

EDUCATION RESEARCH

An exploration of how gender, political affiliation, or religious identity is associated with comfort and perceptions of controversial topics in bioethics

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Abstract

Bioethics is an important aspect of understanding the relationship between science and society, but studies have not yet examined undergraduate student experiences and comfort in bioethics courses. In this study, we investigated undergraduate bioethics students' support of and comfort when learning three controversial bioethics topics: gene editing, abortion, and physician-assisted suicide (PAS). Furthermore, student identity has been shown to influence how students perceive and learn about controversial topics at the intersection of science and society. So, we explored how students' religious affiliation, gender, or political affiliation was associated with their support of and comfort when learning about gene editing, abortion, and PAS. We found that most students entered bioethics with moderated viewpoints on controversial topics but that there were differences in students' tendency to support each topic based on their gender, religion, and political affiliation. We also saw differences in student comfort levels based on identity: women reported lower comfort than men when learning about gene editing, religious students were less comfortable than nonreligious students when learning about abortion and PAS, and nonliberal students were less comfortable than liberal students when learning about abortion. Students cited that the controversy surrounding these topics and a personal hesitancy to discuss them caused discomfort. These findings indicate that identity impacts comfort and support in a way similar to that previously shown in the public. Thus, it may be important for instructors to consider student identity when teaching bioethics topics to maximize student comfort, ultimately encouraging thoughtful consideration and engagement with these topics.

abortion; bioethics; gene editing; inclusive teaching; physician-assisted suicide

INTRODUCTION

The national report *Vision and Change* has outlined a set of core competencies that undergraduate biology students should possess by the time they graduate (1, 2), and bioethics is an important aspect of the core competency of understanding the relationship between science and society (2). Science does not act in isolation; scientific discoveries are applicable to the world around us and have implications for society as a whole (3, 4). As such, it has been recommended that undergraduate biology courses should not only focus on the concepts of biology but also provide examples of ethical dilemmas that surround the science (2).

Although bioethics can be integrated into an undergraduate biology curriculum in multiple ways, it is often incorporated as a stand-alone bioethics course. Bioethics courses are typically centered on socio-scientific issues, which are scientific topics that are relevant to society and are often controversial (5, 6). Socio-scientific issues typically comprise most of the content in bioethics courses because these topics are examples of the social, political, economic, and moral challenges associated with biology (7). For example, many

bioethics courses include topics such as the Tuskegee Study, mistreatment of vulnerable populations, reproduction-related issues, gene editing, and physician-assisted suicide (8–10).

Socio-scientific topics have the potential to induce identity conflicts within individuals if they are both relevant and controversial, which can create teaching challenges (11). Bioethics instructors can face difficulties when presenting controversial topics because 1) students may be uncomfortable with conflict in general, 2) students may be concerned about how they will be perceived by their peers if they express too strong an opinion during discussions about controversial issues, 3) students may think they will receive lower grades if they disagree with their professors in class, or 4) students may have an identity conflict with the topic and disengage (12, 13). Thus, it is important to help students in bioethics courses feel comfortable in engaging with these topics if instructors want them to be able to clarify their thinking and stances on these controversial issues.

Additionally, students often have preconceived attitudes and knowledge about controversial science topics when they enter undergraduate biology courses, and these can impact

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students' engagement with scientific ideas (14). When learning new things about controversial topics, the goal may be for students to be open to conceptual change. However, presenting just facts and not addressing values may leave students unwilling to consider conceptual change. "Conceptual change" describes a special case of learning when the to-be-learned information is in conflict with the learner's background knowledge and requires knowledge restructuring (11). The process of conceptual change requires more than simply the acquisition of new knowledge; motivation and emotion significantly impact students' willingness to change their attitudes toward controversial topics (14). The goal of many bioethics courses is to encourage students to consider ethical issues and related dilemmas that they may encounter during their future careers (15). Thus, instructors may not see conceptual change as a goal of instruction. However, students should at least be open to conceptual change in the light of new information so that they can fully consider the ethical dilemmas discussed in the course. Because of the role that motivation and emotion play in conceptual change, if students are uncomfortable while learning bioethics topics they may be less able to undergo conceptual change.

Because of the controversial nature of many of the topics presented in bioethics courses, some students may feel less comfortable than others because of their specific identities and backgrounds. The limited research that has been done in this realm has most frequently explored the relationship between students' identity and their willingness to participate in discussions about specific topics. One study analyzed the effect of gender on student language choice and communication in undergraduate psychology courses during online discussions regarding controversial topics, and researchers found that women tend to make less assertive comments than men and are more likely to leave comments in agreement with their peers, whereas men tend to leave more aggressive comments and are more likely to disagree with others than women are (16). Research has also shown that Republicans are more reluctant than Democrats to discuss a wide variety of topics in their college courses, particularly those that are political (17). Finally, regarding religion, studies have shown that non-Buddhist religious students (e.g., Christians) are more reluctant than Buddhist or atheist students to participate in discussions about politics in their college classrooms (17). In another study, biology instructors observed that religious students may worry that they will be judged about their views on stem cell research in their high school biology courses, causing them to primarily stay silent during discussions (18). Thus, gender, political affiliation, and religious affiliation may be related to how students experience bioethics content and how comfortable they feel about engaging in discussions about it.

