes them unique because individuals with those identities can make choices about whether and how they reveal their identity to those around them to avoid negative perceptions from others (Quinn, 2006). Though having the ability to make those decisions may seem advantageous, both revealing and concealing can have negative consequences. Revealing a CSI can be a difficult and potentially risky decision because revealing in an unwelcoming setting or to individuals who may hold bias against that identity can lead to ostracism (Lynch and Rodell, 2018) and fear of detrimental outcomes such as being discriminated against or even fired (Chadoir and Quinn, 2010; Newheiser and Barreto, 2014). However, choosing to conceal a

CSI can also have negative consequences, such as reducing an individual's sense of belonging in their environment (Newheiser and Barreto, 2014) and increasing their psychological stress about being perceived as inauthentic or unlikable by others (Quinn, 2006; Lynch and Rodell, 2018).

Christianity: Privileged in society, but a CSI in Biology

Generally, Christians are not considered stigmatized in the United States, and although the nation is becoming more secular, Christians still represent a majority religious identity (Pew Research Center, 2019; PRRI Staff, 2021) and are in many ways a privileged group nationwide. For example, though the US does not have an official religion, one of the primary Christian holidays, Christmas, is a federal holiday, and Sunday, the Christian holy day, remains a designated weekly day off in most educational and corporate settings. Thus, the typical calendar affords Christian students and workers the ability to practice their faith outside of their work hours, while the same is not true for non-Christian religious individuals (Blumenfeld, 2006; Seifert, 2007). Additionally, Christianity is perceived as closely associated with US culture and the American identity, whereas individuals with certain nonreligious identities, such as atheists, are often stigmatized and perceived as immoral in society (Edgell *et al.*, 2016; Stokes, 2017; Moon *et al.*, 2021; Rios *et al.*, 2021).

However, distinct from the broader society in the United States, Christians have been shown to be stigmatized in most academic biology contexts (Ecklund and Scheitle, 2007; Barnes *et al.*, 2017b, 2021a; Scheitle and Ecklund, 2018), in part due to perceived tension between religion and science. There is a long history of Christians who are creationists seeing to undermine the validity of evidence for evolution, which has established a religion versus science narrative in the United States (Szasz, 1971; Numbers, 2006; Shapiro, 2013). Indeed, having a Christian identity can affect student perceptions of topics often covered in undergraduate biology courses such as vaccines (Corcoran *et al.*, 2021), stem cell research (Bryant and Gudgin, 2008), reproduction (Pew Research Center, 2015a), and evolution (Funk, 2015; Pew Research Center, 2015b) in ways that are counter to the cultural norms and beliefs of many academic biologists. Those counter views have led to negative stereotypes and attitudes about religion and religious individuals among academic biologists and have fueled tension between academic biologists and Christians (Rios *et al.*, 2015; Barnes *et al.*, 2020c).

This presumed dichotomy between religion and science in the United States seems to influence undergraduate biology instruction, which can result in Christian students feeling stigmatized. The Christian identity is often conflated with having anti-science views without acknowledging the spectrum of Christian viewpoints that are compatible with science (Colburn and Henriques, 2006; Owens *et al.*, 2018). Although there can be potential compatibility between Christianity and evolution (e.g., multiple Christian organizations have declared being supportive of or neutral towards evolution (Pope Pius XII, 1950; Pope John Paul II, 1966; Masci, 2014; The Church of Jesus Christ of Latter-Day Saints, 2016), and there are many examples of Christians who accept evolution [The Clergy Letter Project, 2023]), many undergraduate biology instructors have been shown to be unwilling to discuss this potential compatibility due to their own negative attitudes towards religion

(Barnes and Brownell, 2016). While certain interpretations of Christianity and the Bible can conflict with the principles of evolution, such as a literal interpretation of the creation stories found within the Christian Bible or the belief that the Earth is 10,000 years old (Baker, 2012), there are many ways of reconciling a belief in a higher power with an acceptance of evolution (Gould, 1999; Colburn and Henriques, 2006; Konnemann *et al.*, 2016). Yet biology instructors tend to focus on the areas of conflict between religion and evolution when teaching about evolution, which propagates the thinking that one can either be a Christian who rejects evolution or an atheist who accepts evolution (Barnes *et al.*, 2020a). In a 2020 study, members of our research team surveyed students about their evolution acceptance and perceived conflict between religion and science and found that approximately 30% of biology students did not accept the evolutionary tenet that all life shares a common ancestor and over half of the sample did not think it was possible for someone to believe in God *and* accept evolution (Barnes *et al.*, 2020a).

Growing evidence suggests that there is a secular culture in academic biology environments that can affect Christian individuals in those spaces. Even though the majority of undergraduate biology students in the United States are Christian (Barnes *et al.*, 2021c), there is a strong underrepresentation of Christians in visible and privileged positions in biology. The majority of biology instructors do not identify as Christian (Larson and Witham, 1998; Liu, 2009) and only 4.7% of evolutionary biologists report believing in a higher power (Graffin and Provine, 2007); thus, the individuals with the most power and prestige in undergraduate biology classrooms, and who establish the cultural norms for a discipline, are likely to not be Christian. This creates an overwhelmingly secular culture in academic biology in the United States (Larson and Witham, 1998; Liu, 2009) that contributes to Christians feeling stigmatized, even as they exist in a majority at the undergraduate level.

Stigma against Christians has been reported by undergraduates, graduate students, and faculty in academic biology contexts in the United States. Christian undergraduate students report instances of undergraduate biology instructors saying anti-religious statements and making them feel like they need to leave their Christian identity outside of the biology classroom (Barnes *et al.*, 2017b). Notably, even if biology instructors do not discuss religion while talking about evolution, which is what most biology instructors do (Barnes and Brownell, 2016), Christian students assume that instructors will not be receptive to their Christian identity because they anticipate stigma (Barnes *et al.*, 2017b). Both graduate and undergraduate Christian biology students have reported anticipating negative reactions if they were to reveal their identities to other biologists, including a worry that they would not be seen as credible scientists if their colleagues knew they were Christian (Barnes *et al.*, 2017b, 2020c). When Christian students do reveal their identity to academic biologists, they can receive negative feedback from their colleagues and mentors that their Christian and science identities are not compatible (Barnes *et al.*, 2021a). However, Christian students also experience stigma when they choose to conceal their Christian identity; students report that their mentors, instructors, and colleagues make jokes at the expense of Christians without knowing they are in the presence of Christian colleagues and students whose sense of belonging can be compromised by flippant

anti-religious remarks (Barnes *et al.*, 2017b, 2021a). Additionally, for religious graduate students, concealing their religious identity has been shown to negatively correlate with identification as a scientist (Scheitle and Dabbs, 2021). In a recent study where we explored the experiences of Black Christian graduate students in biology, these students highlighted the burden of having to navigate the stigma of their race and their religion in biology spaces, with many of them indicating that their religious beliefs helped them deal with systemic racism in science, yet those religious beliefs also contribute to them feeling othered in academic biology (Google *et al.*, 2023).

Beyond just self-reports of anticipated and experienced stigma against Christians in biology, research has begun to document the actual cultural stigma that exists against Christians in academic biology (Ecklund and Scheitle, 2007; Barnes *et al.*, 2017b; Scheitle and Ecklund, 2018). Though most academic scientists do not perceive that science and religion have to conflict with one another (Ecklund and Park, 2009; Ecklund *et al.*, 2011), biology faculty themselves have reported having negative attitudes towards religion, particularly fundamentalist and evangelical Christian religions (Ecklund *et al.*, 2011; Barnes and Brownell, 2016). Further, in an audit study, although biology faculty did not show a negative bias towards Christian students broadly, they rated an evangelical biology Ph.D. applicant as less competent, less hireable, and less likeable than an identical applicant who did not reveal a Christian identity (Barnes *et al.*, 2020c). So, Christian students' worries and perceptions are somewhat validated by the self-reported attitudes and experimental audits of biology faculty themselves.

