Christian Student Experiences During Peer Interactions in Undergraduate Biology Courses

by

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ABSTRACT

Increasingly, college courses have transitioned from traditional lecture to student-centered active learning, creating more opportunities for students to interact with each other in class. Recent studies have indicated that these increased interactions in active learning can create situations where students' identities are more salient, which could result in novel challenges for students with marginalized identities. Christianity has been shown to be a marginalized identity in the context of undergraduate biology courses, but it is unknown whether Christian students experience challenges in their interactions with other students in class. The social psychology framework of concealable stigmatized identity (CSI) was used to explore the experiences of Christian students during peer interactions in undergraduate biology courses. Thirty students were interviewed, and most felt their religious identity was salient during peer interactions in biology. Students also reported that they have more opportunities to reveal their religious identity in courses that incorporate peer discussion than in courses that do not. Students claimed that revealing their religious identity to their peers could be beneficial because they could find other religious students in their courses, grow closer with their peers, and combat stereotypes about religious individuals in science. Though most students anticipated stigma, which caused some students to choose not to reveal their religious identities, comparatively few had experienced stigma during peer interactions in their college biology courses, and even fewer had experienced stigma from peers who knew they were religious. These findings indicate that it be may important to teach students how to be

culturally competent to reduce Christian students' anticipated and experienced stigma in active learning courses.

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Introduction

Undergraduate college science courses are increasingly shifting away from traditional lecture formats where students passively listen to an instructor to active learning courses where students construct their own knowledge (Freeman et al., 2014). Active learning often engages students in small groups, so active learning environments tend to increase student interactions. Previous studies have indicated that the changing interactions in active learning classrooms can present challenges for students from marginalized backgrounds (Cooper, Downing, et al., 2018; Cooper & Brownell, 2016; Eddy et al., 2015; Gin et al., 2020). Christianity is considered a Concealable Stigmatized Identity, or CSI, in the context of biology (Barnes et al., 2021), so Christian students may also experience challenges when they reveal this identity. Thus, in this study we sought to understand the experiences of Christian students when they interact with their peers in undergraduate biology courses.

Active Learning Courses

Active learning is a broad umbrella term to describe teaching practices that are distinct from a passive lecture where students listen to an instructor (Driessen et al., 2020). While active learning can take many different forms, according to Freeman and colleagues, "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" (Freeman et al., 2014). 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).

Active learning has also been shown to decrease achievement gaps among underrepresented students in STEM courses (Theobald et al., 2020), which indicates that active learning courses can be more equitable and inclusive. However, other studies have indicated that active learning can present novel challenges for some groups of marginalized students (Cooper, Downing, et al., 2018; Cooper & Brownell, 2016; Eddy et al., 2015; Gin et al., 2020), many of which originate from the increased frequency of student interactions in active learning. Our research group was the first to show that increased group work in active learning courses can cause students with LGBTQ+ identities to be reminded of their identity more frequently and be concerned about how other students would treat them because of their identity (Cooper & Brownell, 2016). Further, we found that certain active learning strategies, including small group work, can increase student anxiety, which can be detrimental for maximizing the learning of students who identify as anxious (Cooper, Downing, et al., 2018; Downing et al., 2020). We found that students with disabilities can struggle with groupwork in active learning courses and may not receive adequate accommodations to help support them in these learning environments (Gin et al., 2020). Finally, inequities in groupwork can create unique forms of gender disparities that would not be present in classrooms without groupwork (Cooper, Krieg, et al., 2018; Eddy et al., 2015). This work collectively highlights that peer interactions in active learning can create novel challenges for marginalized groups because of the extent to which students are interacting with each other as opposed to not talking with each other in a traditional lecture course. Further, there could be an increase in relevance of their identities because of either the course content or

off-topic conversations that stemmed from group interactions, which in turn may lead to challenges for them because of their marginalized identities. Thus, it may be more important to consider students' identities in active learning environments because they may affect students with certain identities in different ways than others.

Concealable Stigmatized Identities (CSIs)

Stigmatized identities are identities that are devalued in specific social contexts, and they are associated with negative stereotypes (Quinn, 2006; Steele et al., 2002). Individuals can be stigmatized due to various factors related to their physical characteristics, moral behaviors, and community affiliations. For example, individuals from minority racial/ethnic groups, individuals with mental or physical disabilities, LGBTQ+ individuals, and religious minorities are commonly stigmatized in society. People often associate those identities with negative stereotypes and, thus, individuals with those identities often experience negative biases and potentially negative interactions that stem from identity conflict.

Some stigmatized identities are less visibly apparent than others and are called concealable stigmatized identities, or CSIs. While gender or racial identities are typically visibly apparent during social interactions, other identities may not be obvious from one's physical appearance; those invisible identities would need to be revealed for someone to know who has them and, thus, are considered concealable stigmatized identities. Possible CSIs include LGBTQ+ status, having depression (Cooper et al., 2020), and in the context of biology, religious identity (Barnes et al., 2021; Scheitle et al., 2021). When individuals hold a CSI, they can make choices about whether and how they reveal their identity to those around them (Quinn, 2006). For instance, they can use impression management strategies to try to control how others

perceive them, or they can decide to conceal their CSI from others altogether. Revealing a CSI can be a difficult and potentially risky decision because revealing in the wrong setting can lead to ostracism (Lynch & Rodell, 2018) and a hesitation to reveal to others in the future (Chaudoir & Quinn, 2010). However, choosing to conceal a CSI can also have negative consequences, such as reducing individuals' sense of belonging in their environment (Newheiser & Barreto, 2014) and increasing their psychological stress about being perceived as inauthentic or unlikable by those around them (Lynch & Rodell, 2018; Quinn, 2006). Therefore, the decision to reveal or conceal one's CSI has impacts.

Studies investigating CSIs in the classroom have shown that, when courses incorporate greater opportunities for peer discussion, students with specific CSIs feel they have more opportunities to reveal their identity to others (Cooper & Brownell, 2016). Additionally, students' CSIs may be more salient in environments like active learning courses because the increased peer interaction may lead to increased social comparisons (Cooper, Downing, et al., 2018; Cooper, Krieg, et al., 2018). However, this means that active learning environments may present additional unique challenges for students with CSIs if they anticipate stigma from their peers about their identities.

Christianity as a CSI in Biology

Generally, Christians are not considered stigmatized in the United States; though the nation is secularizing, Christians still represent a majority religious identity in the United States (NW et al., 2019; PRRI Staff, 2021). Christianity is perceived as closely associated with U.S. American culture, and atheists are often stigmatized and perceived as immoral in the United States (Edgell et al., 2016; Moon et al., 2021; Rios et al., 2021; Stokes, 2017). However, it is

possible for identities to only be stigmatized in specific social environments, and studies have shown that Christianity is specifically stigmatized in academic biology environments (Barnes, Truong, et al., 2017; Ecklund & Scheitle, 2007). Biologists, and specifically evolutionary biologists, are primarily non-religious, so there is a dominant secular culture in academic biology in the United States (Liu, 2009). The importance of evolution as a thread underlying all of biology (AAAS, 2011; Brownell et al., 2014) and the historical contention between religion and evolution in the United States has influenced this secular culture in a way to often pit biologists against Christians (Shapiro, 2013; Szasz, 1971). Biology faculty and biologists themselves have reported having negative attitudes towards evangelical and fundamentalist Christian religions (Barnes, Truong, et al., 2020; Barnes & Brownell, 2016; Ecklund et al., 2011). For example, in an audit study, although biology faculty did not show a negative bias towards Christian students broadly, they did rate an evangelical student as less competent, less hirable, and less likeable than an identical applicant who did not reveal a Christian identity (Barnes, Truong, et al., 2020). Christian undergraduates in biology courses also perceive that members of the biology community view them in a negative ways, such as perceiving that their scientific work is less valuable than that of their non-religious peers (Barnes, Truong, et al., 2017, 2020). Additionally, one's Christian identity typically is not visibly apparent, and a previous study from our research group on Christian graduate students have supported the assertion that Christianity is a CSI in academic biology (Barnes et al., 2021). We found that Christian graduate students anticipated stigma about their identity in biology environments, and worried about the professional consequences of revealing their identity (Barnes et al., 2021). Further, this could be particularly

salient for students of color, who tend to identify as Christian at higher rates than white students (Barnes, Supriya, et al., 2020).

Christian students' religious identities have been shown to be salient in biology courses, particularly in courses that have content that intersects with religious beliefs (Barnes et al., 2021). For example, biology courses that cover specific topics that may conflict with Christian students' religious identity, such as evolution and bioethics topics, remind students of their religious CSI more than other topics would (Barnes, Truong, et al., 2017). One previous study found that highly religious students are less comfortable participating, have a lower sense of belonging, and feel less scientifically capable than their non-religious peers in active learning biology courses (Henning et al., 2019). Thus, similar 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. But, to our knowledge, no study has explored how Christian students' religious identity impacts their experiences during peer interactions in their biology courses and how this compares to traditional lecture courses. Understanding Christian students' experiences during peer interactions may help us understand how active learning biology courses can differentially impact Christians.

The Relationship Between Peer Interaction and Student Identity

Previous focus on student-instructor interactions

Though peer interaction is a key component of active learning, most studies that have focused on student identity have investigated how students' identities are impacted by professor behaviors and professor-student interactions in active learning classrooms (Cooper, Downing, et al., 2018; Downing et al., 2020). For example, researchers have investigated the language

instructors use when teaching their biology courses and how students perceive it to determine which practices establish inclusive learning environments (Harrison et al., 2019; Ovid et al., 2021; Seidel et al., 2015). Studies from our group have also emphasized that it is important for professors to possess cultural competence, which is the ability of individuals from one culture to bridge cultural differences and effectively communicate with individuals from a different culture, when teaching evolution (Barnes & Brownell, 2016, 2018). Instructor cultural competence has been found to reduce students' perceived conflict between religion and science and increase inclusivity of biology courses for religious students (Barnes & Brownell, 2017). However, as undergraduate college courses increasingly transform into active learning environments, peer behavior may become more relevant to students' experiences and identities in the classroom. Few studies have focused on the impact of increased interactions among students in active learning on students with marginalized identities.