Even though bioethics aligns with various core competencies in biology education, and we know bioethics topics can be controversial in society, no studies that we know of have examined students' perceptions and comfort when learning about bioethics topics in bioethics classes. To address this gap in the literature, we designed a study to specifically explore students' perceptions of three commonly taught bioethics topics (gene editing, abortion, and physician-assisted suicide) and their comfort when learning about these topics in undergraduate bioethics courses. Because we have reason

to believe that identities may influence students' experiences with these topics, we also examined how gender, religious identity, and political identity may influence student responses. Based on previous research on identity conflict and the culture of science and biology (19–21), we would predict that religious students, women, and nonliberal students may be less comfortable than nonreligious students, men, and liberal students when learning about various topics covered in bioethics courses.

Our specific research questions were as follows:

- 1) Before instruction, to what extent do students in bioethics courses support gene editing, abortion, and physician-assisted suicide?
 - a) Are there differences in student support levels based on gender, religious affiliation, or political affiliation?
- 2) Are there differences in the comfort levels of students from different groups when learning about gene editing, abortion, and physician-assisted suicide?
- 3) What factors influence students' comfort levels when learning about gene editing, abortion, and physician-assisted suicide?

METHODS

We surveyed students from five elective bioethics courses offered to biology majors and nonmajors at a research-intensive institution in the southwestern United States in fall 2020. Each of the five courses were different iterations of the same bioethics course, titled "Bioethics," and they were all taught by a different instructor. At this institution, Bioethics is one of many courses that can be used to satisfy a degree requirement for biology majors. Because of the COVID-19 pandemic, every section of the course was delivered via either synchronous or asynchronous remote/online instruction.

Five of the instructors teaching bioethics agreed to send two surveys to students in their course and to offer students a small amount of extra credit for completing the surveys. These instructors e-mailed the first survey during the first 2 weeks of the course so that we could explore student perceptions of bioethics topics before they learned about them. Instructors then sent the second survey during the final 2 weeks of the course so we could assess the comfort/discomfort students experienced while learning about these topics in the course. All research was approved by Arizona State University's Institutional Review Board (protocol 00012078).

The Surveys

Before conducting our study, we gathered bioethics course syllabi from all the instructors at this institution who were teaching bioethics to determine which controversial topics were introduced in each course. Then, we compared the topics in each course and chose common topics taught in all courses. We found that all instructors taught gene editing, abortion, and physician-assisted suicide. Based on this list of topics and using prior literature on common perceptions about these topics (22–25), we created a survey to explore student support for these topics before learning about them. To explore the comfort/discomfort they experienced while

learning about these topics, we created a second survey to administer at the end of their bioethics course.

We conducted four cognitive interviews (26, 27) with undergraduate students for both surveys to establish response process validity and identify whether any items on the survey were unclear or misinterpreted (28). We modified the items on each survey based on the cognitive interviews. For example, when students misinterpreted an item or found it to be confusing, we revised the item based on the students' feedback to be clearer. We also piloted the survey in summer 2020 in one bioethics course during the final week of the course to identify any weaknesses in the survey. We modified some of the logic of the open-ended response questions based on the pilot so that students who were less than completely comfortable when learning a topic were able to describe why they were less than completely comfortable. A copy of all final survey questions administered and used in the analyses can be found in the Supplemental Material (available at <https://doi.org/10.5281/zenodo.5838973>).

Support for gene editing, abortion, and physician-assisted suicide.

To explore student support for abortion, gene editing, and physician-assisted suicide before students learned about bioethics, we asked students to choose whether they supported gene editing, abortion, and physician-assisted suicide in all, certain, or no situations. If a student selected that they support one of these topics only in certain situations, they were provided a list of specific scenarios and asked to select which ones they supported. We created these scenarios based on those used in previous studies that investigated the opinions of members of the American public (22–25) as well as comments provided in our cognitive interviews and pilot study.

Comfort when learning gene editing, abortion, and physician-assisted suicide.

Our second survey was intended to document student comfort when learning about abortion, gene editing, and physician-assisted suicide in bioethics courses, and it included both open-ended and closed-ended questions. First, students were asked to indicate how comfortable they felt learning about each topic as 1: not at all comfortable, 2: slightly comfortable, 3: moderately comfortable, 4: mostly comfortable, or 5: completely comfortable. Then, students who selected that they were completely comfortable were asked to explain why they felt completely comfortable learning about that topic. Students who selected anything other than "completely comfortable" were asked to explain why they felt less than completely comfortable learning about that topic. Finally, students were asked to indicate how comfortable they were in the overall course. Students who selected that they were completely comfortable in the overall course were asked why they felt completely comfortable. Students who selected anything other than "completely comfortable" were asked to explain why they felt less than completely comfortable in the course.

Demographics.

At the end of the surveys, students were asked demographics questions, including their gender, their political affiliation, and their religious affiliation. We recognize that gender is

not a binary but a spectrum and highlight the limitation of treating this variable as dichotomous (47). For gender, students were asked whether they most closely identified as woman, man, nonbinary, or something else, which they were then asked to describe. Students were also able to select that they preferred not to answer. We then asked students to identify themselves as 1) extremely liberal, 2) liberal, 3) slightly liberal, 4) moderate, 5) slightly conservative, 6) conservative, or 7) extremely conservative. Finally, we asked students to self-identify from the following list of religious affiliations: 1) Buddhist, 2) Christian, 3) Hindu, 4) Jewish, 5) Muslim, 6) I don't identify with a religion, 7) option not available, or 8) prefer not to answer. A copy of these demographic questions can be found in the Supplemental Material.

Analyses

Three hundred twenty-eight students (response rate = 67.8%) completed the first survey before instruction, and 280 students (response rate = 57.8%) completed the second survey after instruction. We classified students as having completed the survey if they answered at least 95% of the questions and indicated that they gave honest, attentive responses [see honesty check question in the Supplemental Material (29)].