CSIs in Active Learning Courses

Active learning is a broad umbrella term used to describe teaching practices that are distinct from an exclusively passive lecture where students listen to an instructor (Cooper *et al.*, 2017; Driessen *et al.*, 2020). While active learning can take many different forms, according to Freeman and colleagues (2014), "active learning engages students in the process of learning through activities and discussion in class, as opposed to passively listening to an expert; it emphasizes higher order thinking and often involves group work". A meta-analysis of over 200 studies across undergraduate STEM has shown that active learning increases student conceptual gains and decreases student failure (Freeman *et al.*, 2014), which has prompted national recommendations to transform undergraduate science courses into active learning environments (AAAS, 2011; Singer *et al.*, 2013).

Studies investigating CSIs in the classroom have shown that when courses incorporate greater opportunities for peer discussion, as active learning courses often do, students with various CSIs feel they have more opportunities to reveal their identity to others (Cooper and Brownell, 2016). Additionally, students' CSIs may be more salient in environments such as active learning courses because the increased peer interactions may lead to increased social comparisons and instances of engaging in conversations that stray from the primary course content (Cooper *et al.*, 2018a, 2018b, 2020). Though sometimes that can be beneficial for building student relationships, it may present challenges for students with CSIs if they anticipate stigma from their peers about their identities or if they hold identities that they perceive are in the minority. For example, our research

group found that increased group work in active learning courses can cause students with LGBTQ+ identities to be reminded of their LGBTQ+ identity more frequently and be concerned about how other students would treat them because of their identity (Cooper and Brownell, 2016). We hypothesize that peer interactions during active learning biology courses may present additional challenges for Christian students as well.

We want to make clear that the experiences of Christians are fundamentally different than those of individuals with other stigmatized identities who are underrepresented in undergraduate biology, such as racial, LGBTQ+, and disability-related identities that have been subjected to racism, homophobia, transphobia, and ableism not just in biology, but in all of society (Bonilla-Silva, 2006; Harpur, 2009; Feagin, 2013; Nadal, 2013). Indeed, Christians are a privileged majority in society, a stigmatized minority in professional academic biology, and a stigmatized *majority* in undergraduate biology learning environments, differentiating them from students with other CSIs that are in the minority both inside and outside the classroom.

However, based on the limited research on the experiences of Christians in active learning biology, Christian students' experiences may overlap with those of students with other CSIs specifically in the context of peer interactions in biology courses where student identities can influence how they feel contributing in the classroom. A previous study that surveyed students found that highly religious students are less comfortable participating, have a lower sense of belonging, and feel less scientifically capable than their nonreligious peers in active learning biology courses (Henning *et al.*, 2019), which aligns with research on LGBTQ+ students (Cooper and Brownell, 2016; Henning *et al.*, 2019) and students with mental health struggles in active learning courses (M. Cohen *et al.*, 2019). This implies that, similarly to students with other CSIs, Christian students may feel their religious identity is especially salient when interacting with peers in their active learning biology courses, and it seems to negatively affect their experiences.

Thus, we set out to answer the following research questions through an interview study:

1. How, if at all, do Christian students feel their religious identity is salient when they are interacting with their peers in their undergraduate biology courses?
2. To what extent and why do Christian students reveal or conceal their religious identity when interacting with their peers in undergraduate biology courses?
3. How, if at all, do Christian students experience stigma about their religious identity when interacting with their peers in their biology courses?

Should the experiences of Christians in biology be considered an issue of inclusion?

Some may argue that it is unnecessary or even problematic to discuss Christians as a stigmatized group and seek to reduce stigma against Christians in biology. We acknowledge that Christianity has at times been weaponized against marginalized and minoritized groups in society, specifically indigenous groups, women, and LGBTQ+ individuals, and in no part condone these actions (Ronda, 1977; Ruether, 1998; Bjork-James, 2019). However, we assert that there is benefit to considering

Christianity as a stigmatized identity within biology for three reasons.

First, we posit that the perceived conflict between religion and science leads to barriers in scientific literacy and acceptance of science in the general public; if Christians feel stigmatized and antagonized in science classes, then they will likely adopt anti-science attitudes, which can negatively affect policy and funding decisions for science (Prewitt, 1982; Motta, 2018). Second, we argue that to maximize inclusion, it is important to consider inclusive practices for students even in majority groups – especially when they are known to become the minority at higher ranking positions in academic biology. For instance, the experiences of women in biology have been identified as an equity issue because even though they make up over 60% of undergraduates in biology courses (Eddy *et al.*, 2014; Eddy and Brownell, 2016; Cooper *et al.*, 2018b), they become increasingly underrepresented at higher ranking professional positions within academia, likely due to systemic inclusion issues, similar to Christians in biology (Wilkins-Yel *et al.*, 2022; Schmader, 2023). Further, many Christian students do not realize that they are in the majority in undergraduate biology courses because Christianity likely operates as an invisible majority; since at the professoriate level Christians are the minority, biology instructors may cue that everyone is secular, making Christian students *perceive* that they are underrepresented in the class even though they are likely part of the majority (Barnes *et al.*, 2017b). The perception of underrepresentation is sufficient to impact Christian student behavior and experiences in biology. Third, there is strong evidence that making college biology classrooms more inclusive for Christians will disproportionately benefit racially underserved students such as Hispanic and Black students. Black and Hispanic students tend to be more religious than white students (Barnes *et al.*, 2020b; Scheitle and Dabbs, 2021) and Black graduate students in biology are majority Christian and struggle with the anti-Christian narratives in the context of academic biology (Google *et al.*, 2023). Therefore, understanding and improving the experiences of Christian students in biology could disproportionately benefit racial minorities and help increase diversity in STEM, providing additional motivation to recognize and study Christianity as a stigmatized identity in biology.

Additionally, in this study, we decided to focus on Christian students specifically, rather than religious students broadly, for three main reasons. First, other religions are stigmatized differently than Christianity, which means that the experiences of non-Christian religious students during peer interactions in biology may differ from those of Christian students. In the United States, Christianity is primarily only stigmatized in science environments, whereas other religions such as Islam and Judaism are stigmatized in society more broadly through anti-Semitism and Islamophobia (Sunar, 2017; Casey, 2018; Mitchell, 2021; Mohamed, 2021). Therefore, the experiences of Muslim and Jewish students as stigmatized groups outside of the classroom may impact their experiences within the classroom, which may warrant that their experiences should not be collapsed with Christian students. Secondly, in this study, we explore the experiences of Christian students through the lens of CSIs, and exploring the experiences of students with other religious identities through that lens may not be as useful since other religious identities are often more visibly apparent.

Though some Christians wear crosses, in other religions, like Islam, it is customary for many or most followers to visibly indicate their religious identity (e.g., kippah, hijab; Lipka and Theodorou, 2016; Rahmath *et al.*, 2016), which means those identities may not function as CSIs in the same ways that Christianity does. The concealability of those religious identities often differs by gender and religiosity as well (Rahmath *et al.*, 2016; Pew Research Center, 2017; Schrijvers, 2020), adding further complexity and variability in the experiences of individuals with those identities. Third, religion is not a monolith. Within Christianity alone, individuals' experiences and perspectives can differ based on their religiosity and the specific denomination they subscribe to (Exline, 2003; Martin, 2010; Jensen *et al.*, 2019; Scott *et al.*, 2022), and other religions have different denominations, sects, and traditions as well that likely contribute nuance to the experiences of students with those identities. We therefore decided to explore the experiences of Christian students specifically rather than religious students broadly not for lack of interest, but because we realized that the experiences of Christian students are already quite variable and students with non-Christian religious identities warrant their own studies.

METHODS

All research was approved by Arizona State University's Institutional Review Board (protocol 00014955).

Recruitment

We recruited undergraduate students who identify as Christian at a research-intensive university in the southwestern United States. To recruit students, we emailed instructors teaching upper-division biology courses during the fall 2021 and spring 2022 semesters asking if they would forward a recruitment email to students currently enrolled in their courses. Twelve instructors teaching a variety of courses, including Evolution, Animal Physiology, Ecology Genetics, Cell Biology, and Bioethics, agreed to forward a recruitment email to their students.

The recruitment email stated that we were interested in learning about the experiences of religious students in biology, and it requested that religious students volunteer to participate in a 30- to 60-minute interview about their experiences in exchange for a \$20 Amazon gift card. The email then asked students to complete a brief survey if they were interested in participating in the study. Students who completed the survey were sent a link to sign up for an interview appointment, and if they signed up, they were sent an additional link to attend the virtual interview at their selected time. Though we recruited students with a series of religious identities, we will only be describing interviews conducted with Christian students for the reasons described above.