Increasing focus on peer-peer interactions

In active learning courses, there is an attention shift from nearly exclusively instructor-student interactions to peer-peer interactions. Thus, to make active learning environments more inclusive for students with stigmatized identities, it may be important to move beyond only investigating instructor behavior to also investigate how students behave when interacting with one another. For instance, even if instructors use language that helps foster an inclusive environment, if students use exclusive language when interacting with one another, individuals with stigmatized identities may feel excluded from their active learning courses since peer interactions are more prevalent in those contexts. Additionally, though we know that instructor cultural competence helps make biology courses more inclusive (Barnes, Elser, et al., 2017;

Barnes, Werner, et al., 2020; Bowen et al., under review; Ferguson & Jensen, 2021; Lindsay et al., 2019), it may be equally important to understand whether students themselves are culturally competent to each other (Truong et al., 2018). If students cannot bridge their cultural gaps to effectively communicate with one another, interactions between religious and nonreligious students may perpetuate students' perceived conflict between religion and science and reduce inclusivity for religious students.

In a previous study, Christian students reported that behaviors of both their peers and instructors can impact their experiences in their biology courses (Barnes et al., 2017). Since peer impact may be increasingly relevant in active learning, we wanted to explore Christian students' experiences when interacting with their peers. Doing so could help us better understand how Christian students' experiences in biology are impacted by biology active learning environments.

Thus, we set out to answer the following research questions:

1. When they are interacting with their peers in their undergraduate biology courses, do students feel like their religious identity is salient? If so, how?
2. Compared to a traditional biology lecture course, do religious students feel like there are more opportunities to reveal their religious identity in courses that incorporate peer discussion?
3. To what extent do students reveal their religious identity when interacting with their peers in undergraduate biology classes?
    a. What do students perceive are specific benefits to revealing their religious identity to their peers in their undergraduate biology courses?

b. How, if at all, do religious students anticipate stigma about their religious identity when interacting with their peers in their biology classes?
c. How do students decide whether to conceal or reveal their religious identity when they are interacting with their peers in biology classes?
d. Are there ways that students reveal their religious identity to peers in their biology courses to avoid negative perceptions?

4. What makes religious students more or less comfortable when interacting with their peers in undergraduate biology courses?
5. How, if at all, do religious students experience stigma about their religious identity when interacting with their peers in their biology classes?

Methods

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

We recruited Christian undergraduate students at a single 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 semester asking if they would forward a recruitment email to students currently enrolled in their courses. Twelve instructors agreed to forward a recruitment email to their students, and we completed interviews with 30 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. Due

to the low number of religious non-Christians who indicated interest in the study, we focused our interviews on only Christian students. The email then asked students to complete a brief survey if they were interested in the participating in the study. That survey gathered information about students' personal demographics, their beliefs about evolution, and their willingness to participate in an interview. Students who indicated that they were willing to participate in an interview 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.

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 them to select the denomination of Christianity they most closely identified with from a list of options. We also asked whether they identified as an Evangelical Christian. Additionally, to assess students' religiosity, we asked them to rank how much they agreed with four statements, regarding, for example, their church attendance and belief in God, on a Likert scale of "Strongly disagree" to "Strongly agree." We calculated students' composite average for their religiosity. We assigned each Likert scale response with a numerical value (Strongly disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly agree = 5), summed the value of students' responses to each of our four religiosity questions, and divided that total by four.

We also wanted to collect data on students' views on evolution because 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 (Barnes, Dunlop, et al., 2020; Yasri & Mancy, 2016). In that question, we provided students a list of statements about evolution and asked them to select the statement that most closely aligned with their views. 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:

To conduct the interviews, we used the Concealable Stigmatized Identity (CSI) framework from social psychology (Quinn, 2006), which had been used in a previous study to understand the experiences of Christian graduate students in biology programs (Barnes et al., 2021). To ensure that our interview questions aligned with the CSI framework, we asked many of the same questions as the researchers who interviewed Christian graduate students in that previous study; however, we modified some of the questions and included additional interview questions to accommodate our focus on students' experiences during peer interactions in biology courses. For example, to collect data related to the CSI concept of "salience," we asked students questions such as "When you are interacting with peers in your biology courses, are you ever reminded of your religious identity?" We made similar revisions when assessing "reveal" and

"conceal" (i.e. "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?" and "Can you tell me about instances when you have revealed that you are religious to one of your peers in your biology courses?"), "anticipated stigma" (i.e. "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" (i.e. "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?"), and "impression management strategies" (i.e. "Are there particular ways you talk about your religious identity with your peers to avoid any negative perceptions?").

We then created additional questions to help us determine (a) whether Christian students feel they have more opportunities to reveal their religious identities in biology courses that incorporated peer discussion (i.e. "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?"), (b) what they perceive are the benefits of revealing their religious identity to their peers in biology classes (i.e. "Talk to me about the potential benefits you see, if any, of revealing your religious identity to other students in your biology classes"), (c) what they perceive are the benefits and disadvantages of being religious when interacting with their peers in biology classes (i.e. "Talk to me about what you perceive are the potential benefits of being religious when interacting your peers in your biology courses" and "Talk to me about what you perceive are the potential disadvantages of being religious when interacting with your peers in your biology courses"), and (d) how comfortable they are when interacting with their peers in biology classes

(i.e. “How does your religious identity influence your comfort level when you are interacting with your peers?").

A copy of all the interview questions that we asked participants can be found in the **supplemental material**.

All interviews were conducted by a single researcher (B.A.E.) to ensure consistency across interviews. B.A.E. conducted interviews with students until data saturation was reached. 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-minutes in length. Each interview was audio-recorded and professionally transcribed for data analysis purposes.

Interview Analyses:

We used inductive coding methods to analyze the interview transcripts (Cho & 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 of the interview transcripts to compile a list of themes that appeared in the interviews, 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 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. Revisions were 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. Their coding aligned 93% of the time. However, to control for any agreement that may have occurred by random chance, we also used a Kappa statistic, Cohen's kappa (Hallgren, 2012). The average Cohen's kappa value for the five interviews was 0.83, which indicates a high and acceptable level of agreement (Landis & 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 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 students' responses. However, themes only reported by two students are still in the rubric in the **supplemental material**. All names are pseudonyms to protect student identity. Students' quotes were lightly edited for clarity.

Results & Discussion

Demographics:

Of the 30 Christian students who we interviewed, most were women, white and had parents who also went to college. Most participants were non-denominational Christians, were

not politically conservative, and accepted evolution. Participants scored an average of 4.2/5 on our religiosity scale, indicating an overall high religiosity of this 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 1**.

Table 1. Aggregated demographics of students in the study:

Student demographic	Participants n (%) n = 30	Student demographic	Participants n (%) n = 30	Student demographic	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%)
Master's degree	8 (26.7%)	Atheistic evolution	0 (0%)		
Higher than a master's degree	5 (16.7%)				
*For the corresponding description of each view of evolution, see the **supplemental material**.					

Finding 1: Most Christian undergraduate biology students felt their identities were salient during peer interactions, which increased with particular topics in biology.

Christian students felt that peer interactions increased the salience of their identities. Some students claimed their identity was salient because of differences between themselves and other students that were revealed through peer interactions and conversations. For example, Kristin, an LDS student, stated that she is reminded of her religious identity during peer interactions because of "what other people wear or how they act," and she went on to state, "I don't cuss, and I try to wear relatively modest clothing and so I guess I stand out in that way." Similarly, Molly, an LDS student, explained that the differences between herself and her peers impacted her, "day-to-day interactions with fellow students because [their] lifestyles are in sharp contrast." In a previous study, students LGBTQ+ identities reported that their identity was more salient in active learning because they had to interact with their peers more frequently, and thus could no longer be invisible in their courses (Cooper & Brownell, 2016). Similarly, here, we see that Christian students recognize differences between themselves and their peers during interactions with them, indicating that increased peer interactions remind students of their identities and the parts of themselves that they perceived are different from those around them.

Although simply talking to their peers reminded some students of their religious identity, for others, their religious identity became salient when they talked about specific topics with their peers. As seen in previous investigations of Christian students in biology (Barnes, Truong, et al., 2017), many students claimed that they are reminded of their

religious identity during peer discussions about evolution and bioethics. Students explained that those topics were unique because they have the potential to conflict with their religious identity, and their opinions about those topics are informed by their religious identity. Thus, they were reminded of their religion when they talked about those topics with their peers. For example, Olivia said:

> *Olivia (nondenominational): "When we talk about subjects… like evolution... people will start talking about their own opinions on it. And I think 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."*

In contrast, some students reported that their religious identity was never salient during undergraduate biology courses, regardless of the modality. Echoing findings from a previous study our of our research group of undergraduate Christian biology students (Barnes, Truong, et al., 2017), the students who reported this often claimed that they compartmentalize or "silo" religion and science when they are in their biology classes, meaning they intentionally keep their religious faith separate from the scientific information that they learn in class. For instance, Daniel described his tendency to avoid using his religious beliefs to inform his opinions about scientific topics such as evolution:

> *Daniel (LDS): "I tend to silo my thinking sometimes, especially if we've come across a topic like evolution... I don't really have a whole ton of clarity from the religious perspective as to whether I believe evolution is the way that species*

came to be as they are. So, I just don't worry about it, and I focus on it from a biologist's perspective."

Though some students claimed their religion was never salient in biology because they siloed their religious and science identities, most students claimed their religion was salient during peer interactions. Some reported their identities were salient simply because they noticed differences between themselves and their peers during peer interactions, whereas others felt their religious identity was salient during specific discussions with their peers, such as those about topics like evolution or bioethics topics.

This finding implies that, just as students' LGBTQ+ identities and mental health tend to be more salient in active learning courses because students cannot just sit invisibly in the classroom (Cooper, Downing, et al., 2018; Cooper & Brownell, 2016), Christian students' religious identities are also salient during active learning biology courses when they are asked to talk with their peers. Further, the topics of these peer discussions seems to matter in terms of increasing the relevance of their identity.

Finding 2: Christian students have more opportunities to reveal their religious identity in courses that incorporate peer discussion than in traditional lecture courses.