To determine student support for abortion, physician-assisted suicide, and gene editing at the start of bioethics, we calculated frequencies of students who supported each topic in no, some, or all situations before instruction. For students who chose "some situations," we calculated the percentage of students who supported each situation listed.

To determine whether there were differences in student support before instruction based on gender, religion, or political affiliation, we first categorized students as 1) a man or woman, 2) religiously affiliated or not affiliated, and 3) politically liberal or not politically liberal. To run these analyses, we removed gender nonbinary students because there were too few of them to include in our statistics as their own group. For religiously affiliated, we included students who identified as Buddhist, Christian, Hindu, Jewish, or Muslim, as well as students who selected "option not available" but described that they identified with another religious affiliation associated with these five religions (e.g., Catholic). Students who selected that they did not affiliate with a religion were categorized as not religiously affiliated, or nonreligious. Students who did not fit into either category (e.g., students who selected "prefer not to answer" or those who selected "option not available" and then described that they were "spiritual") were removed from our analyses because there were too few of them to include in our statistics as their own group. Finally, we divided students into the groups of "liberal" and "nonliberal" by classifying any student who selected that they were extremely liberal, liberal, or slightly liberal as "liberal" and any student who reported that they were moderate, slightly conservative, conservative, or extremely conservative as "nonliberal." We made this distinction because of the stigma associated with being conservative on college campuses, particularly in biology academic units; studies have found that conservative students are more reluctant to share their views on controversial topics and feel they may be judged for their views (17),

and we have previously seen that students who hold conservative viewpoints may label themselves as moderate because of this stigma. Thus, we wanted to differentiate between liberal and nonliberal to account for this. We then ran ordinal regressions to explore whether there were statistically significant differences in student support levels for each topic based on gender, religion, or political affiliation. Three hundred students were included in these analyses.

To determine whether there were differences in students' comfort while learning the bioethics topics based on gender, religion, or political affiliation, we ran logistic regressions on data collected after instruction, with whether the student reported being completely comfortable while learning the topic as the dependent variable and student gender, religion, and political affiliation as predictor variables. We treated comfort as a binary outcome variable because more than half of students said they were completely comfortable whereas fewer students chose the less than completely comfortable options. Two hundred and sixty-three students were included in these analyses.

All quantitative analyses were done with IBM SPSS Statistics (version 27). We report coefficients and traditional statistical significance ($P < 0.05$) in this article, but omnibus statistics, confidence intervals, and exact P values for each analysis are included in the Supplemental Material. Syntax for the analyses is also available in the Supplemental Material.

To determine why students were completely or less than completely comfortable when learning bioethics, we qualitatively analyzed students' written responses to our open-ended questions ("Please explain why you were completely/not completely comfortable...") asked after instruction. We used inductive coding to create coding rubrics for each open-ended question from the survey (30). Researchers established interrater reliability with the resulting coding rubrics. One researcher coded 10% of the responses or 10 responses (whichever was greater); then two researchers independently coded the same responses and compared their codes to the first author's original coding to determine the percent agreement for each coding rubric. When any discrepancies were present, the initial researcher adjusted the corresponding coding rubric accordingly, and a new set of responses were coded by all three researchers. For one of the rubrics, only the initial researcher and one other researcher coded a second set of responses after adjustments had been made. All of the coding rubrics had between 73% and 100% agreement, which is considered acceptable (31). Once interrater reliability was established for each rubric, the initial researcher coded all the responses to each open-ended question according to the final coding rubrics. The final coding rubrics can be found in the Supplemental Material. Two hundred and sixty-three students were included in these analyses.

Positionality Statement

The authors acknowledge that our identities influence this work. We all identify as women but hold a variety of religious beliefs (agnostic during childhood but currently Christian; atheist during childhood and college but currently agnostic;

Christian during childhood and college but currently atheist) and political identities (extremely liberal; conservative during childhood and college but currently liberal; conservative during childhood but currently moderate).

RESULTS

Demographics

Of the 300 students included in our regression analyses from the first survey, 163 (54.3%) students were religious (45.3% Christian, 9.0% not Christian) and 137 (45.7%) students were nonreligious. There were 202 women (67.3%) and 98 men (32.7%), and, politically, 144 students were liberal (48.0%) and 156 students were nonliberal (52.0%).

Of the 263 students who were included in our regression analyses from the second survey, 136 (51.7%) students were religious (43.0% Christian, 8.7% not Christian) and 127 (48.3%) students were nonreligious. There were 182 women (69.2%) and 81 men (30.8%), and, politically, 132 students were liberal (50.2%) and 131 students were nonliberal (49.8%). See Table 1 for a breakdown of the characteristics of students from our first and second surveys. For a breakdown of all other demographic variables, see the Supplemental Material. We also report variance inflation factor (VIF) values testing for collinearity among these variables in the Supplemental Material.

Research Question 1: Before Instruction, to What Extent Do Students in Bioethics Courses Support Gene Editing, Abortion, and Physician-Assisted Suicide?

We found that most undergraduates enter bioethics courses supporting gene editing and physician-assisted suicide only in some situations (80.7% gene editing, 56.0% physician-assisted suicide), but for abortion students were relatively evenly split between supporting it in all situations or in certain situations (Fig. 1). Relatively few students claimed that they did not support each topic in any situation (7.7% gene editing, 9.7% abortion, 16.7% physician-assisted suicide).