Pre-Interview Surveys

In our pre-interview survey, we asked students a variety of questions about their personal demographics and beliefs. First, we asked each student to select their religious identity, and we then asked the students who identified as Christian to select the denomination of Christianity they most closely identified with from a list of options. Additionally, we used four items from a previously published instrument to assess student religiosity based on their religious beliefs and religious behavior

(A. B. Cohen *et al.*, 2008). For example, students were asked to rank how much they agreed with statements regarding their church attendance and belief in God on a Likert scale of "Strongly disagree" to "Strongly agree." We then calculated students' composite average for their religiosity by assigning each Likert scale response a numerical value (Strongly disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly agree = 5) and averaging them.

We also collected data on students' views on evolution. Some Christian students' views on evolution may conflict with what is taught in biology courses and could therefore impact their experiences during peer interactions in those courses. Thus, we included a question from previously published instruments intended to help determine individuals' views on evolution and religion (Yasri and Mancy, 2016; Barnes *et al.*, 2020a). In that question, we provided students with a list of statements about evolution and asked them to select the statement that most closely aligned with their beliefs about evolution and religion. Each statement corresponded with a particular view of evolution. The list of statements and each statement's corresponding view of evolution can be found in the Supplemental Material.

We collected additional demographic information from each student, including their gender, race/ethnicity, parents' education level, and political identity, to document sociological variation among the participants. We also asked students about their year in school, intended career, and if they were majoring in biology to help us understand approximately how many biology classes they had likely taken during their time in college.

All survey questions that we analyzed are included in the Supplemental Material.

Interviews

At the beginning of each interview, we asked participants to consider their experiences from all of their current and previous college and university biology courses, including but not limited to the course they were recruited from, when answering our questions. To conduct the interviews, we used the CSI framework from social psychology (Quinn, 2006), which aims to understand the aspects of an individual's experiences that are unique to having a CSI, such as identity salience, instances where someone reveals or conceals their identity, impression management strategies, and anticipated and experienced stigma. The CSI framework had been used in a previous study to understand the experiences of Christian graduate students in biology programs (Barnes *et al.*, 2021a). We built upon the interview script that researchers used to elicit information about Christian graduate students by modifying and adding interview questions to direct our focus on students' experiences during peer interactions in undergraduate biology courses. For example, to collect data related to the CSI concept of "salience," or how noticeable or significant an identity is in a particular setting, we asked students questions such as "When you are interacting with peers in your biology courses, are you ever reminded of your religious identity?" A list of additional concepts we hoped to target in our interviews, as well as an example of the questions we asked to target each concept, is shown in Table 1.

A copy of all the interview questions that we asked participants can be found in the Supplemental Material.

TABLE 1. Concepts we sought to understand related to Christian students' experiences during peer interactions and interview questions we asked to target each concept

Concealable stigmatized identity (CSI) concepts	Interview questions
Salience (how noticeable or significant an identity is in a particular setting)	"When you are interacting with peers in your biology courses, are you ever reminded of your religious identity?"
Reveal (an individual's decision to tell others around them that they hold a particular stigmatized identity)	"Can you tell me about instances when you have revealed that you are religious to one of your peers in your biology courses?"
Conceal (an individual's decision to hide a particular stigmatized identity from others)	"Can you tell me about instances in your biology courses when you have had the chance to reveal to your peers that you are religious, but decided not to?"
Anticipated Stigma (an individual's concern that others will view or treat them negatively based on their stigmatized identity)	"If you were to tell a peer in your biology courses that you are religious, would you worry about what they would think about you? Why or why not?"
Experienced Stigma (the severity and frequency of firsthand experiences when an individual is treated negatively based on their stigmatized identity)	"Have any of your peers in your biology courses ever done anything that made you feel like they did not value you as a person who is religious?"
Impression Management Strategies (ways in which an individual controls how others perceive their stigmatized identities)	"Are there particular ways you talk about your religious identity with your peers to avoid any negative perceptions?"
Opportunities to Reveal	"Compared to a traditional lecture course, do you feel like there are more opportunities to reveal your religious identity in courses that incorporate peer discussion?"
Benefits of Revealing	"Talk to me about the potential benefits you see, if any, of revealing your religious identity to other students in your biology classes."
Benefits of Being Religious	"Talk to me about what you perceive are the potential benefits of being religious when interacting your peers in your biology courses."
Disadvantages of Being Religious	"Talk to me about what you perceive are the potential disadvantages of being religious when interacting with your peers in your biology courses."

All interviews were conducted by a single researcher (B.A.E.) to ensure consistency across interviews. B.A.E. conducted interviews with students and reached data saturation (Guest *et al.*, 2006). In total, 30 Christian students were interviewed about their experiences in their undergraduate biology courses. All interviews were conducted via a video-conferencing platform, and they averaged approximately 40-min in length. Each interview was audio-recorded and professionally transcribed for data analysis.

Interview Analyses

We used a combination of deductive and inductive coding methods to analyze the interview transcripts (Cho and Lee, 2014). First, after each interview, B.A.E. took notes on preliminary themes in the data. Once all interviews were conducted, B.A.E. read those notes and all the interview transcripts to compile a list of themes that appeared in the interviews related to the concepts in the CSI framework that we were targeting in our research questions, and she drafted a codebook that included the name and a detailed description of each theme. Then, S.E.B. and M.E.B. each read a unique subset of three to six interviews to confirm that the codebook captured the concepts present within them and revised the codebook. B.A.E. and C.B. independently coded five interviews and compared their codes to determine if any further revisions needed to be made to the codebook. Further revisions were then made to the codebook based on observations and discrepancies noted in both rounds of review. The final codebook can be found in the Supplemental Material.

Once the codebook was finalized, B.A.E. and C.B. used it to independently code five more interviews to ensure that the codebook was reliable and that the coding could be replicated by other researchers. The average Cohen's kappa value for the five interviews was 0.83, which indicates a high and acceptable level of agreement (Landis and Koch, 1977). B.A.E. and C.B. then independently coded the remaining interviews and compared their codes for each interview. If they disagreed on a code, they discussed the data and came to agreement about whether the code in question should be counted as present or absent.

We do not report the frequency of each theme in the results because our study design was qualitative in nature and, thus, the frequency may not reflect the true prevalence among a broader population of Christian undergraduate students. However, we do indicate when "most" students (two-thirds or more), "many" students (between one-third and two-thirds), or "some" students (less than one-third) mentioned a theme in their interview to help establish the prevalence of a theme. Additionally, we only report on themes that were present in three or more (10%) students' responses. However, themes only reported by two students are included in the Supplemental Material. All participant names were replaced with pseudonyms to protect student identity. Some students' quotes were lightly edited for clarity.

Positionality Statement

The authors acknowledge that our identities and ideologies influence this work. We hold a variety of religious beliefs and

TABLE 2. Aggregated demographics of students in the study

Student demographic	Participants n(%) n = 30	Student demographic	Participants n(%) n = 30	Participants n(%) n = 30	
Gender:		Christian Denomination:		Intended Career:	
Man	9 (30.0%)	Catholic	8 (26.7%)	Healthcare professional	15 (50.0%)
Woman	20 (66.7%)	Nondenominational	11 (36.7%)	Research scientist	10 (33.3%)
Non-binary	1 (3.3%)	Protestant	3 (10.0%)	Other	5 (16.7%)
Race/ethnicity:		The Church of Jesus Christ of Latter-Day Saints (LDS)	8 (26.7%)	Year in School:	
Asian	4 (13.3%)	Average Religiosity:	4.2/5	First year/Sophomore	15 (50.0%)
Hispanic or Latinx	10 (33.3%)	*View of Evolution:		Junior/Senior	15 (50.0%)
White	15 (50.0%)	Young Earth creationism	2 (6.7%)	Politics:	
Multiracial	1 (3.3%)	Old Earth creationism	2 (6.7%)	Extremely liberal	2 (6.7%)
Parent Education:		Creationism with some evolution	5 (16.7%)	Liberal	8 (16.7%)
Less than high school completed	4 (13.3%)	Humans only creationism	2 (6.7%)	Slightly Liberal	4 (13.3%)
High school diploma or GED	1 (3.3%)	Interventionist evolution	2 (6.7%)	Moderate	6 (20.0%)
Some college but no degree	3 (10.0%)	Theistic evolution	11 (36.7%)	Slightly Conservative	5 (16.7%)
Associate degree	1 (3.3%)	Deistic evolution	3 (10.0%)	Conservative	5 (16.7%)
Bachelor's degree	8 (26.7%)	Agnostic evolution	3 (10.0%)	Extremely Conservative	0 (0.0%)
Master's degree	8 (26.7%)	Atheistic evolution	0 (0.0%)		
Higher than a master's degree	5 (16.7%)				

*For the corresponding description of each view of evolution, see the Supplemental Material.

perspectives: one author was agnostic during childhood but is currently Christian, one author was atheist during childhood and college but is currently agnostic, one author was Christian during childhood and college but is currently atheist, and one author was Christian during childhood and is still currently Christian.