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 felt as though they interacted with their

peers more and had “more communication” with them in those courses. For example, Olivia pointed out that without peer discussions, students would not have the opportunity to reveal their religious identity at all:

> *Olivia (nondenominational): “I think if you don't have discussions with people, then there would be no chance for you to reveal the fact that you're religious even if you wanted to. So having discussion allows a space for that to happen.”*

Macie expressed a similar sentiment as she explained that when students talk to each other more, 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… 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 said that they had more opportunities to reveal their religious identity in “small group discussions,” which are more common in active learning courses. For instance, Peter (nondenominational) stated that he felt “[religious identity] is more likely to come up if it's, say, a group of five or just a small group” than if there is a whole-class discussion. Other students explained that they would personally be more likely to reveal their own religious identity to their peers if they were in a small group. For example, Jamie (nondenominational) said, “I sometimes have social anxiety, so it would be easier for me personally [to reveal my religious identity], in a smaller setting.” Some students also felt they had more opportunities to reveal their religious identity

because they were able to grow closer to their peers and "develop friendships and relationships with them" in courses with peer discussions. For instance, Erin mentioned that in courses that incorporate peer discussion, after students answer the questions their instructors pose to them, they have time to get to know each other better:

> *Erin (Catholic): "There would be more opportunities because you're talking to people, and after maybe you're done answering the question or figuring out whatever you have to talk about, you have some extra time, and people usually just make some sort of small talk. It gets a little bit more personal."*

This echoes what has been shown previously as far as students ending conversations about the biology topics and then discussing social plans or more personal information has been previously indicated as a situation for when identities matter more for LGBTQ+ students (Cooper & Brownell, 2016). For LGBTQ+ students, this presented both opportunities to reveal their identity, but also concern about the need to lie or evade questions if they were not comfortable revealing their identity.

Brooke specifically mentioned that when students are asked to engage in discussions with the same group over the course of the semester, they may feel more comfortable sharing personal information with each other:

> *Brooke (nondenominational): "If you're with the same group, you kind of get to know them. So I think that does increase the possibility that you could feel more comfortable discussing things like religion and science."*

Researchers have previously found this was also the case for students with anxiety. They found that students' anxiety in active learning courses is reduced when

they are able to work in groups of students who they know better, as opposed to having to work with students they have never interacted with before (Cooper, Downing, et al., 2018; Downing et al., 2020). Interestingly, there seems to be a gender difference in student preference for working with peers who they know more; in a previous study, women, but not men, preferred working in groups with their friends (Eddy et al., 2015).

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 claimed they did not feel the opportunity to reveal their religious identity in either course modalities. Those students explained that even when their biology courses incorporate peer discussions, their religion is not relevant to most of those discussions, so the opportunity to reveal does not present itself. For instance, Erica said:

> *Erica (Protestant): "I just don't think it really comes up that much in these discussions. By that time, we're speaking about some specific events or some specific process or something… I just don't think it really comes up in much of these peer discussions because we have a focused goal."*

In summary, most students felt they had more opportunities to tell their peers that they are religious in biology courses that incorporate peer discussion regardless of the topic because, in those courses, students talk to each other more often, develop closer relationships with each other, and work in small groups more frequently.

Previous studies have indicated that students have more opportunities to reveal certain CSIs, like LGBTQ+ identities, in courses that incorporate peer discussion than in

traditional lecture courses (Cooper & Brownell, 2016). Our finding corroborates that idea and shows that Christian students also perceive that they have more opportunities to reveal their CSI in active learning courses that incorporate peer discussions.

Finding 3: Even though they perceive potential benefits from revealing, Christian students anticipate stigma that affects them revealing their religious identity when interacting with peers in their biology courses.

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

We found that Christian students perceive various benefits of revealing that they are religious during peer interactions in their biology courses. Similarly to previous studies (Barnes et al., 2021), some students expressed that by revealing their religious identity, they could correct misconceptions about religious individuals in biology by showing 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 would be beneficial because she would be "showing them a new background" and proving "that you can be religious and study evolution openly."

However, 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 other peers who were 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." Daniel specified that revealing would

be beneficial because he could find other students who identified with the same Christian denomination as him:

> *Daniel (LDS): "Well, the biggest one is there are so many members of my church at the university that 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.'"*

In a previous study, LGBTQ+ students explained that they also thought active learning classes were beneficial because they gave students more opportunities to come out and find other individuals who were similar to them (Cooper & Brownell, 2016). Therefore, Christian students are not the only group of students who find it beneficial that when they reveal their identity to their peers, they may find others who identify the same way. This finding is unsurprising in the context of social psychology; previous studies on homophily, or the tendency for individuals to be drawn towards people who are like them, have shown that similarity fosters connection, and in general, people's personal networks tend to be largely homogenous in regards to many sociodemographic, behavior, and personal characteristics (McPherson et al., 2001). Additionally, in classroom contexts, students form peer clusters around shared characteristics or identities (Farmer & Farmer, 1996; Freeman et al., 2017). Thus, Christian students' desire to find peers who are also religious aligns with the human tendency to seek connection through similarities.

Additionally, some students mentioned that, regardless of whether their peer had the same religious identity as them, if they were to reveal that they are religious to their peers, other students in their biology courses may feel comfortable enough to reveal that

they are religious, too. For instance, when asked what she felt would be a benefit of telling her peers that she is religious, Amie (LDS) said, "I feel like a huge potential benefit would be making somebody else comfortable enough to reveal it as well." Perhaps Christian students recognized that if revealing their own religious identity was beneficial for them, then peers revealing their own religious identities could also help them. As far as we know, previous studies have not found that students with other CSIs perceive revealing to be beneficial for this reason. However, one study found that students with LGBTQ+ identities thought that coming out in class was beneficial because doing so would allow other LGBTQ+ students to approach them as a resource if they were unable to come out themselves (Cooper & Brownell, 2016). Though that perceived benefit differs from what we saw in this study, the two benefits are similar in that when both Christian and LGBTQ+ students reveal, they want their decision to help others with similar identities to feel safer and more comfortable with their identities.

Finally, many students said that revealing their religious identity to their peers is a vulnerable experience, and, thus, revealing is beneficial because doing so helps them bond with and grow closer to their peers. For instance, Macie discussed that revealing that she was religious allowed her to build deeper friendships with her classmates:

> *Macie (nondenominational): "I think that it 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."*

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 & Taylor, 1973). Additionally, self-disclosure correlates with liking others more; people like others more who disclose more, people disclose more to others they like, and when people disclose more, they like the others to whom they have disclosed more afterwards (Collins & Miller, 1994). Thus, it makes sense that Christian students felt that revealing was helpful for deepening their relationships with those who they revealed to.

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. Since 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.

Christian students anticipate stigma during peer interactions in their biology courses.

Despite perceiving that there are benefits of revealing their Christian identity during peer interactions, most students expressed that they would anticipate stigma from their peers if they were to tell them that they are religious.

As we have seen in previous studies (Barnes et al., 2021; Barnes, Truong, et al., 2017), 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 did not believe in topics like evolution or science more broadly. Many students also explained that they 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 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" or would assume that they "ignore evidence" or "bury their heads in the sand" because they are religious. 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," "unwelcoming," or "closed-minded" towards others and their beliefs. Finally, some students were concerned that their peers may apply stereotypes to them based on their specific Christian denomination. For instance, Grace, an LDS student, explained that if her peers found out about her religious identity, they might assume that she "[doesn't] drink alcohol at all" or "must have a husband, and he must have a bunch of wives." Similarly, Megan expressed that she worried her peers would associate her with the actions and proclaimed attitudes of the Catholic church:

> *Megan (Catholic): "I think that Catholics don't have the best image to them. So yes, 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. Similarly to previous studies (Barnes, Truong, et al., 2017), many students worried that revealing their religious identity could lead to "arguments," "conflict," or "tension" with their peers, especially if their peers strongly disagreed with their faith. Many also worried that their peers may exclude them from study groups and group projects or may choose not to interact with them as much 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:

Ira (nondenominational): "I don't like when people put me in a box and I'm not able to get out of that in any way, because I don't think it should be my job to justify my religious beliefs to other people... So, I don't want my education to be affected because of the box that somebody else puts me in."

Importantly, students' concerns about being excluded by their peers are valid based on prior literature. Studies have shown that if someone reveals a CSI in the wrong setting (to the wrong person, at the wrong time, or in the wrong way), they may be ostracized by others (Lynch & Rodell, 2018). Thus, if a Christian revealed to a peer who was not accepting of their religious identity or revealed in a way that caused their peer to

associate them with negative ideas about Christians, their concerns about facing social consequences for revealing could come true.

We also saw that some students worried that if they were to reveal that they were religious during peer interactions, they would make their peers feel uncomfortable. These students expressed concern that revealing could make their peers feel as if "they are not accepted." 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 just 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 most students anticipated stigma in the form of stereotypes, social consequences, or potential conflict and tension. Specifically, students worried that their peers would assume they didn't believe in science or that they were less scientifically capable, controlled by their religion, naïve, trying to convert others, or judgmental. Some also worried they would be negatively stereotyped based on their specific denomination of Christianity. Additionally, students worried that their choice to reveal would spark arguments and conflict with their peers or make their peers to want to stop being their friend or stop working in groups with them.

Students with many CSIs anticipate stigma upon revealing to their peers, such as students with depression and students who have an LGBTQ+ identity (Cooper et al., 2020; Cooper & Brownell, 2016). A study investigating the experiences of students with depression in research environments found that students often concealed their depression for a variety of reasons, including because they did not want to be treated negatively by members of their lab (Cooper et al., 2020). Additionally, LGBTQ+ students reported that even though they recognized most people were no longer overtly homophobic, they still experience more subtle forms of homophobia and, thus, worry about how their peers would react if they were to come out (Cooper & Brownell, 2016). Therefore, our finding that Christians anticipate stigma from their peers about their religious identity aligns with findings about students with other CSIs.

Additionally, this finding may be related to stereotype threat. Stereotype threat has been defined as the threat that others' judgments or their own actions will negatively stereotype them or confirm stereotypes about their group, and it arises when one is in a situation for which a negative stereotype about one's group applies (Steele, 1997). Christian individuals can experience stereotype threat in situations when potential conflict between religion and science are made salient. For example, a prior study found that stereotype threat caused Christians to perform worse on science-related tasks, but their performance was no longer impacted when they perceived that those around them thought religion and science are compatible (Rios, 2021). Here, we saw that Christians anticipated stigma about their religious beliefs and worried they would be stereotyped by

their peers because of them. Thus, Christian students may experience stereotype threat during peer interactions, which could impact their performance in those interactions.