We probed into the specific scenarios in which students support each topic (Figs. 2–4). The students who selected that they support gene editing only in certain situations were most likely to support it in cases of curing life-threatening diseases in adults (97.1%) and children (94.6%), and they were least likely to support it in cases of enhancing physical characteristics (12.4%) or intelligence (11.2%). The students

Table 1. Percentages of students in our samples who held particular gender, religious, and political identities

	First Survey Sample (<i>n</i> = 300)	Second Survey Sample (<i>n</i> = 263)
<i>Gender</i>		
Woman	67.3%	69.2%
Man	32.7%	30.8%
<i>Religious affiliation</i>		
Religiously affiliated	54.3%	51.7%
Not religiously affiliated	45.7%	48.3%
<i>Political affiliation</i>		
Nonliberal	52.0%	49.8%
Liberal	48.0%	50.2%

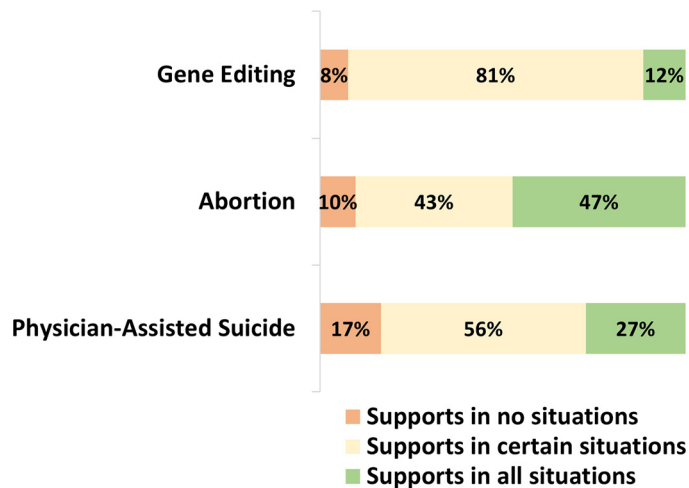


Figure 1. Stacked bar charts representing the percentage of students who support bioethics topics in all, certain, or no situations. Student responses ($n = 300$) were to the question “In which scenarios do you believe gene editing/abortion/physician-assisted suicide to be acceptable? Select all that apply” before bioethics instruction.

who selected that they support abortion only in certain situations were most likely to support it in cases where the pregnancy results from rape (88.4%) or when the mother’s health is at risk (89.9%), and they were least likely to support it when the pregnancy is in the third trimester (7.8%) or when the parents want an abortion because they do not want the sex of the child (4.7%). Finally, the students who selected that they support physician-assisted suicide only in certain situations were most likely to support it in cases where a terminally ill patient requests to stop all medical treatment (93.5%) and were least likely to support it in cases where the patient is requesting assisted suicide because they are in extreme emotional pain (29.8%).

Research Question 1a: Are There Differences in Student Support Levels Based on Gender, Religious Affiliation, or Political Affiliation?

Using ordinal regressions, we found that at the beginning of a bioethics course there were differences in student

support based on different genders, religious affiliations, and political affiliations. Controlling for political affiliation and gender, religious students were less likely than nonreligious students to support gene editing ($P = 0.004$), abortion ($P < 0.001$), and physician-assisted suicide ($P < 0.001$) (Table 2). Additionally, controlling for political and religion affiliations, women were more likely than men to support abortion ($P = 0.004$), but there was not a significant gender difference in support for gene editing ($P = 0.125$) or physician-assisted suicide ($P = 0.993$). Finally, controlling for gender and religious affiliation, we also found that nonliberal students were less likely than liberal students to support both abortion ($P < 0.001$) and physician-assisted suicide ($P = 0.007$), although there was not a significant difference in their support for gene editing ($P = 0.794$).

Research Question 2: Are There Differences in the Comfort Levels of Students from Different Groups When Learning about Gene Editing, Abortion, and Physician-Assisted Suicide?

At the end of their bioethics courses, students reported having high comfort levels overall when learning about gene editing, abortion, and physician-assisted suicide (Fig. 5). However, there were differences in comfort levels of students from different demographic groups (Table 3). Using logistic regressions, we found that there were differences in the comfort levels of students based on gender, religious affiliation, and political affiliation when learning about these three topics. Religious students reported being less comfortable than nonreligious students when learning about both abortion ($P = 0.006$) and physician-assisted suicide ($P = 0.031$), but the difference between religious and nonreligious students’ comfort when learning about gene editing did not reach statistical significance ($P = 0.092$) (Table 3). Additionally, nonliberal students were less comfortable than liberal students when learning about abortion ($P < 0.001$), as well as in the overall bioethics course ($P = 0.006$), but there was not a significant relationship between political affiliation and comfort for gene editing ($P = 0.093$) or physician-assisted suicide ($P = 0.168$). Women were less comfortable than men when learning about gene editing ($P = 0.037$), although there were no significant relationships between

% of student support - gene editing scenarios

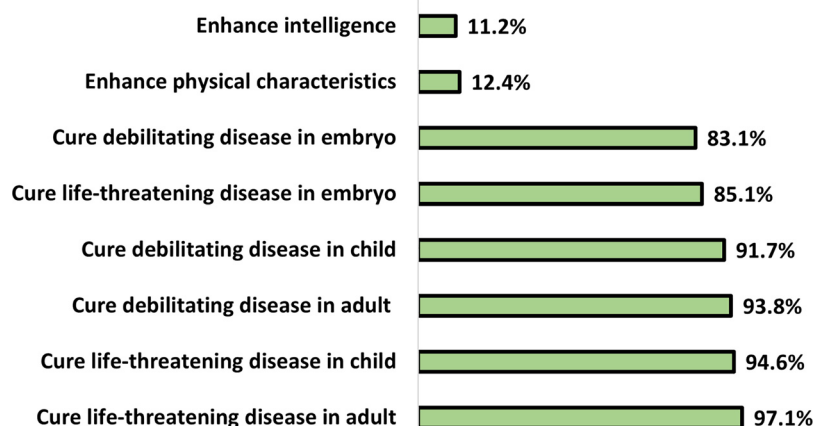


Figure 2. Percentage of students who support gene editing in specific situations. Student responses to the question “In which scenarios do you believe gene editing to be acceptable?” before bioethics instruction. Only students who selected support in certain situations ($n = 242$) were given this question, and students could select all that apply.