We were intentional about the roles each author took in the research process based on their religious identity. For example, studies have shown that perceived identity similarities and differences between interviewers and participants can impact the information that participants are willing to share during an interview (Edwards, 1990; Song and Parker, 1995); thus, B.A.E., who currently identifies as Christian, conducted all interviews with students. To further leverage our religious identities, all four authors reviewed at least 10–20% of the interview transcripts alongside the code book to ensure that our interpretations of the data aligned despite our differing religious identities. B.A.E. then coded all interviews with C.B., who also identifies as Christian.

We recognize that some of our other identities and experiences may have impacted this work as well. We all identify as women. B.A.E., S.E.B., and M.E.B identify as white and C.B. identifies as Black. We were all undergraduate biology majors, and B.A.E., S.E.B., and M.E.B. all received graduate degrees in biology and have taught undergraduate biology courses. Additionally, some of us hold other concealable stigmatized identities such as depression, anxiety, and are members of the LGBTQ+ community, which influences how we think about concealable stigmatized identities more broadly. One of us who identifies as a member of the LGBTQ+ community has experienced trauma related to Christians who ascribe to anti-LGBTQ+ Christian doctrine. Two of us have received negative messages from both anti-evolution creationists and antireligious atheists in response to our prior work.

Despite our different identities and experiences, we all have a shared philosophy that even though there are some areas of conflict between religion and science, there is potential compatibility between them and that we want to create inclusive undergraduate classrooms for all students. We are not proponents of teaching religion or teaching anything that would be considered antievolution in the classroom; however, we feel that students' religious identities and beliefs should be respected and welcomed in all courses. Those philosophies contributed to our conception of this work.

RESULTS AND DISCUSSION

Demographics

Of the 30 Christian students who we interviewed, most were women, White, and had parents who also went to college. The largest groups of students were nondenominational Christians, were politically liberal, and accepted evolution. Participants scored an average of 4.2/5 on our religiosity scale, indicating an overall high religiosity of the sample. Participants were predominantly biology majors (29/30), and half of them were in their junior or senior year of college. Half also planned to become healthcare professionals in the future. A full summary of the demographic information that we analyzed from the 30 participants is shown in Table 2.

Finding 1: Many Christian undergraduate biology students felt their religious identities were salient during peer interactions, and they felt they had more opportunities to reveal their religious identities in courses that incorporate peer discussion.

Many Christian undergraduate biology students felt their religious identities were salient during peer interactions; saliency increased when specific topics in biology were discussed

Christian students felt that peer interactions increased the salience of their religious identities in their biology courses. Many students explained that their religious identity was particularly salient when they discussed specific biological topics with their peers. As seen in previous investigations of Christian students in biology (Barnes *et al.*, 2017b), many students reported that they are reminded of their religious identity during peer discussions about evolution and bioethics. Students explained that those topics are unique both because they have the potential to conflict with their religious identity and because their personal opinions about those topics are informed by their religious identity. For example, Brooke, who accepts evolution, said:

Brooke (nondenominational): “[I’m usually reminded of my religious identity] during the evolution unit when things start getting brought up about creationism and how species evolve. I think that starts really getting at religious beliefs and how some people think they will not coincide with scientific discovery.”

Similarly, Olivia, who also accepts evolution, explained:

Olivia (nondenominational): “When we talk about subjects like evolution, people start talking about their own opinions on it. I’m reminded of my own religious identity because I know that my opinions are somewhat informed by my religion, and I’m reminded that other peoples’ opinions are also formed by their religion, or their lack thereof.”

Later in our interview with Olivia, when we asked whether she was reminded of her religious identity during discussions about any other topics, she replied, “In bioethics, yes. Because when we talk about things like informed consent, or when can a human consent to things, when is it taking away another human’s rights, it definitely reminds me of abortion debates.”

Further, some students explained that their religious identity was salient, not because of particular topics of discussion, but because of differences between themselves and other students that were revealed through peer interactions and conversations in biology environments more broadly. For example, Kristin, an LDS¹ student, stated that she is reminded of her religious identity during peer interactions in biology because she observes “what other people wear or how they act” during conversations and notices differences between their behaviors and her own. Thus, simply talking to peers in their biology courses reminded some Christian students of their religious identity.

¹Member of the Church of Jesus Christ of Latter-Day Saints

This finding implies that Christian students’ religious identities are salient during peer interactions in biology courses broadly but are especially salient during peer interactions centered around discussions of particular topics that are directly related to the tension between Christianity and science.

Compared to traditional lecture courses, Christian students have more opportunities to reveal their religious identities in courses that incorporate peer discussion

In contrast to traditional lecture courses, most students stated that they had more opportunities to reveal their religious identity in courses that incorporated peer discussion, and they cited multiple reasons for why this was the case. Many students reported they had more opportunities to reveal their religious identity in courses that incorporated peer discussion simply because they had “more communication” with other students in those courses, in part because of “small group discussions,” and because “having discussion allows a space for revealing one is religious.” For example, Macie explained that when students talk to each other more in their science courses, religion is more likely to come up in discussion:

Macie (nondenominational): “If my peers and I are talking more frequently versus sitting and listening to a lecture, then obviously we’re going to be discussing all sorts of topics and fleshing things out...Most of the time when I’m in science, I’m thinking about God and I’m thinking about his involvement in the design of all sorts of scientific concepts. So, the more that I talk to people, the more my thoughts about God’s involvement in science are going to come up, and the more opportunities there are to share them.”

Some students, like Molly (LDS), also felt they had more opportunities to reveal their religious identity in courses with peer discussions because they are often closer to their peers and “develop friendships and relationships with them” in those courses.

Though most students felt that they had more opportunities to reveal their religious identity in courses that incorporated peer discussions than in traditional lecture courses, some students reported that they did not perceive that they had the opportunity to reveal in either course modality. Those students explained that even when their biology courses incorporate peer discussions, their religious identity is not relevant to most course discussions, so they do not perceive an opportunity to reveal it. For instance, Erica said:

Erica (Protestant): “In these discussions...we speak about specific events or specific processes...I just don’t think [religion] really comes up in many of these peer discussions because we have a focused goal.”

Likewise, Trinity said:

Trinity (nondenominational): “It’s not something that I would bring up in a discussion post. Like if we had to discuss things in class, it’s really the last thing I would bring up because it’s not immediately relevant.”

STEM environments have frequently been described as neutral or even “chilly” spaces where discussions of personal

identities are absent (Malcom and Feder, 2016; Wilkins-Yel *et al.*, 2022). That coupled with the secular culture of biology may contribute to students feeling that even when they are engaging in more conversations with their peers, their religious identity does not feel relevant.

In summary, most students felt they had more opportunities to tell their peers that they are religious in courses that incorporate peer discussion because students in those courses talk to each other more often and develop closer relationships with each other.

Finding 2: Even though Christian students perceive potential benefits from revealing, they anticipate stigma and rarely reveal their religious identity when interacting with peers in their biology courses.

Christian students perceive that revealing they are religious during peer interactions in biology courses can be beneficial

We found that Christian students perceive various benefits of being religious and revealing that they are religious during peer interactions in their biology courses. Similarly to Christian graduate students (Barnes *et al.*, 2021a), some students expressed that by revealing their religious identity, they could correct misconceptions about religious individuals in biology and show both their religious and nonreligious peers that it is possible for someone to believe in science and also be religious. For instance, Melody (Catholic) explained that telling peers in her biology course that she is religious is beneficial because she could “show them a new background” and prove “that you can be religious and study evolution openly.” In another example, Camila said:

Camila (Catholic): “One benefit [of revealing] is changing the stereotype that people who are religious can’t believe in science...showing that we can believe both might make other people feel valid in their identity as both a religious person and a scientist.”