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

Students' anticipated stigma seemed to impact their tendency to reveal to their peers. Despite many students seeing potential benefits of revealing their Christian identity, most students reported that they rarely told their peers in their biology courses that they are religious, and many of them said that the reason why they never or rarely reveal is because they anticipate stigma when doing so. For instance, Diego (Catholic) explained that he had never revealed that he was religious to a peer in his biology class, and, when asked why he had never revealed, he said, "I don't want to be associated with the concepts and biases people may have towards religious people."

Many students also explained that they never or rarely tell their peers that they are religious because they feel like they do not have the opportunity to do so during their peer interactions. For instance, Sofia explained that she rarely tells her peers that she is religious because it does not come up in discussions with them:

> *Sofia (Protestant): "I think even right now that we're in person, it's not something that most people come up to you and ask about, or even if I'm next to someone, we tend to talk about other things in our lives or about ourselves, not necessarily religion."*

Some of those students did not mention whether they would reveal that they were religious if they had the chance to do so. However, as seen in previous studies (Barnes et al., 2021), many students specified that they would "always be open to mentioning" their

religious identity if they were given the opportunity to reveal. 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, Maria explained that even though she didn’t reveal her religion often, she would not hesitate to do so if it came up in conversation:

> *Maria (nondenominational): “I'm not like ashamed to reveal it. It just doesn't seem relevant... but I don't shy away from bringing it up. If the conversation seems like it should be relevant, then I'll always choose to express how I feel.”*

Though most students said that they rarely revealed their religious identity in their biology classes, some 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.

Interestingly, we saw that even though students claimed that their identities are salient during peer interactions and they have increased opportunities to reveal their religious identity in courses that incorporate peer discussions, most students perceive that they have few opportunities 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 that they believe 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, students may feel that even though they were reminded of their own religious identity during a peer interaction, that does not mean that religion is salient to others in the group, so they may feel their religious identity is not relevant enough to others to warrant revealing during those peer interactions. Thus, incorporating peer interactions into biology courses where religion is especially relevant may allow students to feel they have more opportunities to reveal, which could then allow them to reap the benefits of revealing such as finding other religious students, which could then reduce their anticipated stigma. However, more research is needed to determine whether increasing such opportunities would be beneficial in that way.

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 perception.

Though most students reported that they would be willing to tell their peers that they are religious if it was relevant to the conversation, many students reported that a variety of other factors also impacted whether they were willing to reveal to their peers. As seen in a previous study on Christian graduate students (Barnes et al., 2021), many students in this study reported that their willingness to reveal depended on how "open-minded" and "accepting" their peers seemed towards others' views. Some of these students said that they would reveal if their peer seemed willing to respectfully listen to

them, and on the flip side, others specified that they would not reveal if their peer seemed "closed-minded," "critical," or "aggressive" towards others' views. In addition to their peers' open-mindedness, many students explained that their degree of closeness with their peers impacted their decision to reveal their religious identities. Those students often expressed that they would be more willing to reveal to someone if "they considered them a friend" than if they had just met the peer or if they were just "acquaintances." Finally, students noted that their decision to reveal depends on the religious identity of the peer they are interacting with. Many students said that they would reveal that they are religious if they knew their peer was also religious or if their peer revealed first. This means that students not only think it is beneficial to know of other religious students in their courses, but they also feel more inclined to reveal that they are religious to peers who have already revealed themselves. Thus, from these findings, corroborated by similar findings from a previous study (Barnes et al., 2021), we can see that when students reveal their religious identities to their peers, it makes other religious students feel more comfortable sharing that they are religious, too, which could make them feel more comfortable in their peer interactions and biology courses overall.

Notably, some students also said that they would reveal if they felt that doing so could help their peer become religious or learn more about their religion. For example, Levi explained that he felt his biology classes were an opportunity to share his religion with his peers:

> *Levi (Protestant): "I feel like I get to give someone else a new point of view. And in my religion, it's all about planting the seed. It's not converting someone. It's*

just like, 'Yeah, this might true. It was true for me, I believe in it, it's helped me so much in my life. So if you want help in your life, I suggest you just have a prayer, or you should go to church or talk to someone religious...' And so it's like giving them a new pathway possibly… If that's what we truly believe and that's the truth to us, then I want someone else to know about it. So being in a biology class, any class really, it's just another benefit to being like, 'Okay, well, there's more people here, more people I can talk to about it.'"

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 maybe more fulfillment or happiness in their life."

This finding is interesting because, though some students reveal to help others find their faith, we also saw that some Christian students anticipated stigma related to that idea because they did not want their peers to think they were revealing in hopes of introducing others to their religion. Thus, we see that some students fear being associated with actual behaviors of their Christian peers in their biology courses.

When students did decide to reveal to their peers that they are religious, most of them reported trying to do so in particular ways to avoid stigma. Stigma researchers refer to those methods as impression management strategies (Chaudoir & Quinn, 2010). Impression management strategies can help students to avoid the negative stereotypes and stigmatization of their personal identities when they reveal them to others. As our research group has previously observed for Christian graduate students in biology

(Barnes et al., 2021), in this study, many students reported that when they revealed, they often specifically used self-group distancing strategies (Roberts, 2005) by pointing out aspects of their own character or behaviors that separate themselves from stereotypes their peers may hold against religious people. 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 share their political party or explain that they have progressive political views when they reveal in order 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. Also seen previously (Barnes et al., 2021), some students in this study described that when they revealed, they would integrate, which means they would intentionally speak positively about their religion to shut down any negative perceptions from their peers (Roberts, 2005).

However, we also found various novel ways students revealed their religious identity to avoid negative perceptions from peers in their biology courses. For example, many students explained that when they talk about their religious identity, they are careful not to push their religion on their peers, and they make it clear they are not trying to convert them. Some students explained that they do so by allowing their peers to bring up the topic of religion in their courses rather than bringing it up themselves. For example, 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 that really wants to push my beliefs on top of everybody and try to force that on anyone. Even with my friends, if they want to talk about God or get closer to God. I'm not the one that usually brings it up because I don't want to be the one that's forcing my way onto them. But if they do bring it up, then that's when I'll jump in. So I think that's more inviting and not as overbearing."

Others explained that, to avoid appearing as if they are pushing their religion on their peers, they try to respect that their peers have their own personal backgrounds and beliefs. For example, Camila said:

Camila (Catholic): "If I ever talk about religion, I always want it to be in terms of me and what I believe… I never want others to be like, oh, well you're making me feel like I'm wrong for believing another way."

Some students also said that they discuss their religious identity casually or in a "laid back" manner when they reveal it to their peers. To do so, some students explained that they try to make it seem as if their faith is "not a big deal" or is simple, rather than complex. For instance, Connor (nondenominational) explained that when he reveals to his peers, he makes his religion appear "simple" and "relaxed," especially if he is trying to help them "find their religion or get a little bit stronger in their religion." Alternatively, others explained that they discuss their identity casually by revealing more general information about their religiosity rather than specific details about their religious affiliation, practices, or beliefs. For 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 a member of the Church of Jesus Christ of Latter-Day Saints:

> *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."*

In another example, Maria expressed a sentiment found in a previous study (Barnes et al., 2021) when she explained that she is comfortable telling her peers that she attends church but does not feel comfortable stating that she believes in God; she also elaborated on why she feels the two sentiments are different:

> *Maria (nondenominational): "I think if someone asks, 'Oh, what are you doing after class,' and you're like, 'Oh, I'm going to go to church.'... I honestly think most students would not think that's very drastic. I don't think you're facing any risk by saying that. But I think that if there were a lecture and you were like, 'Hey guys, I believe in God'... For some reason it just has a different tone to it."*

To summarize, various factors impact whether a Christian student is willing to reveal their religious identity to their peers, 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. Some use the strategy of self-group distancing by either stating that they believe in science, explaining that they are

politically progressive, or describing that they disagree with some of the ideals and behaviors of the church or its followers. Alternatively, some used the strategy of integration by speaking positively about their religious identity when revealing, and others tried to avoid negative perceptions by making it clear they were not trying to convert their peers or by discussing their religion in a laid back or nonspecific way.

Finding 4: Christian students' religious identity impacts their comfort when interacting with their peers in their biology courses.

Students' religious identity made them feel less comfortable during specific peer interactions.

Students mentioned a variety of ways in which their religious identity impacts their comfort. Many students mentioned at least one specific situation in which their religious identity made them feel less comfortable during peer interactions in their biology courses. Many students felt less comfortable during peer interactions where they were discussing specific controversial topics that are relevant to their religion, such as evolution, bioethics topics, and religion itself. For instance, when asked if there were any topics she felt less comfortable discussing as a religious student, Maria mentioned that she is less comfortable discussing how life began because the topic is controversial:

> *Maria (nondenominational): "I mean, definitely the start of life, like, what is the design of the world? If God does exist, what is his role? I think the beginning of life is really where people focus the controversy."*

Alternatively, Melody mentioned that she would feel uncomfortable discussing abortion because she does hold the same beliefs about the topic as most other religious individuals:

> *Melody (Catholic): "The thing is, I am pro-choice, which is very different from my religion. So, if people knew I was Catholic, and then I said I was pro-choice to people who are pro-life, if there were other people who are religious, I would feel very judged by them."*

We have seen similar sentiments in various studies conducted by members of our research team. For instance, Barnes and colleagues found that Judeo-Christian students were less comfortable discussing evolution and bioethics topics in their biology courses (Barnes, Truong, et al., 2017). Additionally, in a recent study on students' experiences in bioethics courses, our team found that religious students were less comfortable than their nonreligious peers when learning about controversial bioethics topics like abortion and physician assisted suicide (Edwards et al., 2022). Thus, it is unsurprising that students reported feeling less comfortable engaging in peer discussions about controversial topics that are relevant to their religious identities in this study.

Some students also felt less comfortable during peer interactions if they had not formed an opinion on or were less knowledgeable about the topic of discussion. For instance, Grace said:

> *Grace (LDS): "If I have a solid thought on something, and I've wrestled with it, and I've really thought about it, I'm more inclined to share it. But topics that I'm like, 'Oh, I don't know a lot about,' I feel less comfortable sharing."*

Similarly, when studying students' experiences in bioethics courses, we found that students felt comfortable discussing various controversial topics if they had a well-formed view on them or were confident in their opinions about them (Edwards et al., 2022).