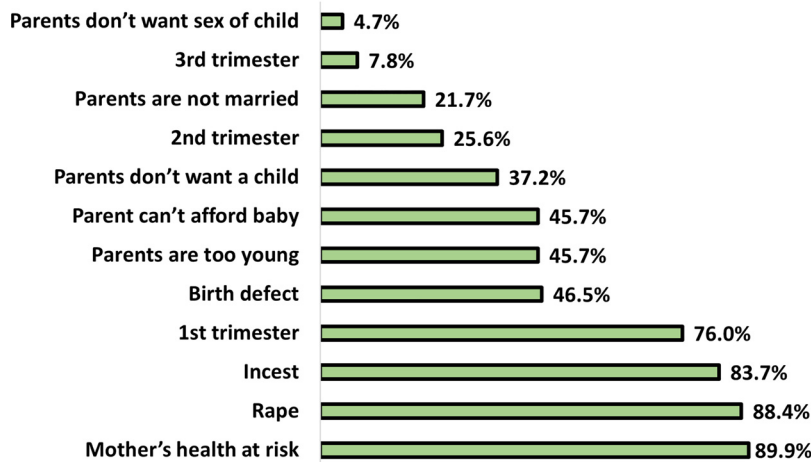
% of student support - abortion scenarios

Figure 3. Percentage of students who support abortion in specific situations. Student responses to the question “In which scenarios do you believe abortion to be acceptable?” before bioethics instruction. Only students who selected support in certain situations ($n = 129$) were given this question, and students could select all that apply.

gender and comfort for abortion ($P = 0.709$) or physician-assisted suicide ($P = 0.494$). Finally, neither gender nor religion had significant relationships with students' comfort levels in the bioethics courses overall (gender, $P = 0.419$; religion, $P = 0.721$).

Research Question 3: What Factors Influence Students' Comfort Levels When Learning about Gene Editing, Abortion, and Physician-Assisted Suicide?

When analyzing students' open-ended responses regarding why they felt completely comfortable when learning about each topic, we found many common themes across questions about gene editing, abortion, and physician-assisted suicide. For example, many students claimed that

they were comfortable because they were familiar with the topics before the bioethics class (Table 4). Many students reported that they were comfortable because they felt that the classroom environment was open, safe, or unbiased or their instructor practiced a specific teaching method that made them comfortable. For example, some students mentioned that the instructor never tried to push their views onto them, which made them feel completely comfortable when discussing their own views. For gene editing and abortion, many students said that they were comfortable because they were confident in their opinions on the topic. Alternatively, for gene editing and physician-assisted suicide, many students claimed that they were comfortable because they thought the topics covered were interesting.

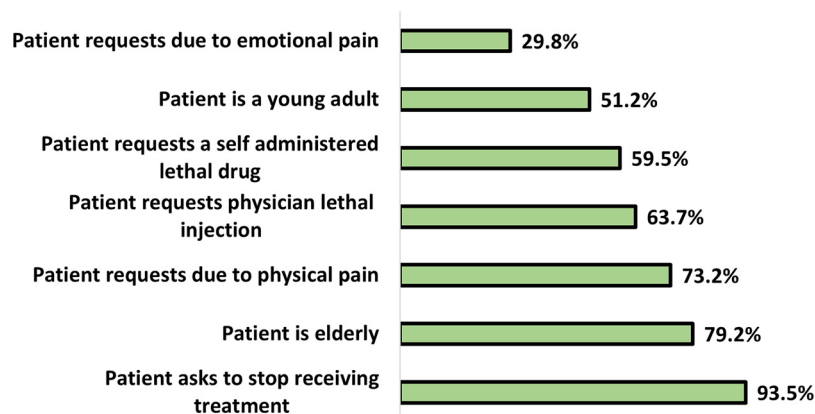
% of student support - PAS scenarios

Figure 4. Percentage of students who support physician-assisted suicide (PAS) in specific situations. Student responses to the question “In which scenarios do you believe physician-assisted suicide to be acceptable?” before bioethics instruction. Only students who selected support in certain situations ($n = 168$) were given this question, and students could select all that apply. First, students were given the following prompt: Patient “Doe” has terminal cancer, and doctors believe they only have six months to live. They are feeling sick and experience an immense amount of pain every day. They now want to stop their pain and suffering. In which scenarios do you believe physician-assisted suicide to be acceptable for patient “Doe”? Select all that apply. 1) Patient “Doe” is a young adult. 2) Patient “Doe” is elderly. 3) Patient “Doe” requests a doctor to stop all medical treatment. 4) Patient “Doe” requests a doctor to give them a prescription for lethal drugs that they take on their own. 5) Patient “Doe” requests a doctor to give them a lethal injection. Then, students were given the following prompt: Patient “Smith” does not have a terminal illness, but they experience an unbearable amount of pain every day. They now want to stop their pain and suffering. In which scenarios do you believe physician-assisted suicide to be acceptable for patient “Smith”? Select all that apply. 6) Patient “Smith” has a physical disorder which causes an unbearable amount of physical pain. 7) Patient “Smith” has a mental disorder that causes an unbearable amount of emotional pain.