We also found novel reasons why students felt it was beneficial to reveal to their peers that they are religious. For example, many students claimed that a benefit of revealing is that *they* could find peers who are also Christians. For instance, Sofia (Protestant) said, “A huge benefit to me would be if I were to tell someone that I was Christian, and they were also Christian,” and similarly, Daniel said:

Daniel (LDS): “the biggest [benefit] is there are so many members of my church at [my institution]...sometimes I’ll say something about church and someone else will say, “Oh yeah, I’m also a member of that church. I go to this other congregation.”

This finding is unsurprising; previous studies on homophily, or the tendency for individuals to be drawn towards others who are like them, have shown that similarity fosters connection, and people’s personal networks tend to be largely homogenous in regards to many sociodemographic, behavioral, and personal characteristics (McPherson *et al.*, 2001). Though Christian students may find it beneficial to find other Christian students in many of their courses, it may be particularly helpful in biology environments because they seem to perceive they are in the minority in those contexts despite likely being in the majority.

More surprisingly, some students felt they benefitted when their peers revealed that they were religious, regardless of whether their peer was also a Christian. For instance, when asked how revealing her religious identity to her peers may be beneficial, Amie (LDS) said, “I feel like a huge potential benefit would be making somebody else comfortable enough to reveal [their religious identity] as well.” Christian students may feel they benefit from finding other religious peers regardless of the peers’ religious identity because they often perceive they are in the minority as a religious individual in biology, not just as a Christian individual in biology, or perhaps Christian students suspect that if revealing their religious identity is beneficial for them, their peers may also benefit from revealing their own religious identities.

Finally, many students said that revealing their religious identity to peers in their biology courses is a vulnerable experience, so it is beneficial because it helps them grow closer to and “strengthen [their] friendships” with their peers. For instance, Macie discussed that revealing that she is religious allowed her to build deeper friendships with her classmates:

Macie (nondenominational): “I think that [revealing my religious identity] would cultivate deeper friendship, like revealing any information does. The more information you reveal towards other individuals, the more vulnerability, usually that creates closer connection. And I’ve seen that when I do share with people.”

Though revealing a stigmatized identity can be risky because others can respond negatively (Chaudoir and Quinn, 2010; Lynch and Rodell, 2018), previous studies have shown that self-disclosure, or revealing personal information to another person, plays an important role in the building and maintaining of relationships (Altman and Taylor, 1973). Additionally, self-disclosure correlates with liking others more; people like others more who disclose more, people disclose more to others who they like, and when people disclose to others, they like the others to whom they have disclosed more afterwards (Collins and Miller, 1994). Thus, it makes sense that Christian students felt that revealing helped them deepen their relationships with peers in their biology classes, specifically when those who they revealed to reacted positively despite the stigma against Christians that is present in biology environments.

Because we found that students have more opportunities to reveal their religious identity in courses that incorporate peer discussion, students are likely better able to reap these benefits of revealing in courses that incorporate peer discussion. Because active learning courses are known to incorporate increased peer interactions, they are likely spaces where Christian students are better able to reap the benefits of revealing to their peers. However, as noted previously, revealing one’s stigmatized identity can come with tradeoffs, such as experiencing potential stigma from others. Therefore, to fully grasp how active learning may impact Christians, it is also important to understand both how Christian students think their peers will react and how their peers actually react when they reveal their religious identities.

Christian students anticipate stigma during peer interactions in their biology courses

Despite perceiving that revealing their Christian identity during peer interactions can be beneficial, most students expressed

that they anticipate a negative social evaluation of their identity when telling their peers that they are religious.

As we have seen in previous studies (Barnes *et al.*, 2017b, 2021a), most students worried that if they were to reveal that they are religious, their peers would judge, stereotype, or make assumptions about them. For example, many students expressed concern that if their peers found out they were religious, their peers would assume that they “do not accept scientific topics” such as evolution. Many students also worried their peers would think they were less scientifically capable or could not be a scientist because they are religious. Other students felt that their peers may make false assumptions about them beyond their scientific beliefs and capabilities. For example, some students said they thought their biology peers would assume they are controlled by their religion or “don’t form [their] own opinions.” Similarly, some students worried that their peers would view them as “naïve” individuals who “ignore evidence” or “bury their heads in the sand” because they are religious, which may have been particularly prevalent due to the context of biology courses and the stereotype that religious individuals do not accept science. Some also said they worried that if they revealed that they are religious, their peers would think they would “try to invite them to church” or try to convert them. Others expressed concern that if their peers knew they were religious, their peers may assume they are “judgmental,” “condescending,” or “closed-minded” towards others and their beliefs. Finally, some students were concerned that their biology peers may apply stereotypes to them based on their specific Christian denomination. For instance, Megan expressed that she worried her peers would associate her with the actions and proclaimed attitudes of the Catholic church:

Megan (Catholic): “Catholics don’t have the best image. So, I do worry, okay, well, they know that I’m Catholic, do they think that I support these bad things?...There are years of homophobia and racism embedded into the actual religion...I would just hate for someone to have that idea of me...If they think that I’m someone who believes in those ideologies, then it would just make me feel so terrible.”

Beyond stereotypes, many students worried that revealing their religious identity would negatively impact their relationships with their peers. As seen with Christian undergraduate students in biology more broadly (Barnes *et al.*, 2017b), many students worried that revealing their religious identity during peer interactions could lead to “arguments,” “conflict,” or “tension” with their peers, especially if their peers strongly disagreed with their faith. Jamie expressed that idea when they said, “When you talk about religion in a biology course..., fighting and really heated arguments are a huge risk.” Many also worried that their peers may exclude them from study groups and group projects or may choose not to “talk to [them] or sit by [them] anymore” after finding out they are religious. For instance, Ira emphasized that she worried her education would be negatively impacted if she told her peers she was religious because they would assume she is someone who “must not believe biology, [even though] that’s completely false”:

Ira (nondenominational): “I don’t like when people put me in a box and I’m not able to get out...because I don’t think it should be my job to justify my religious beliefs to other people.

I don’t want my education to be affected because of the box that somebody else puts me in.”

Additionally, some students were concerned that, by revealing they are religious, they may make their biology peers feel uncomfortable because it is typically assumed that most people in biology are not religious. For instance, Olivia explained that her revealing may make her peers feel uncomfortable if they have had negative experiences with other religious individuals in the past:

Olivia (nondenominational): “I think a lot of Christians here in America are very homophobic or prejudiced against people who don’t live the same way that they do, and I don’t want somebody to think that I would judge them in that way. So that’s concerning to me because if I say, “Well, I’m Christian,” and they’ve had poor experiences with Christians being hateful before, then I don’t want them to feel uncomfortable.”

All in all, we saw that during peer interactions in their biology courses, most students anticipated stigma about their identities in the form of stereotypes, social consequences, or potential conflict and tension.

Most Christians rarely reveal their religious identity to peers in their biology courses

Students’ anticipated stigma seemed to impact their tendency to reveal their religious identity to their peers. Even though students recognized that revealing their religious identity could be beneficial, most reported that they did not reveal to peers in their biology courses, and many said that they never or rarely reveal because of the stigma they anticipate when doing so. For instance, Diego (Catholic) explained that he had never revealed to a peer in his biology class, and, when asked why, he said, “Religious people that study science can be looked down upon...I don’t want to be associated with the concepts and biases people may have towards religious people.” Another student, Lori, also expressed that her fear of stigma reduced her willingness to reveal her religious identity specifically in biology courses when she said:

Lori (nondenominational): “It is very scary to bring up anything regarding faith...especially in biology where most people are very academically minded and don’t believe in God. You do fear that people will stereotype you as judgmental, conservative, or not one to have fun or talk about certain things. So anytime those situations come up where I can mention my faith, I do hesitate and I wonder, ‘Is this going to change how they perceive me, or will we still be friends, or will they get annoyed and ignore me?’”