Finally, as seen in previous studies on Judeo-Christian students (Barnes, Truong, et al., 2017), some students said that they felt uncomfortable during peer interactions in their biology courses because, as religious students, they feel like a minority in those courses and interactions. For instance, Maria expressed that she felt like religious students are the "sore thumb" in biology courses:

> *Maria (nondenominational): "I feel like most biology students are not religious. So, you're just simply not in the majority. I feel like anyone who's not in the majority belief of thoughts... you're like the sore thumb… I think that if you were to take a sample of like 10 biology students in a large 300-person lecture class, I feel like one out of 10 would be religious. So, I feel like in those instances, if you were to bring up religion, you would now kind of have that label that you're the religious biology student. Whereas I don't think that that one person is looking at the other nine and being like, 'They're the non-religious biology students.'"*

This finding is particularly interesting because religious students are not a minority in biology classes. Over half of the students enrolled in undergraduate biology courses identify as Christian (Barnes, Dunlop, et al., 2020); thus, students' idea that they are in the minority in their biology courses is an incorrect assumption. However, this misconception aligns with some of our other findings in the study. Students thought that

revealing was beneficial both because doing so may help other students feel comfortable revealing and because they may find other religious students in their courses.

Additionally, students reported that overall, they had few opportunities to reveal their religious identity in their biology courses, which means they may not be able to reap their proposed benefits of revealing very often. Thus, students' misconception that religious students are a minority in their biology courses may be perpetuated by the lack of opportunity to reveal. If students had the opportunity to reveal more frequently or if the classroom environment allowed students to be more open about their religious identities, their misconception may be corrected because they would find other religious students, ultimately allowing them to feel more comfortable and represented in the course.

In summary, various factors made religious students feel less comfortable during peer interactions in their biology courses, including discussions about controversial topics or topics they had not previously formed an opinion about, as well as the general feeling that, as a religious student, they are a minority in their peer interactions in their biology courses.

Students felt more comfortable during peer interactions when there were other religious students around them.

Though some factors caused Christian students to feel a degree of discomfort during peer interactions, many students reported that they felt comfortable from representation in a biology course or discussion. In other words, they felt comfortable because they were exposed to or interacting with others who were religious like them. Melody (Catholic) explained that she felt this was a common cause of comfort when she

said, “Everyone feels more comfortable if they're with people who have the same viewpoints as them.” In a more personal explanation, when asked how she would feel if another student in her biology course told her they were religious, Sofia (Protestant) stated, “I would feel more comfortable; I'd be a little more open, just because I know that they understand where I'm coming from, the way that I carry myself, and my actions.” Similarly, Amie expressed that she specifically feels comfortable when she knows that other students in her course share her faith because it helps show her that she’s not alone:

> *Amie (LDS): “If you know that you're not alone in your religion, it makes it so much easier... I think I would feel relieved to know that I'm not alone because I know that I'm not, but I don't know who else is religious. And so it would be a relief to truly know that I'm not alone.”*

Here, we saw that students’ perceived benefits of revealing aligned with what made them comfortable in the course: students felt that revealing was beneficial because they may find other religious students or help other religious students feel comfortable enough to also reveal, and when they knew that other students in their course were religious, they felt more comfortable during peer interactions. Additionally, a previous study found that Judeo-Christian students feel more comfortable in biology courses when their instructor shares stories about religious scientists because they felt more represented (Barnes, Truong, et al., 2017). In this study, we saw that during peer interactions, students feel similar comfort from representation when they know of peers who are also religious. This may be because peer representation is more relevant than role models in the context of peer discussions. Thus, in active learning courses, it may be important for

biology instructors to highlight that a large portion of biology students are religious, in addition to sharing information about religious scientists. That way, students feel represented and know they are not alone in their religious identity during peer discussions in biology. Additionally, allowing students more opportunities to reveal their religious identity to one another can help them recognize that there are more religious students in their courses than they believe.

Students had differing opinions about how comfortable they felt when interacting with peers who they had already revealed to.

Finally, we asked students how comfortable they would feel if they told a peer that they are religious and then had to interact with that same peer again in the future. Students had differing opinions about how comfortable they would feel in that situation. Some reported that their comfort depended on how their peer reacted when they first revealed that they were religious. Those students expressed that they would feel more comfortable if their peer were respectful of their views when they revealed but would feel less comfortable if their peer had been judgmental towards them because of their religious identity. For instance, Levi said:

> *Levi (Protestant): "I guess it depends on how that first conversation goes. If they're accepting of me, then it's like, 'Okay, well they already know who I am. So I can say more about what I believe. I can say things more without a filter because they understand me.' But if they're rude about it, then it's like, 'Okay. Well, it's going to be kind of uncomfortable because they know what I believe, and they don't like it.'"*

Some students expressed that they would feel less comfortable when interacting with peers who knew they were religious because they felt they would have to behave in ways that positively represented their faith when interacting with those peers again in the future. For instance, Olivia expressed that sometimes, when people know she is religious, she feels a lot of pressure to "represent Christianity well":

> *Olivia (nondenominational): "I just feel sometimes it's hard to be someone who's like an outwardly a Christian and who other people know as a Christian, because they look to you a lot to see what your opinion would be… I think there's just a lot of pressure maybe to represent Christianity well."*

Similarly, Molly explained that she would be more cautious of her words and behaviors if others knew that she was religious so that they would not think poorly of her religion as a whole:

> *Molly (LDS): "I would say I would be a little bit more careful in my wording if somebody knows that I'm religious... Not trying to offend people or being just very clear with my wording… If people already know that I'm religious, and there hasn't been any judgment about me being religious, then I tend to worry about, okay. If this person doesn't interact with a ton of people who are religious, then I'm the religious person. So if I do anything that's off color, then I don't want them to attribute that to, oh, religious people are this way, instead of thinking, oh, this person did this one thing. So I try to be careful of that."*

Similar feelings of pressure impact students in specific minority groups, such as members of the Black community. One study found that high-achieving Black

undergraduate students feel pressure to represent the Black community in a way that combats negative stereotypes, such as being especially nice or non-aggressive (Fries-Britt & Griffin, 2007). Thus, it seems that students with other stigmatized identities feel pressured in similar ways as Christian students reported in this study.

Alternatively, many students also said that they felt more comfortable during discussions with peers who knew they were religious. Some felt this way because their peer would know them better after they had revealed. For instance, Erin said:

> *Erin (Catholic): "Being religious is who I am. So if that's something that I've shared, I would feel more comfortable because I would think that people kind of have an idea of what I believe in and how I may see things."*

Similarly, Grace explained that she felt revealing would help her build friendships with her peers that would then make her feel more comfortable in future discussions:

> *Grace (LDS): "When you share, I feel like that's a personal thing. So, if I share that personal aspect of me, somebody shares something personal of them, and then that creates trust, somebody who's on your side, I guess, in conversations. You have a friend."*

Some other students reported that they would feel more comfortable in discussions with peers who already knew they were religious because they no longer had to worry about how their peer would react if they were to find out. For instance, Lori said:

> *Lori (nondenominational): "I guess I feel more free that they know that I'm a Christian already and they still will talk to me or accept me. So then I have more*

free freedom to be myself in those peer discussions... I feel more comfortable bringing up my faith because they already know that I'm a Christian. Whereas if they didn't know that, then in a way I feel like be more awkward… If they're open when I reveal, then I feel more comfortable bringing up my faith more. Whereas, if I haven't brought up that foundation point that I'm a Christian, then I wouldn't know how they would respond to me bringing up my faith."

In summary, we identified that students felt differentially comfortable when interacting with peers who already knew they were religious. Some students claimed that their comfort depended on how their peer reacted when they revealed. Alternatively, some said they were less comfortable after revealing due to the pressure to represent their religion well, and many reported that they were more comfortable after revealing because they would be closer to the peer or because they would not have to worry about revealing anymore.

Finding 5: Christian students experience far 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 experiences and negative experiences related to their religion when interacting with faculty members, instructors, and members of the biology community more broadly (Barnes et al., 2021; Barnes, Truong, et al., 2017). However, we found that during peer interactions, few students actually experienced stigma in their biology courses, and most students instead had positive experiences.

Some students did report that they had experienced stigma during peer interactions in their undergraduate biology courses. For example, similarly to previous studies (Barnes et al., 2021; Barnes, Truong, et al., 2017), 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 in an online biology course assumed that religious individuals did not believe in evolution:

> *Camila (Catholic): "We were in a little breakout room, and 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 these things because there's so much evidence for it. And 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 their peer make negative comments or jokes about religious people during peer interactions in their biology courses. 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): "I mean we were just discussing evolution… Personally, I don't know who they were. They were just random classmates of mine. They were just discussing evolution and saying, 'Yeah, I don't believe in God, blah, blah, blah, blah, blah,' that kind of stuff. It turned into, 'Being religious kind of sucks.*

I'm atheist. I don't believe in God,' this and that, and more and more of them joined in."

Here, we saw that, like Brandon and Camila, most 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 they were in the presence of one. However, many students explicitly stated that they had never experienced stigma when interacting with their peers in their undergraduate biology courses, especially 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 like a neutral disposition to it. It's not like they're not super excited. They also don't really hate it. They just don't really care... As I said before, 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 despite never having experienced any. For example, Kristin said:

Kristin (LDS): "Well, I feel like most people I've met are really inclusive. So I don't really know why I'm worried about judgment. I feel like most people at this

university are really accommodating just because it's such a diverse school. There's a lot of different religions and I think that people totally understand."

Similarly, Molly explained that her fear of judgment is unfounded, and she speculated that social media may be responsible for her anticipated stigma:

Molly (LDS): "Every once in a while, when I'm having discussions with my peers, there's this thought in the back of my mind that, Oh, they're going to find out that you're 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 of any sort, which I think is interesting. Because it's pretty much unfounded in my actual experiences... I think it's more of a larger social thing. I think I make assumptions about people's thinking... I assume that people will have assumptions about me because I'm religious, mostly just because of nonspecific things I've seen on social media."