Table 2. Coefficients for students' support based on gender, religious, and political identity

	Gene Editing	Abortion	Physician-Assisted Suicide
Woman	-0.484	0.762*	0.002
Religious	-0.942*	-1.479†	-1.123†
Nonliberal	0.082	-1.518†	-0.673*

Coefficients from ordinal regressions predicting students' responses to the questions "Do you support gene editing/abortion/physician-assisted suicide in no situations, some situations, or all situations?" disaggregated by gender, religious affiliation, and political affiliation ($n = 300$). Significant difference: * $P < 0.01$; † $P < 0.001$.

Finally, for abortion and physician-assisted suicide, many students stated that they were comfortable when learning about the topic because they tend to support it.

We also identified themes for why students were completely comfortable that were unique to specific topics (Table 4). For instance, students reported that they were comfortable when learning about gene editing because of its relevance to the future (30.9%). Some of these students specifically said they were comfortable because they felt that the use of gene editing technology in the future is inevitable (9.4%) or because they believed the technology has the

potential to largely benefit people and society in coming years (21.5%). Additionally, for physician-assisted suicide, some students claimed that they were comfortable when learning about the topic because they had some sort of personal experience with it before, whether it be with physician-assisted suicide itself or death or suicide in general (4.4%).

For students who were less than completely comfortable when learning about abortion, gene editing, or physician-assisted suicide, many themes arose relating to why they were not completely comfortable (Table 5). For all three topics, many of these students cited that they were less than completely comfortable because they do not support the topic. These students also said that they were less than completely comfortable when learning about gene editing, abortion, or physician-assisted suicide because the nature of the topic itself was uncomfortable. For abortion and physician-assisted suicide, some students specifically mentioned that the topic was either controversial or sad/sensitive. For abortion and physician-assisted suicide, many students also stated that discussions of death and/or suicide that went along with these topics made them less than completely comfortable. Additionally, for gene editing and abortion,

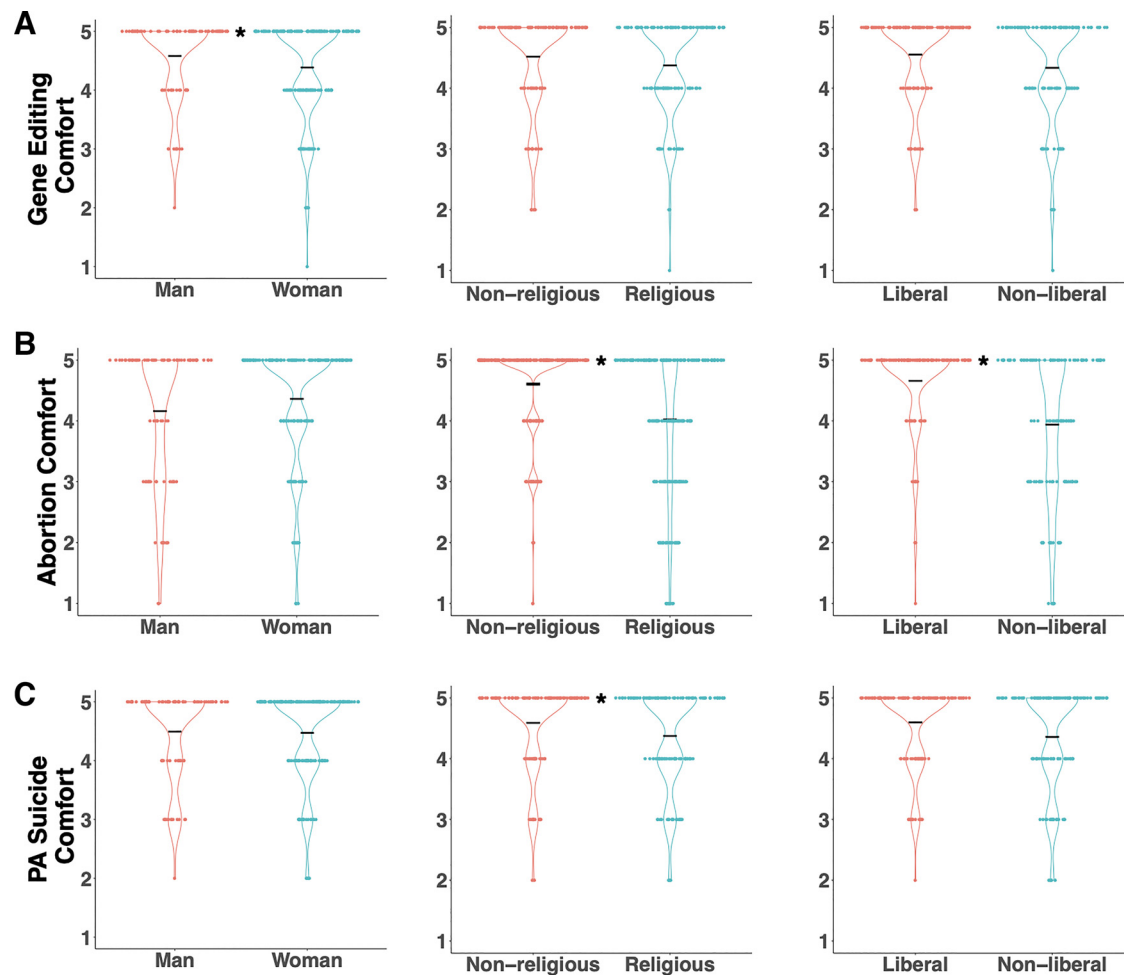


Figure 5. Violin plots overlaid with data points displaying students' responses to the question "On a scale of 1–5, how comfortable were you when learning about gene editing (A), abortion (B), physician-assisted (PA) suicide (C)?" broken down by gender, religion, and political affiliation. The black bar represents the mean of the data ($n = 263$). * $P < 0.05$.