Some students also explained that they never or rarely reveal their religious identity to their peers because they feel as though it would be strange or unnatural to bring it up during their peer interactions. For instance, Sofia explained that she rarely tells her peers that she is religious because religion does not come up in discussions with them:

Sofia (Protestant): “[Religion is] not something that most people come up to you and ask about...We tend to talk about other things in our lives or about ourselves, not necessarily religion.”

Students like Sofia often mentioned that even though they discuss noncontent material with their peers during their biology courses, they do not discuss the topic of religion. It is possible that these students unconsciously attempt to conceal their religious identity to avoid stigma from their peers by discussing topics other than religion when conversing with them. However, as found with Christian graduate students (Barnes *et al.*, 2021a), many undergraduate students specified that they would “always be open to mentioning” their religious identity if an opportunity presented itself. Kristin (LDS) expressed this idea when she said, “If somebody asked me about my religion, I would definitely explain, but it’s never really been brought up.” Similarly, Camila said:

Camila (Catholic): “I don’t think I’ve ever had an opportunity to [reveal my religious identity]...I would only talk about it when it’s relevant to what’s being discussed in the class, and I don’t think I’ve ever had an opportunity in which [my identity] was relevant and I still held back in talking about it because I didn’t want to.”

In contrast, some students did say that they frequently revealed their religious identity to peers. For instance, Javier (Catholic) explained that he “probably talks about [his religious identity] every day at some point.” Similarly, Iris (nondenominational) estimated that if she were in a peer group of five students in one of her biology courses, four of them would probably know that she was religious because she had revealed to them previously.

Here, we saw that even though students claimed that their identities are salient during peer interactions and that they have increased opportunities to reveal their religious identity in courses that incorporate peer discussions, most choose not to reveal their religious identity during peer interactions in their biology courses. We hypothesize that this inconsistency may have arisen from a variety of potential factors. Just because students reported that their religious identity was salient during particular peer interactions in their biology courses does not necessarily mean they perceive that those salient times are opportunities for them to reveal. Though they are personally reminded of their religious identity during those peer interactions, they may feel uncomfortable due to anticipated stigma. Additionally, even though students may be reminded of their own religious identity during a peer interaction, they may feel their religious identity is not relevant enough to others or to the discussion to warrant revealing during those interactions, especially given the culture of STEM environments to often leave identities outside of the classroom and the secular culture of biology that is not welcoming to religious identities. Similarly, though students recognize that they theoretically have more opportunities to reveal their religious identity in courses that incorporate peer discussion, they may not actually recognize those opportunities to reveal in the moment as they engage with their peers. In practice, simply talking to their peers more often in their biology courses may not actually be enough for Christian students to feel they are able to reveal their identity during those discussions.

Various factors impact students’ willingness to reveal their religious identity to their peers in biology courses, and when they reveal, they often do so in particular ways to avoid negative perceptions

Most students reported that they would be willing to reveal their religious identity to peers in their biology courses if it was relevant to the conversation. However, a variety of factors beyond relevance also impacted students’ willingness to reveal to their peers. As found in our previous study on Christian graduate students (Barnes *et al.*, 2021a), many students in this study reported that they would reveal if their peer seemed “open-minded,” “accepting,” and willing to respectfully listen to them, but they would not reveal if their peer seemed “closed-minded,” “critical,” or “aggressive” towards others’ views. Many students also expressed that they would be more willing to reveal to someone if “they considered them a friend” than if they had recently met the peer or if they were just “acquaintances.” Finally, many students said that they would reveal that they are religious if they knew their peer was also religious.

Notably, some students also said they would reveal if they felt that doing so could help their peer learn more about Christianity. For example, Levi (Protestant) explained that he felt his biology classes provided an opportunity to share his religion with his peers by “planting the seed,” and Allan expressed a similar sentiment:

Allan (LDS): “Maybe someone is curious about religion, and they want to learn more. I think me being able to reveal my religious identity could help them find more fulfillment or happiness in their life.”

Here, we saw that even though some Christian students anticipate stigma when revealing their religious identity because they do not want their peers to think they are trying to convert them, some Christian students do reveal in hopes of introducing others to Christianity. Thus, we see that some students fear being associated with actual behaviors of some of their Christian peers in their biology courses.

When students did decide to reveal to peers in their biology courses, most of them reported trying to do so in particular ways by using impression management strategies (Chadoir and Quinn, 2010). Impression management strategies can help students with CSIs to avoid the negative stereotypes and stigmatization of their personal identities when they reveal their identities to others. Like Christian graduate students (Barnes *et al.*, 2021a), many students in this study reported that when they revealed to their peers, they often used self-group distancing strategies (Roberts, 2005) by pointing out aspects of their own character or behaviors that separate themselves from negative stereotypes their peers may hold against religious individuals. For example, some said that, when they tell their peers that they are religious, they explicitly state that they also accept science. Some also explained that they tell their peers they have progressive political views when they reveal to distance themselves from stereotypes about religious individuals’ political beliefs. Similarly, some students explained that when they reveal to their peers, they indicate that even though they are religious and believe in the foundational ideals of Christianity,

they do not believe in some of the controversial ideas and behaviors of their church, its leaders, or its followers. Additionally, some undergraduate students in this study described that when they revealed to peers in their biology courses, they would intentionally speak positively about their religion to shut down any negative perceptions from their peers (Roberts, 2005).

We also found various novel impression management strategies that undergraduate students used when revealing. For example, many students explained that when they talk about their religious identity in a biology class, they are careful not to push their religion on their peers, and they make it clear they are not trying to convert them. For instance, Connor expressed that he would talk about his religion with his peers if they were to bring it up, but he would not discuss it without prompting:

Connor (nondenominational): “I guess I’m just not the type of person who really wants to push my beliefs on top of everybody. Even with my friends, if they want to talk about God or get closer to God, I’m not the one who usually brings it up because I don’t want to be the one who’s forcing my way onto them. But if they do bring it up, then that’s when I’ll jump in. I think that’s more inviting and not as overbearing.”

Again, here, we found that even though some students wanted to reveal their religious identity to encourage their peers to consider becoming religious, many other students actively attempt to reveal in a way that separates themselves from stereotypes related to converting others.

Some students also said that they discuss their religious identity casually or in a “laid back” manner when they reveal to peers in their biology courses by making it seem as if their faith is “not a big deal” to them or by revealing more general information about their religiosity rather than specific details about their religious affiliation, practices, or beliefs. For example, Maria (nondenominational) explained that she is comfortable telling her peers that she attends church but does not feel comfortable stating that she believes in God. In another example, Amie explained that she would feel comfortable telling her peers about the morals she holds because of her religious identity, but would not feel comfortable sharing that she is LDS:

Amie (LDS): “I don’t ever reveal exactly what church I’m from, but I’ll reveal my philosophies...I wouldn’t feel comfortable just going out and saying I’m a member of the Church of Jesus Christ of Latter-day Saints, but I would feel comfortable talking about how it’s important to love everybody as you would love yourself and how it is important to always be honest and kind.”

To summarize, various factors impact whether a Christian student is willing to reveal their religious identity to peers in their biology courses, including the open-mindedness of the peer, the closeness of their relationship with the peer, and the peer’s religious identity. Additionally, when they do reveal, Christian students use specific impression management strategies to avoid negative perceptions that they may expect their peers to hold due to the stigma against Christians and secular culture in academic biology environments.

Finding 3: Christian students experience less stigma than they anticipate when interacting with their peers in biology courses.

Previous studies have found that Christian students have a mixture of both positive and negative experiences related to their religion when interacting with faculty members, instructors, and members of the biology community more broadly (Barnes *et al.*, 2017b, 2021a). However, we found that despite their *anticipated* stigma, few of the Christian students in our study actually *experienced* stigma during peer interactions in their biology courses, and most students who revealed instead had positive experiences.

Some students did report that they had experienced stigma during peer interactions in their undergraduate biology courses. For example, similar to previous studies (Barnes *et al.*, 2017b, 2021a), some students explained an instance in which one of their peers had assumed that religion and science were incompatible. For instance, Camila explained that one of her peers assumed that religious individuals did not believe in evolution:

Camila (Catholic): “There was a person who was talking about how they sort of thought it was ridiculous that people who are religious don’t believe in [evolution] because there’s so much evidence for it. So, I spoke up and I was like, ‘Well, I’m religious. And yeah, I believe that there’s a God. And I still think evolution is real. And I think that it’s a natural thing.’”