In fact, most students reported that they'd actually had a positive or neutral 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 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 upbringing and bringing biology into that, which was very interesting."

To summarize, though most students anticipate stigma from their peers about being religious, comparatively few students actually experienced such stigma. Some students explained an experience in which a peer in one of their biology courses had assumed religion and science are incompatible, and others reported instances in which a peer made negative comments or jokes about religious biology students specifically or religious individuals more broadly. However, many students explicitly stated that they had never experienced stigma about their religion during peer interactions in their biology courses, and most students reported having had a positive or neutral experience with their peers when they revealed that they are religious.

Here, we saw that there was a large difference between the proportion of students who anticipated stigma and the proportion of students who actually experienced it. Interesting, this disconnect between anticipated and experienced stigma extended to the specific types of stigma students anticipated as well. Of the stereotypes that students worried they would be associated with, the most commonly cited one was that students worried their peers would assume they did not believe in science. However, very few students had experiences where their peers actually expressed such ideas about religious individuals. Similarly, though many Christians perceive that there is bias against them in academic biology, one study found that biology instructors did not have a negative bias

against Christians broadly (Barnes, Truong, et al., 2020). Though that study found that biology instructors did have a bias against fundamental and Evangelical Christians, the lack of bias against Christian students overall corroborates our finding that Christian students in our study anticipated more stigma than they actually experienced. It should be noted that this difference between anticipated and experienced stigma is comparable to the difference between the degree of perceived and actual conflict between religion and science. Religion and science operate within two nonoverlapping domains of knowledge and, thus, do not conflict (Gould, 1999). However, many individuals still believe that religion and science—evolution in particular—cannot coexist, including undergraduate biology students (Barnes, Dunlop, et al., 2020). In a 2020 study, members of our research team surveyed students about their perceived conflict between religion and science and found that over half of their sample did not think it was possible for someone to believe in God and accept evolution (Barnes, Dunlop, et al., 2020). 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, it is possible that reducing the degree of perceived conflict between religion and science may also reduce religious students' anticipated stigma during peer interactions in biology courses.

Previous studies investigating Christian students' experiences in biology have found that students have both positive and negative experiences when revealing their religious identity in biology courses (Barnes et al., 2021; Barnes, Truong, et al., 2017). However, none have noted such a stark difference between the degree of anticipated and

experienced stigma in the classroom. Thus, this finding may be unique to peer interactions in biology courses.

Additionally, students mostly experienced stigma from peers who did not know they were religious; only a couple of students reported experiencing stigma when they had actually revealed their religious identity to their peers. This brings greater relevance to the idea that we may want to teach students how to be culturally competent because they seem to respect their peers when they know about their identity, but stressing the importance of respecting all identities regardless of if they know whether someone has them will help make biology classrooms more inclusive for students with CSIs like Christianity.

Intersectionality of identities may compound the challenges of active learning

Students' identities do not impact their experiences in isolation. Thus, the experiences of students with multiple stigmatized identities likely compound on one another, which means it is important to consider students holistically when analyzing their experiences in the classroom. For example, previous studies have shown that during groupwork, students with marginalized racial/ethnic identities tend to organize into groups with students who also have those identities (Freeman et al., 2017). Additionally, in another study, when given the choice to be a collaborator, leader, listener, or recorder during group work, Asian American and underserved American students were more likely than their white peers to prefer taking on the passive role of listener during group work, and Asian American students were more likely than white students to report that someone in their groups dominated their group discussions (Eddy et al., 2015). Because

students with different racial or ethnic identities have unique experiences in active learning courses, it makes sense that Christian students who are also racial minorities could have different experiences than Christians who are white.

Members of our research team previously found that intersectionality of identities impacted Christian graduate students' experiences during their biology programs (Barnes et al., 2021). We also saw this theme emerge for undergraduate students; some students mentioned that their experiences as a Christian student during peer discussions in their biology courses may have been impacted by the intersectionality of their religious identity with another of their personal identities, particularly their race or ethnicity. For example, Julia (Catholic) expressed that her experiences as a Mexican student were highly intertwined with and hard to parse out from her experiences as a religious student when she said, "Since 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. So 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 from 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 and that's not a targeted group here. I don't feel like it is at all [at this location]. So I think I don't really face any repercussions."*

Though the samples of students of color from this undergraduate study and the study on graduate students were small, intersectionality arose as a theme in both. Here, Asian and Hispanic students were a minority of the students who we interviewed, yet this theme still arose from both groups. This implies that intersectionality may be an important factor to consider for the experiences of Christian students who are also racial or ethnic minorities. Indeed, we found in our past study that students of color in undergraduate biology classes tend to identify as Christian at much higher rates than white students (Barnes, Supriya, et al., 2020) and this is especially true for Black students who are the only racial/ethnic group that remains majority Christian in graduate biology programs (Google et al., in preparation). We did not interview any Black students in this study, so future studies should interview Black Christian students to determine how intersectionality may impact their experiences in biology broadly and during peer interactions specifically.

The need for culturally competent students in active learning courses

Our results highlight that, though previous studies have investigated instructor talk to determine how instructors establish inclusive learning environments (Seidel et al., 2015), we may need to study student talk as well to investigate whether the language that *students* use fosters an inclusive environment. Similarly, as we build active learning courses, it may not be sufficient to just have instructors know to be culturally competent. As we create more student-centered classrooms, the importance of students being culturally competent increases. In a previous study, non-religious students claimed that culturally competent instruction changed their views of their religious peers (Barnes, Elser, et al., 2017), and teaching non-religious students how to be culturally competent themselves may further shape their views and behaviors to be more accepting of their religious peers. Another previous study found that when students participated in a two-week long active learning biology program to help them transition from high school to college, they felt they were able to take a more equitable approach to group work (Cooper et al., 2017). The study concluded that their findings showed it is possible to prime students how to maximize their own and others' experiences in active learning courses (Cooper et al., 2017). Thus, training students on how to engage with one another within their undergraduate biology courses could help make active learning courses more inclusive, especially during their peer interaction components.

We saw that most students who experienced stigma only experienced it from students who did not know they were religious. So most students did not seem to be outwardly malicious when someone revealed their Christian identity. Therefore, teaching students how to be equitable in their active learning courses and informing them about

what language they should and should not use regardless of who they are speaking to could help minimize instances where they accidentally insult their peers who have CSIs. This could then improve the experiences of Christian students in science. Based on our findings, increasing students' cultural competence could help reduce Christian students' anticipated stigma and in turn, help them to feel more comfortable revealing, which would allow them to find other religious students in their courses. Student cultural competence could then help increase Christian students' comfort in active learning courses by helping them feel more represented in their interactions, reducing their misconception that they are a minority in biology, and reducing their discomfort when discussing controversial topics related to their religious identity. Importantly, teaching students how to be culturally competent could improve the experiences of students with other CSIs, too, because students would ideally learn how to be more inclusive of all individuals, not just Christians. Further research is needed to determine how to teach students how to be culturally competent in active learning courses.

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 (Michael Lipka & Benjamin Wormald, 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.

In this study, we 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. Other religions are stigmatized in different ways and contexts than Christianity, which means that the experiences of non-Christian religious students during peer interactions in biology may differ from those of Christian students. For example, in the United States, Christianity is primarily only stigmatized in science, whereas other religions, such as Islam, are stigmatized in society more broadly (Casey, 2018). Therefore, the experiences of Muslim students as a stigmatized group outside of the classroom may impact their degree of anticipated and experienced stigma in the classroom. Additionally, in some religions, it is custom for followers to wear clothing that symbolizes their religious identity, which means those identities do not function as CSIs like Christianity does. Thus, using the CSI framework may not be appropriate to investigate the experiences of students with those religious identities. However, 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.

Similarly 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, students had fewer in-person experiences due to the online instruction format adopted during the pandemic. This may have impacted some of our results because students may not have had as many experiences to draw from when responding to our interview questions. Thus, future studies could investigate Christian students' experiences during peer discussions again in future semesters to see if our findings hold when students have had more in-person biology courses and ultimately more in-person peer interactions.

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APPENDIX A

SUPPLEMENTAL MATERIALS

This supplement contains the following:

Additional File 1: Copy of Survey Questions Analyzed:

Religious Affiliation:

I most closely identify as:

- Buddhist
- Christian (for example, Catholic, Protestant, Orthodox, CJD-LDS, nondenominational)
- Hindu
- Jewish
- Muslim
- I don't identify with a religion (for example, atheist or agnostic)
- Option not available, please describe _____
- Prefer not to answer

If "Christian" is chosen:

With what denomination of Christianity do you most closely identify?

- Catholic
- Jehovah's Witness
- Orthodox
- Nondenominational
- Protestant (for example, Baptist, Methodist, Pentecostal, Lutheran, Presbyterian)
- The Church of Jesus Christ of Latter-day Saints
- Option not available, please describe _____
- Prefer not to answer

Do you identify as Evangelical Christian?

- Yes
- No
- I'm not sure
- Decline to state

Religiosity:

Please indicate how much you agree or disagree with the following statements:

I attend religious services regularly (when they are available).

- Strongly disagree
- Disagree

- Neutral
- Agree
- Strongly agree

I believe in God.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I consider myself a religious person.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I consider myself a spiritual person.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Year in School:

What is your year in school?

- First/sophomore
- Junior/Senior
- Postgraduate
- Decline to state

Biology Major:

Is your major in biology? (includes biomedical sciences, biology and society, conservation biology, genetics, neurobiology/physiology/behavior, microbiology, medical microbiology, molecular bioscience, neuroscience)

- Yes
- No

Intended Career:

What is your intended career?

- Healthcare professionals (examples include Physician, Nurse, EMT). Please describe: _____
- Research scientist (examples include Professor, Biologist, Chemist, Zoologist, Physicist, Geologist): Please describe: _____
- Option not available. Please describe: _____
- Decline to state

Parent Education Level:

What is your parents' highest completed level of education? If you have more than one parent with differing levels of education, choose the higher of the two.