Table 3. Coefficients for student comfort based on gender, religious, and political identity

	Gene Editing	Abortion	Physician-Assisted Suicide	Overall Class
Woman	−0.608*	0.109	−0.196	−0.236
Religious	−0.460	−0.777†	−0.594*	0.100
Nonliberal	−0.457	−1.235‡	−0.378	−0.778†

Coefficients from logistic regressions predicting whether students were completely comfortable or less than completely comfortable when learning about gene editing, abortion, and physician-assisted suicide and in the overall bioethics class, disaggregated by gender, religious affiliation, and political affiliation ($n = 263$). Significant difference: * $P < 0.05$; † $P < 0.01$; ‡ $P < 0.0001$.

some students claimed that learning about other perspectives on these topics challenged their views and made them less than completely comfortable.

Some themes regarding why students were less than completely comfortable were unique to specific topics (Table 5). For example, many students were less than completely comfortable when learning about gene editing because they were worried about the future of the technology (43.8%). Some were specifically worried about the technology being improperly regulated (19.1%), whereas others were nervous about the potential unintended side effects of the technology (11.2%) or harms that it could induce on a societal level (11.2%), including the possibility that the technology could lead to eugenics (9.0%). Some students also said that they were less than completely comfortable when learning about gene editing because they felt like the technology was an attempt by humans to alter nature or “play God” (5.6%). For abortion, many students cited feeling some identity-related discomfort. Some of these students explained that their religious identity caused them to feel less than completely comfortable when learning about this topic (8.7%), whereas others felt some gender-related discomfort based on who they felt should and should not have input in the abortion debate (5.6%). This included responses

from men who felt their opinion was less relevant than that of a woman as well as responses from women who felt men should not have input on the issue of abortion. Finally, many students were less than completely comfortable when learning about physician-assisted suicide because they were either still unsure of their opinions on the topic (21.4%) or were sympathetic toward physicians because they have to deal with the consequences of the physician-assisted suicide dilemma in their daily lives because of their career (11.9%).

DISCUSSION

In this study of undergraduate students in bioethics courses, we found that, overall, students were not extreme in their views on the controversial topics covered in the curriculum, meaning they typically claimed to support each topic in only certain situations rather than either all or no situations. They also mostly felt comfortable when learning about them. To our knowledge, this is the first study focused on student identity and comfort that has been done in this particular context of undergraduate bioethics courses. Our results were surprising in that they indicate that these students overall may be less polarized in their views than might be expected given the divisive nature of these topics in the American public (32–34). However, we found that students from different social groups tended to have different levels of support and comfort surrounding these topics, which reflects what we see in the broader American public (32, 34–38).

What implications might these results have for instruction on controversial bioethics topics? First, students were overall comfortable when learning about these controversial topics, indicating that discussion about these topics is not necessarily uncomfortable for students. Past studies indicate that instructors may avoid teaching controversial topics because they fear creating conflict and discomfort (39, 40), but

Table 4. Students' responses regarding why they felt completely comfortable

Theme	Gene Editing (<i>n</i> = 149)	Abortion (<i>n</i> = 152)	Physician-Assisted Suicide (<i>n</i> = 158)	Example Quotes	
Student was familiar with the topic before they entered the course	23.5%	17.6%	16.5%	“I have talked about [abortion] a lot with peers, I had already gone through that initial shock of learning about it.”	“I already knew a lot about gene editing so. . . [I was] completely comfortable. . . .”
Instructor’s teaching methods or classroom environment made the student feel comfortable	14.8%	13.1%	20.3%	“I felt completely comfortable because I was learning about gene editing in an objective and nonbiased manner.”	“My instructor respectfully taught all categories of the course and welcomed new ideas and conversation.”
Student was confident in their opinions about the topic	7.4%	13.1%	—	“I was comfortable because I am confident with how I feel about gene editing.”	“I feel comfortable when learning about abortion because I understand my stance on the subject.”
Student found the topic interesting	17.4%	—	9.5%	“I felt comfortable because it was interesting to learn about.”	“I found [gene editing] very interesting and enjoyed learning about it.”
Student supports the topic	—	12.4%	20.9%	“I felt comfortable learning about this because it is something that I think should be allowed in all states.”	“I strongly believe in physician-assisted suicide. . . . It is not something that makes me uncomfortable.”

Themes present across students' responses to the question, “In a short paragraph, please explain why you felt completely comfortable learning about gene editing/abortion/physician-assisted suicide,” as well as the percentage of students who mentioned each theme in their response. — indicates that the theme was not present in students' responses about a particular topic.

Table 5. Students' responses regarding why they felt less than completely comfortable

Theme	Gene Editing (n = 89)	Abortion (n = 92)	Physician-Assisted Suicide (n = 84)	Example Quotes	
The topics themselves were uncomfortable or controversial.	14.6%	55.4%	25.0%	"I did not feel completely comfortable with [abortion] because it is a very controversial [topic]. . ."	"I did not feel completely comfortable discussing physician-assisted suicide because this subject is extremely controversial to discuss."
Student does not support the topic in at least some cases.	22.5%	22.0%	15.5%	"I do not support abortion due to personal beliefs, so some cases were hard to discuss."	"I don't think gene-editing should be used to enhance people to become smarter, taller, stronger, etc. This part made me feel uncomfortable."
Hearing other students' perspectives made them uncomfortable.	10.1%	14.1%	—	"I didn't feel completely comfortable because. . . there were a couple of people that think that gene editing to enhance human physical traits and intelligence is okay, which I don't agree with."	"I believe that access to abortion is a human right. Trying to understand ethical arguments against that right [to abortion] was difficult."
Discussing the concepts of death or suicide made them uncomfortable.	—	8.8%	8.3%	"The thought of terminating a potential life is always disheartening."	"I did not feel completely comfortable learning about physician-assisted suicide because I lost a family member to suicide."