Some students also expressed that they had heard a peer in their biology course make negative comments or jokes about religious people. For instance, Maria (nondenominational) cited an experience in which someone called religious individuals “foolish” during a peer discussion. Similarly, Brandon explained that he heard some of his peers in a biology course discuss that “being religious sucks”:

Brandon (Catholic): “They were just random classmates of mine. They were discussing evolution and saying, ‘Yeah, I don’t believe in God, blah, blah, blah.’ It turned into, ‘Being religious kind of sucks. I’m atheist. I don’t believe in God,’ and more and more of them joined in.”

Here, we saw that, like Brandon, Maria, and Camila, almost all of the students who experienced stigma only experienced it from peers who *did not know* they were religious. Thus, it is likely that their peers made assumptions that students in a biology course would not be religious, and because Christianity is concealable, people inadvertently made negative comments about religious individuals without knowing that a Christian, or multiple Christians, were present. However, many students explicitly stated that they had never experienced stigma when interacting with their peers in their undergraduate biology courses when they had revealed that they were religious. For instance, Trinity said:

Trinity (nondenominational): “My religion is not something that I’ve been made fun of for or anything like that...Everyone is very inclusive and supportive...The way I see it, everyone just has a neutral disposition to it. They’re not super excited. They also don’t hate it. They just don’t really care...Everyone is really easygoing, really supportive, really friendly. And I’ve

never faced anything negative because of my faith or anything like that. So, it's fortunate. It's very nice."

Some even explicitly recognized that they anticipated stigma during their peer interactions in their biology courses despite never having experienced any. For example, Molly explained that her fear of judgment is unfounded based on her personal experiences with her biology classmates:

Molly (LDS): "Every once in a while, when I'm having discussions with my peers [in my biology courses], there's this thought in the back of my mind that they're going to find out that I'm religious, and they're going to be some way about it. Although, in the time I have mentioned that I'm religious, there really hasn't been any pushback, which I think is interesting. Because [my anticipated stigma is] pretty much unfounded in my actual experiences."

In fact, most students reported that they had had a neutral or even positive experience when they told their peers they are religious. For instance, after explaining that he revealed his religious identity to a small group of peers in his biology class, Allan described his peers' reaction:

Allan (LDS): "It went really well...No one was overtly objecting to my beliefs or challenging me. People had differing opinions, but it wasn't contentious at all. It was an amicable conversation."

Julia explained a more positive experience in which she became friends with a peer after revealing to them that she is religious:

Julia (Catholic): "I remember the very first time I met one of my now friends, we were just talking about religion. She's Muslim, so we just had a very nice conversation about our [religious] upbringing and bringing biology into that, which was very interesting."

To summarize, though most Christian students anticipate stigma from peers in their biology courses about being religious, comparatively few students had experienced such stigma, especially when they had revealed that they were Christians. While this may be because students are not revealing their identity very often, it also could mean that Christian students' anticipated stigma does not manifest into actual stigma during peer undergraduate interactions as it does in postgraduate biology environments (Barnes *et al.*, 2021a) or with professional biologists (Barnes and Brownell, 2016, 2018; Barnes *et al.*, 2020c), perhaps because even if they do not realize it, many of their peers are religious. Thus, the cultural stigma against Christians that has been documented in professional academic biology environments may be less pronounced in undergraduate biology environments with interactions between peers at the undergraduate level.

This difference between anticipated and experienced stigma is also comparable to the difference between the degree of perceived and actual conflict between religion and science. Christian students' anticipated stigma may be increased by either their personal misconception that religion and science conflict or a concern that their peers may hold that misconception.

Therefore, reducing the degree of perceived conflict between religion and science may also reduce religious students' anticipated stigma during peer interactions in biology courses.

Intersectionality of identities likely impact student experiences during peer interactions

Student identities do not impact their experiences in isolation. When individuals have multiple stigmatized identities, their experiences of stigma related to one identity can differ based on the other stigmatized identities they hold, adding nuance to their holistic experiences (Crenshaw, 1989, 1990; Remedios and Snyder, 2015; Morrow *et al.*, 2020; Chatzitheochari and Butler-Rees, 2022). Thus, Christian undergraduate students likely have different experiences during peer interactions in biology based on their other identities, such as their racial or ethnic identities.

Though we did not specifically ask students how their other identities may impact their experiences as a Christian, multiple students brought up the influence of intersectionality unprompted. For example, Julia (Catholic) expressed that her experiences as a Latin* student were highly intertwined with and hard to parse out from her experiences as a religious student when she said, "Because I'm Mexican American, it's very hard to disconnect being Mexican from being Catholic." Similarly, Ira, a South Asian student, explained that the fact that she is a woman of color deters her from also revealing her religious identity:

Ira (nondenominational): "I'm a woman of color, and I worry about my credibility. I think adding religion to that makes things worse. So, I just don't even think to talk to other people about my religion because I'm already a woman of color in STEM. And I already feel as though when I'm with men, I get disregarded, and I feel like my voice isn't heard as much. So, I think because of that, and because of having lived through that, I just don't bother talking about my religious beliefs because I will face more of that, and I would just rather not."

Alternatively, Olivia explained that even though she is Hispanic, she passes as white, and that makes her feel less concerned that she may face repercussions when revealing her religion to her peers:

Olivia (nondenominational): "I don't really think there's risks for me because I'm a Christian and I'm not an ethnic minority or anything that would make me a target like that...Well, I'm Hispanic, but I look very white, so I'm basically just a White girl who's a Christian. So I think I don't really face any repercussions."

Though the number of students of color in this study was small, intersectionality still arose as a theme. This implies that intersectionality is likely an important factor to consider for the experiences of Christian students who are also racial or ethnic minorities. This builds on prior work indicating that in graduate school, Black biology students face stigmatization and negative experiences based on both their race and religious identities (Google *et al.*, 2023). Thus, future interview studies should probe at how intersectionality impacts Christian student experiences in active learning biology broadly and during peer interactions specifically. This could be particularly important to diversity, equity,

and inclusion efforts given that students of color in undergraduate biology classes tend to identify as Christian at much higher rates than white students (Barnes *et al.*, 2020b).

Overlap in the experiences of Christian students and students with other CSIs during peer interactions in biology

Despite fundamental differences between Christianity and identities that function as CSIs in broader society, certain elements of Christian students' experiences during peer interactions in biology aligned with previous findings about the experiences of students with other CSIs. For example, both students with anxiety and students in the LGBTQ+ community have reported feeling that their CSIs are more salient in active learning biology courses when they are asked to talk to their peers, which aligned with what we saw for Christian students (Cooper and Brownell, 2016; Cooper *et al.*, 2018a). The Christian students we interviewed also found it beneficial to reveal their religious identity to their peers because doing so could help other students feel comfortable revealing their religious identity as well, highlighting a tendency to seek connection through similarities that studies have also found among both LGBTQ+ students and students with depression (Cooper and Brownell, 2016; Cooper *et al.*, 2020). Like graduate students with depression, Christian undergraduate students' were more likely to reveal their religious identity to peers who they had a closer personal relationship with (Wiesenthal *et al.*, 2023). Additionally, most of the Christian students we interviewed anticipated stigma in the form of stereotypes, social consequences, or potential conflict and tension, which echoes studies on undergraduate students with depression and students who have an LGBTQ+ identity as well (Cooper and Brownell, 2016; Cooper *et al.*, 2020). We recognize that even in biology environments, the experiences of Christian students likely differ from those of students with other CSIs because of the privilege of being Christian in society broadly. However, we did find that there are overlaps in the experiences of Christian students and students with other CSIs within peer interactions in biology classrooms related to the concealable and stigmatized nature of their identities in those contexts, which suggests that similar patterns may emerge for other concealable stigmatized identities (e.g., being an addict, being low-income) that would be of interest to explore.

Could providing more opportunities for students to reveal their identities create more comfortable learning environments and reduce tension between religion and science?