- Less than high school completed
- High school diploma or GED
- Some college but no degree
- Associate degree (for example: AA, AS)
- Bachelor's degree (for example: BA, AB, BS)
- Master's degree (for example: MA, MS, MEng, MEd, MSW, MBA)
- Higher than a Master's degree (for example: PhD, MD, JD)
- Decline to state

Gender:

I most closely identify as:

- Woman
- Man
- Nonbinary
- Please describe your gender identity if the best option is not listed: _____
- Decline to state

Race:

Choose the race/ethnicity with which you most closely identify:

- American Indian, Native America, or Alaskan Native
- Asian (Middle Eastern, East Asian, Southeast Asian, South Asian, West Asian)
- Black or African American
- Hispanic or Latinx

- Native Hawaiian or other Pacific Islander
- White
- Multiracial (please describe your multiple racial/ethnic identities) _____
- Option not available, please describe: _____
- Decline to state

Political Affiliation:

Please indicate your political identity:

- Extremely Liberal
- Liberal
- Slightly Liberal
- Moderate
- Slightly Conservative
- Conservative
- Extremely Conservative

View of Evolution:

There are no right or wrong answers to this question. Please indicate which of the following statements most closely represents your personal view, **based on your personal opinion**:

- All forms of life were first brought into being in their present form by God 6,000-10,000 years ago at the same time. *(Young Earth creationism)*
- All forms of life were first brought into being in their present form by God at different times over billions of years. *(Old Earth creationism)*
- Some forms of life evolved from earlier forms, but God created groups of organisms such as reptiles, birds, mammals, and humans separate from one another and organisms that currently exist have evolved slowly from those first creations. *(Creationism with some evolution)*
- Almost all forms of life evolved from earlier forms, but humans were created by God in their present form separate from the rest of life. *(Humans only creationism)*
- All forms of life evolved from earlier forms, but God intervenes from time to time to shape or override evolution. *(Interventionist evolution)*
- All forms of life evolved from earlier forms, but God set up evolution from the start in a perfect way so that it would fulfill God's purpose and no subsequent intervention was necessary. *(Theistic evolution)*

- All forms of life evolved from earlier forms, but life and evolution were first set in motion by God without a specific purpose or plan. *(Deistic evolution)*
- All forms of life evolved from earlier forms, but I'm not sure whether any God was involved in evolution. *(Agnostic evolution)*
- All forms of life evolved from earlier forms, but no God has ever played a role in evolution. *(Atheistic evolution)*

**The italicized text in parentheses is the technical view of evolution that corresponds with each statement. The italicized text was not included on the official survey, but it is included here for readers' reference.*

Additional File 2: Copy of Interview Questions:

1. Talk to me a bit about your religious identity.
2. When you are interacting with peers in your biology courses, are you ever reminded of your religious identity?
3. Do you ever consider your religious identity when choosing who to sit by in class?
4. Talk to me about what you perceive are the potential benefits of being religious when interacting your peers in your biology courses, particularly during peer discussion.
5. Talk to me about what you perceive are the potential disadvantages are of being religious when interacting with your peers in your biology courses, particularly during peer discussion.
6. To what extent do you reveal that you are religious to students in your biology courses?
7. 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?
8. Can you tell me about instances when you *have* revealed that you are religious to one of your peers in your biology courses?
9. How do you decide whether or not to tell a peer in your biology courses that you are religious?
10. Talk to me about the potential risks you see, if any, of revealing your religious identity to other students in your biology classes.
11. Talk to me about the potential benefits you see, if any, of revealing your religious identity to other students in your biology classes.
12. 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?
13. 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?
14. Are there particular ways you talk about your religious identity with your peers to avoid any negative perceptions?
15. 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?
16. Have any of your peers in your biology courses ever done anything that made you think they *did* value you as a person who is religious?
17. How would you feel if another student revealed to you that they were religious during a discussion in your biology course?

    a. Would your feelings depend on whether someone had the same religious identity than you?
    b. How do you think these feelings compare to how you would feel if another student revealed that they are an Atheist?
18. How does your religious identity influence your comfort level when you are interacting with your peers, particularly during peer discussion?
    a. Are there any topics that you would feel less comfortable discussing because of your religious identity?
        i. Like what?
19. Logic question:
    a. If they said they have revealed: To what extent do you feel
    b. If they said they have not revealed: To what extent do you think you would feel
        i. comfortable in a peer discussion where you have revealed that you are religious to at least one other person?
20. Is there anything else you would like to talk about related to your experiences as a religious student during peer discussions in your biology courses?

Additional File 3: Copy of Codebook Used for Qualitative Analysis:

Salience:

a) **Specific topics:** Student explains that their religious identity is more salient when they are discussing particular topics with their peers that may conflict with their identity or topics for which their opinions are partially shaped by their religion such as evolution, genetics, or bioethics topics.
b) **Differences among students:** Student explains that their religious identity is more salient when they are interacting with their peers and are reminded that their views or behaviors are different from their peers' due to their religious identity.
c) **Awe at creation:** Student says they are reminded of their religious identity when they are discussing a science topic that they perceive to be incredibly intricate or impressive because it reminds them that their creator made everything and is amazing
d) **Not reminded:** Student says their religious identity is never especially salient when they are interacting with their peers.
    I. **Silo religion and science:** Student says that when they are talking with their peers, they keep science separate from their religion. Student may say they try to think about the science itself rather than thinking about what their religion would say about it.

Benefits of being religious:

b) **More open-minded:** Student states that one benefit of being religious is that they are more open-minded, respectful, or empathetic when hearing their peers' views.
a) **Passion for Biology:** Student explains that one benefit of being religious is that their religion increases their enthusiasm, appreciation, or passion for biology.
b) **Different perspective:** Student says that one benefit of being religious is that they add unique perspectives to conversations in biology courses because of their religious background.
c) **Already considered their views:** Student says that one benefit of being religious is that, because of their religious identity, they have already deeply thought about their views on many potentially controversial issues that come up in class and may know what they think about those topics already. Student may also say that students who are not religious may not have thought about their views on those topics until they were brought up in class.

Disadvantages of being religious:

a) **Stereotypes:** Student says that one disadvantage of being religious is that if their peers find out about their religious identities, they may make assumptions about the student and associate them with stereotypes of religious people or judge them.
b) **Closed-minded peers:** Student says that one disadvantage of being religious is their peers may be unwilling to listen to them, be closed-minded towards them, or be confrontational if they find out they were religious.
c) **Difficulty relating to peers:** Student says that one disadvantage of being religious is that because they are religious and they perceive most of their students are not, many of their peers think or behave differently than they do, which can make it difficult to connect with them.
d) **Making other students feel uncomfortable:** Student says that one disadvantage of being religious is that their being religious may make other students in the class feel uncomfortable. Student may mention that their peers' discomfort could stem from their past personal experiences with religion/religious people or the assumptions that they may make about religious people's attitudes or behaviors.

Tendency to Reveal:

a) **Never or rarely because of (anticipated stigma):** Student says that they rarely or never reveal their religious identity to peers in their biology classes depending on the person and situation because they have concerns about what their peer would think of them if they were to reveal.
b) **Never or rarely because no opportunities:** Student says they never or rarely reveal their religious identity in their biology class because there are not opportunities. The student does not say that they would reveal if they could.
c) **Freely:** Student says that they freely reveal their religious identity to peers in their biology classes any time it feels relevant or comes up in conversation.
    I. **Reveals Frequently:** Student says that they frequently reveal their religious identity in their biology classes.
    II. **Reveals Rarely:** Student says that they rarely reveal their religious identity in their biology classes because they do not have the opportunity to do so, but they say that they would reveal if they did have the opportunity to.

Reveal or conceal:

a) **Open-mindedness of peer:** Student says that they would be willing to reveal if their peer seems like they are open-minded or nice or would be willing to

listen to or be respectful of their perspective OR student says they would not be willing to reveal if their peers seemed closed-minded or unwilling to respectfully listen to their perspective.

b) **Relevance to discussion:** Student says that they would be willing to reveal if it seemed relevant to the discussion they were having with their peers OR student says that they would not be willing to reveal if doing so meant bringing their religious identity up out of nowhere when it was not relevant to the conversation.
c) **Closeness with peer:** Student says that they would be willing to reveal if they knew the peer or were friends with them OR student says they would not be willing to reveal if they had just met the peer or hardly knew them.
d) **Other peer is religious:** Student says that they would reveal they were religious if their peers revealed that they were religious first.
e) **Opportunity to evangelize:** Student says that they would reveal they were religious because it may help others to become religious. Student may say it brings them joy or helps them fulfill their duty as a Christian to talk about their religion with those who are not religious. Student may also mention they could invite their peers to church or answer any questions they have about religion if they reveal that they are religious.

Anticipated Stigma:

a) **Stereotypes:** Student says that if a peer knew they were religious, they may stereotype, judge, or make false assumptions about them based on their religious identity.
    I. **Don't believe in science:** Student says that they think many individuals would assume that they don't believe in science or some aspect of it, like evolution.
    II. **Less scientifically capable:** Student says that they think many would individuals discredit them or assume they are less of a scientist or less capable of being a scientist than nonreligious individuals
    III. **No free will:** Student says that they think many individuals would assume that they cannot make decisions for themselves or are required to do and say things because of their religion.
    IV. **Judgmental or closed-minded:** Student says that they think many individuals would assume that they are judgmental of other people or closed-minded about the views of others.
    V. **Denomination specific stereotypes:** Student mentions that they think many individuals would make assumptions about them based on their specific denomination of Christianity. For example, a student who is LDS may say they think that people assume they get have many children or that the men have multiple wives, or a student who is

Catholic may say they think people might assume they are a bad person because of the views and behaviors associated with the faith, like pedophilia or homophobia.

VI. **Convert:** Student says that they think many individuals would assume that they are always attempting to convert their peers or people they interact with.

VII. **Naïve:** Student says that they think many individuals would assume they are naïve because of their faith or turn a blind eye to fact and truth.

b) **Social repercussions:** Student says they may lose friends or be excluded from peer groups or working groups because of their religious identity. Student may also say their peers may dislike them or think less of them if they knew they were religious or be less willing to interact with them.

c) **Confrontation:** Student says that if their peers knew they were religious, it could lead to arguments, confrontation, or tension with them.

Experienced Stigma:

a) **Positive/neutral experience:** Student says that when they revealed they were religious to a peer, the experience was positive or neutral.

b) **Assumed incompatibility of religion and science:** Student says that their peers express shock or surprise at the idea that someone can be religious and accept science.

c) **Jokes/negative comments about religious people:** Student says that peers in their biology courses have made jokes or negative comments about religious people during class.