Students in this study thought revealing their religious identity was beneficial because they could find other students who were religious in their biology classes but students rarely did reveal their religious identities. Students did not reveal because they felt their religious identities were not relevant during discussions and because they anticipated stigma from their peers about their identity. However, Christian students often comprise more than half of students in biology classes nationwide (Barnes and Brownell, 2017; Barnes *et al.*, 2021b), so unlike with other stigmatized identities, Christian students are a stigmatized *majority* in undergraduate biology classes. Therefore, if they were to reveal their identity to their peers, they would be likely to find similar others, which could help reduce their anticipated stigma.

Previous studies have suggested that working with similar others can benefit individuals with particular gender or racial identities and academic performance levels because it can minimize potential distractions from social conflict such as gender bias or racism (Tatum, 1997) and can also allow struggling students to make higher reasoning gains (Jensen and Lawson, 2011). Thus, Christian students may also benefit from finding and working with similar others in their academic science environments.

Interestingly, Christian students mostly experienced stigma from peers who did not know they were religious, so being able to reveal their religious identity might reduce their experiences of stigma. When nonreligious biology students become aware of other students' religious identities, they may be less likely to make jokes or outwardly support negative stereotypes about religion when discussing topics relevant to those identities like evolution. Indeed, a major motivation that Christian graduate and undergraduate students have for revealing their identity in the biology community is to reduce negative stereotypes about Christians within the community (Barnes *et al.*, 2017b, 2021a). This may be an effective impression management strategy: in one of our prior studies, learning about religious scientists reduced some nonreligious students' negative stereotypes about their religious peers in science (Barnes *et al.*, 2017a). Thus, if students had more opportunities to reveal their identities by incorporating peer interactions into biology courses where religion is especially relevant, like when learning evolution, this may allow nonreligious students to see more examples of religious biology students, which could reduce their negative stereotypes and ultimately reduce Christian students' feelings of anticipated and experienced stigma. A previous study proposed that providing students opportunities to discuss their religious identities and have open interfaith dialogue could be beneficial to promote religious inclusion at universities more broadly (Boucher and Kucinskis, 2016), and our results suggest they could be particularly beneficial in biology environments in the United States. Additionally, in a 2023 study, researchers proposed that in Argentina, scientists are not prejudiced against religion, yet much like in the U.S., there is a perception of conflict between religion and science in the public that causes religious scientists to conceal their identities, ultimately allowing the cycle of perceived conflict to continue (Fitz Herbert *et al.*, 2023). Thus, providing opportunities for individuals to talk about their religious identity may be beneficial in science contexts outside of the United States as well. It is important to note that revealing a stigmatized identity is a complicated personal decision, and more research is needed to determine whether increasing Christian students' opportunities to reveal their identities would benefit them. However, this study continues to highlight that religious identity is an important identity to consider in the goal for making biology education environments more inclusive.

Considerations

Giving students structured opportunities to reveal their identities could differentially impact others in the classroom, and future studies should explore this possibility. For instance, experienced stigma may be higher for students with non-Christian religious identities that are stigmatized not only in biology but also in society, so having opportunities to reveal their religious identity may lead to more negative experiences for students with non-Christian religious identities. Additionally, Christian

students revealing their identities may have negative impacts on students with other identities that have been historically oppressed and stigmatized within some Christian cultures. For example, LGBTQ+ students may feel they cannot be themselves around Christian students and, thus, could face adversity if their Christian peers revealed their religious identities more frequently in biology courses; in a previous study of LGBTQ+ students in biology, LGBTQ+ students highlighted that they avoided sitting next to any student in class who looked like they could be religious because of a fear that they would end up having to work with someone who was homophobic or transphobic, although they did acknowledge that not every religious person was anti-LGBTQ+ (Cooper and Brownell, 2016). However, Christian students in this study shared this exact anxiety that their LGBTQ+ peers would perceive them as unaccepting if they knew they were Christian. In diverse classes with students who hold multiple identities that are marginalized in different ways, yet potentially intersect with each other, instructors need to be thoughtful about how the group dynamics may shift when increased interactions among students in active learning are expected. There simply is not sufficient research to point instructors to how students will be differentially affected by having other student groups reveal their invisible identities.

Having the opportunity to reveal one's identities in the context of an undergraduate course may also benefit students with other stigmatized identities besides Christianity. As of 2021, most college students are members of Generation Z, the generation of individuals born between the mid-1990s and early 2010s (McCrary, 2021). As a whole, members of Generation Z tend to embrace the unique identities of others and have greater openness to understanding those who are different than themselves (Francis and Hoefel, 2018). Though this does not alleviate individuals' anticipated stigma when revealing, it does mean that students with a variety of CSIs may experience less stigma than they anticipate from their peers. Thus, by providing students more opportunities to share information about themselves with their peers, biology instructors could potentially create open, inclusive, and comfortable learning environments that lessens that anticipated stigma for students with various CSIs beyond Christianity.

Limitations/Future Studies

This study was conducted at one public research-intensive institution in the southwest United States. Future studies could broaden the sample to conduct quantitative or further qualitative work on the experiences of Christian undergraduate students during peer interactions at a variety of institutions nationwide to produce more generalizable results. Additionally, the institution we recruited from is located in a state that is neither highly religious nor highly secular (Lipka *et al.*, 2016). Studies have shown that students tend to be more respectful and tolerant of religious individuals if religious practice is prominent or commonplace in their area (Ipgrave, 2012). Thus, it may be important for future studies to investigate Christian students' experiences during peer interactions in biology courses at specific institutions located in areas with different religious demographics. For instance, Christian students may have different experiences during peer interactions in their biology courses if they attend a university located in a state with particularly low or particularly high proportions of religious individuals.

As we already mentioned, we explored the experiences of Christian students broadly and did not specifically ask students about the influence of intersectionality on their experiences during peer interactions in their biology courses. Despite that limitation, intersectionality still arose as a theme in our analyses, which suggests that exploring the experiences of Christian students during peer interactions through an intersectionality lens may be an important next step to fully understanding Christian student experiences in that context.

In this study, we also did not investigate the experiences of students with non-Christian religious identities, and we encourage caution when trying to generalize our findings to students with other religious identities. In future studies, it would be important to investigate the experiences of non-Christian religious students during peer interactions in biology so we can better understand how active learning biology courses impact those students, too.

Similar to many institutions nationwide, the university that we recruited from held all courses online for multiple semesters between Spring 2020 and Spring 2021 due to the COVID-19 pandemic. In our interviews, we asked students to consider their experiences from all undergraduate biology courses that they have taken thus far when answering our interview questions, and we emphasized that we were most interested in hearing about their experiences during in-person biology courses. However, due to the online instruction format adopted during the pandemic, students may not have had as many in-person experiences to draw from when responding to our interview questions, which may have impacted some of our results. Thus, future studies could investigate Christian students' experiences during peer discussions in future semesters to see if our findings replicate when students have had more in-person biology courses and ultimately more in-person peer interactions.

Additionally, to increase the likelihood that students had taken multiple in-person undergraduate biology courses, we only recruited from upper-level courses. It is possible that this may have skewed our results regarding the amount of stigma that Christian students experience in their undergraduate biology courses because students who experienced stigma early on in their undergraduate career may have left the biology program before reaching the upper-level courses that we recruited from. Therefore, future studies could interview students in introductory-level biology courses to account for and capture the experiences of Christian students who may avoid upper-level biology courses because of stigma they experience in introductory biology.

CONCLUSION

In this study, we found that Christian students feel their religious identity is salient during peer interactions in biology and perceive that revealing their religious identity to their peers is beneficial, yet they rarely reveal their religious identities during peer interactions in part because they anticipate stigma when revealing. Interestingly, most students anticipated more stigma from their peers than they actually experienced when revealing their Christian identity. Based on our results, providing students more structured opportunities to reveal their identities in undergraduate biology may help Christian students reduce their anticipated stigma. Further, the increased representation of religious individuals in science may help begin to change the

culture of the discipline and lessen the perceived conflict between religion and evolution.

DECLARATIONS

Availability of Data and Materials

The datasets generated and analyzed during the current study are not publicly available to protect the privacy of participants.

ACKNOWLEDGMENTS

We thank members of the Biology Education Research lab at Arizona State University for providing insightful ideas during earlier stages of the project, and we thank Katelyn Cooper and Beckett Sterner for providing valuable feedback on an earlier version of the manuscript. We also thank participants in the study for sharing their experiences with us. Funding for this project was provided by the National Science Foundation (NSF) grant IUSE #1818659.

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