Impression management strategies:

a) **Doesn't push religion on others:** Student says that when they reveal they are religious, they will do so in a way that allows their peer to decide if they want to continue the discussion or not, or they try not to bring their religion up in discussion at all.

b) **Discusses casually:** Student says they discuss their religion in a casual way so it doesn't seem like a big deal to their peers, or student says they will bring up the commonly accepted ideals of their religion but not the more controversial ones. For instance, students may say they go to church but not reveal more details about their specific religious beliefs. Student may also say they will bring religion up in a relaxed or simple way.

c) **Speak positively about religion:** Student says that they talk about their religion in a positive way or highlights what they like about their religion to avoid negative perceptions.

d) **Self-group distancing/assimilating:** Student reveals in a way that separates themselves from the stereotypes typically associated with religious individuals.
    I. **Accepts science:** Student reveals that they are religious but makes it clear that they also accept science.
    II. **Has individual thought:** Student reveals they are religious but discusses it carefully to make it clear that they think deeply about their faith and have free will regarding what they do and believe.
    III. **Politics:** Student reveals that they are Christian but says that they are politically liberal or progressive.
    IV. **Different than their religion:** Student emphasize that they do not agree with some of the sentiments and behavior of their church or religion, its leaders, or its followers. Students may say they believe in foundational ideals like loving one another but disagree with more controversial ideas typically associated with the faith.

Benefits of revealing:

a) **Finding other religious students:** Student says that a benefit of revealing to their peers is that they may find other students who are also religious because they feel similar to them.
b) **Religion and science coexisting:** Student says that a benefit of revealing is that they can show their peers, both those who are religious or nonreligious, that people can be religious and believe in science.
c) **Others reveal:** Student says that a benefit of revealing is that their peers may also feel comfortable enough to reveal their own religious identity.
d) **Increases closeness with peers:** Student says that a benefit of revealing is that their peers can get to know them better and they may grow closer from the vulnerability of revealing.

Comfort:

a) **Less comfortable with specific topics:** Student says the fact that they are religious makes them less comfortable talking about specific topics, such as evolution, ethics topics, and religion itself.
b) **Less comfortable because they feel like a minority:** Student says that they feel they are in a minority because they are religious.
c) **Discomfort from uncertainty:** Student says that they are uncomfortable discussing certain topics because they are not sure of their opinions about them.
d) **Less comfortable if they had revealed:** Student says that they are less comfortable during discussions with peers who knew they were religious. For

example, student may say they feel pressure to represent their entire faith well when interacting with that peer.

e) **More comfortable if they had revealed:** Student says they are more comfortable during discussions with peers who knew they were religious.
    I. **Removed fear of revealing:** They'd no longer have to worry about how the peer would react if they found out they were religious
    II. **Stronger relationships:** They would have a friend in the conversation, or the peer would know them better as a person
f) **More comfortable from representation:** Student says that they feel more comfortable when they see others who are like them, whether it be other students or individuals like professors, scientists, or other role models who are also religious.
g) **Comfortable because they don't feel judged:** Student says they feel comfortable in biology classes as a religious student because they do not believe their religious is judged or discriminated against.
h) **Comfort post-reveal depends:** Student says that their comfort level in a discussion with a peer who knows they are religious depends on how the peer responded when they found out they were religious. Student may say that they feel less comfortable if the peer responded negatively or seemed judgmental about it, or they may say that they would feel more comfortable if the peer responded positively or was open-minded and respectful when they revealed.

Opportunities to reveal:

a. **Yes:** Student says that they do think there are more opportunities to reveal their religious identity in courses that incorporate peer discussion.
    I. **Increased discussion:** Student says that they do think there are more opportunities to reveal because with increased discussion with peers comes increased opportunity for things like religious identity to come up or be shared.
    II. **Closer relationships:** Student says that they do think there are more opportunities to reveal because increased discussion means students are more likely to get close to each other, so they would be more likely to share personal information like religion. Student may say this is especially the case when they have discussions with the same peers throughout the semester.
    III. **Small group:** Student says that they do think there are more opportunities to reveal because they are in smaller groups so people may be more likely to share that they are religious in those settings or may feel more comfortable doing so.

b. **No, religion is not relevant:** Student says that they do not think there are more opportunities to reveal their religious identity because even when students are talking to each other, religion still is not relevant to the conversation, so it does not come up.

Intersectionality: Student mentions intersectionality of their identities. Student may say their willingness to reveal is impacted by the fact that they are or are not a racial minority. Student may say their religious identity is very intertwined with another aspect of their identity.

Mention anticipated stigma despite no experienced stigma: Student explicitly recognizes and mentions that they realize that they anticipate stigma from their peers due to their religious identity even though they have never actually experienced stigma.

Never experienced stigma: Student says that they have never experienced stigma during discussions with their peers because of their religious identity.

Additional File 4: Participant Demographic Table

Table S1. Each participant's religious denomination, religiosity, view of evolution, year in school, race, and political identity.

Pseudonym	Christian Denomination	Religiosity	View of Evolution	Year in School	Race	Political Identity
Jamie	Nondenominational	3.5	Theistic evolution	Junior/Senior	White	Moderate
Molly	The Church of Jesus Christ of Latter-Day Saints	4.75	Interventionist evolution	Junior/Senior	White	Slightly conservative
Megan	Catholic	3.5	Agnostic evolution	First year/Sophomore	Hispanic or Latinx	Extremely liberal
Daniel	The Church of Jesus Christ of Latter-Day Saints	4.75	Theistic evolution	Junior/Senior	White	Conservative
Grace	The Church of Jesus Christ of Latter-Day Saints	5	Theistic evolution	Junior/Senior	White	Slightly liberal
Ira	Nondenominational	2.75	Interventionist evolution	First year/Sophomore	Asian	Liberal
Peter	Nondenominational	3.5	Old Earth Creationism	First year/Sophomore	Asian	Slightly conservative
Melody	Catholic	4.25	Agnostic evolution	Junior/Senior	Hispanic or Latinx	Liberal
Erin	Catholic	4.75	Theistic evolution	First year/Sophomore	Hispanic or Latinx	Slightly conservative
Sofia	Protestant	3.5	Human only creationism	First year/Sophomore	Hispanic or Latinx	Moderate
Maria	Nondenominational	4	Theistic evolution	Junior/Senior	Hispanic or Latinx	Extremely liberal
Connor	Nondenominational	4.5	Theistic evolution	First year/Sophomore	White	Moderate
Allan	The Church of Jesus Christ of Latter-Day Saints	5	Young Earth creationism	Junior/Senior	White	Conservative
Trinity	Nondenominational	4.5	Theistic evolution	First year/Sophomore	Asian	Slightly liberal

Lori	Nondenominational	5	Creationism with some evolution	Junior/Senior	Asian	Conservative
Brooke	Nondenominational	3.75	Theistic evolution	First year/Sophomore	White	Slightly liberal
Camila	Catholic	4.25	Deistic evolution	First year/Sophomore	White	Liberal
Brandon	Catholic	4	Creationism with some evolution	First year/Sophomore	Hispanic or Latinx	Liberal
Erica	Protestant	4	Deistic evolution	Junior/Senior	White	Slightly conservative
Javier	Catholic	4.5	Theistic evolution	Junior/Senior	Hispanic or Latinx	Liberal
Macie	Nondenominational	1	Human only creationism	First year/Sophomore	White	Slightly conservative
Iris	Nondenominational	4.75	Young Earth creationism	First year/Sophomore	Multiracial	Liberal
Julia	Catholic	4.5	Agnostic evolution	Junior/Senior	Hispanic or Latinx	Liberal
Levi	Protestant	4.5	Old Earth Creationism	First year/Sophomore	White	Conservative
Luke	The Church of Jesus Christ of Latter-Day Saints	5	Creationism with some evolution	Junior/Senior	White	Conservative
Diego	Catholic	5	Deistic evolution	Junior/Senior	Hispanic or Latinx	Moderate
Olivia	Nondenominational	4.5	Theistic evolution	First year/Sophomore	Hispanic or Latinx	Liberal
Gabby	The Church of Jesus Christ of Latter-Day Saints	3.75	Theistic evolution	First year/Sophomore	White	Moderate
Amie	The Church of Jesus Christ of Latter-Day Saints	4.25	Creationism with some evolution	Junior/Senior	White	Moderate
Kristin	The Church of Jesus Christ of Latter-Day Saints	5	Creationism with some evolution	Junior/Senior	White	Slightly liberal

APPENDIX B

IRB APPROVAL

EXEMPTION GRANTED

Sara Brownell
CLAS-NS: Life Sciences, School of (SOLS)
-
Sara.Brownell@asu.edu
Dear Sara Brownell:

On 11/24/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Exploring the Experiences of Religious Students During Peer Discussions in Undergraduate Biology Courses
Investigator:	Sara Brownell
IRB ID:	STUDY00014955
Funding:	Name: NSF: Directorate for Education & Human Resources (EHR), Grant Office ID: GR3501, Funding Source ID: FP00013365
Grant Title:	GR3501;
Grant ID:	GR3501;
Documents Reviewed:	• Emails to Students and Instructors.pdf, Category: Recruitment Materials; • Interview Consent Statement.pdf, Category: Consent Form;• Interview Questions.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Letter Addressing All Modifications, Category: Other; • Pre-Interview Demographic Survey Consent Statement.pdf, Category: Consent Form;

	• Pre-Interview Demographic Survey.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Protocol, Category: IRB Protocol; • Provost Review .pdf, Category: Other; • ReCCEE Grant Proposal.pdf, Category: Sponsor Attachment;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 11/24/2021.
In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).
If any changes are made to the study, the IRB must be notified at research.integrity@asu.edu to determine if additional reviews/approvals are required. Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.
REMINDER - All in-person interactions with human subjects require the completion of the ASU Daily Health Check by the ASU members prior to the interaction and the use of face coverings by researchers, research teams and research participants during the interaction. These requirements will minimize risk, protect health and support a safe research environment. These requirements apply both on- and offcampus.
The above change is effective as of July 29th 2021 until further notice and replaces all previously published guidance. Thank you for your continued commitment to ensuring a healthy and productive ASU community.
Sincerely,

IRB Administrator
cc: Baylee Edwards