Themes present across students' responses to the question, "In a short paragraph, please explain why you felt less than completely comfortable learning about gene editing/abortion/physician-assisted suicide," as well as the percentage of students who mentioned each theme in their response. — indicates that the theme was not present in students' responses about a particular topic.

instructors can create a comfortable environment even when teaching about controversial topics. However, given that students with different genders, religions, and political affiliations have different comfort levels, our results also show that comfort may vary depending on the cultural makeup of students in the class and the topics covered.

Students in this study reported several specific strategies that made them feel comfortable when learning these controversial topics, so instructors may find these useful for trying to maximize student comfort. From our qualitative results, we saw that students' familiarity with a topic upon entering a course, their personal experiences with the topic, and the extent to which a student supports a topic impacted students' comfort. However, these are all outside an instructor's control. There are some factors that instructors can influence; for example, students said that when instructors incorporated diverse perspectives into their teaching this made them feel more comfortable. Thus, instructors could increase student comfort overall by incorporating different views that students might possess. It is important to note that there is no "correct" view on these bioethics topics. This differs from other topics in biology that are societally controversial but are scientifically verifiable, like human-induced climate change or evolution, for which an instructor would not present alternative views (i.e., creationism) because they are in direct conflict with scientific evidence. But, in the cases of gene editing, abortion, and physician-assisted suicide, support for these topics is not a scientific decision but an ethical decision, and thus exploring the ethical dimensions of these topics from various viewpoints is appropriate and, in light of these results, might create more comfortable classes for students.

Religious students were both less supportive of and less comfortable when learning about abortion and physician-assisted suicide than nonreligious students. This implies that religious cultural competence may be useful in the

context of bioethics courses. Biology instructors are typically nonreligious (41), so they may have views different from their religious students and thus may not have experienced the same discomforts when learning about each topic. This cultural disconnect could act as a barrier to effective instruction and communication of bioethics topics. Although the need for cultural competence in biology courses such as evolution has been advocated for in recent years (42, 43), our findings indicate the need to consider implementing this in bioethics courses as well.

A similar pattern appeared when analyzing support and comfort across political affiliations. Nonliberal students were both less supportive of abortion than their liberal peers and less comfortable when learning about it. Oftentimes, religion and politics are associated as aligned or confluences of one another; however, our statistical analyses control for all other demographic variables, and results from our collinearity test exemplify that religion and politics each had their own independent effects on students' support and comfort. This means that to address the comparatively low comfort of nonliberal students, further action must be taken than simply addressing discomfort related to religion and perhaps there is also the need for political cultural competence in bioethics courses given the liberal attitudes of most biologists (44).

Ultimately, this study shows for the first time that the identities of undergraduate students in bioethics courses influence how they will relate to bioethics curriculum in undergrad bioethics courses. Thus, if instructors teach bioethics and ignore student identities, they may miss the opportunity to tackle potential identity-based hurdles related to student comfort.

Limitations/Future Studies

This study was conducted at one public research-intensive institution in the southwest United States. This institution is

located in a state that has historically been Republican but recently is considered a swing state. This state is neither highly religious nor highly secular (45). Future studies could broaden the sample to students in bioethics courses at multiple universities in the United States to produce more generalizable results. Additionally, this study analyzed bioethics courses taught by five different instructors, so future studies could survey students being taught by only one instructor to control for any differences in student comfort that may have been induced by a particular instructor themselves.

This study was also conducted in the context of the COVID-19 pandemic, which may have impacted our results. This context placed students under additional stress as they were learning in new formats and environments and figuring out how to balance the reality of the pandemic itself (46), so their comfort in bioethics may have been conflated with their comfort in their lives in general. Additionally, the bioethics courses that we surveyed were administered in synchronous and asynchronous online formats because of the pandemic. Future studies could evaluate student comfort in bioethics courses that are administered in person to assess how this learning format impacts comfort. Students' lives may also be less impacted by the added stress of the COVID-19 pandemic once courses return fully in person, removing some of the potential conflation.

We made the decision to collapse our variables into religious versus nonreligious, men versus women, and liberal versus nonliberal. However, these categories do not fully capture the complexities of these identities, so future work may need to focus more specifically on certain identities and their experiences in bioethics courses (e.g., the experiences of Muslim students compared with Christian students or Libertarian students compared with Republican students).

In our results, we see that students with specific identities may be less comfortable than those with other identities, which could cause students with different identities to be differentially successful in their bioethics courses. However, in future studies, it may be informative to collect information about factors beyond comfort, such as students' academic performance in their bioethics course or their knowledge retention on the topics covered in these courses. This could help researchers to determine whether comfort truly corresponds with students' success and knowledge development in bioethics courses, thus adding further relevance to this work.

SUPPLEMENTAL DATA

Supplemental Material: <https://doi.org/10.5281/zenodo.5838973>.

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AUTHOR CONTRIBUTIONS

B.A.E., J.A.R., S.E.B., and M.E.B. conceived and designed research; B.A.E., J.A.R., S.E.B., and M.E.B. performed experiments; B.A.E., J.A.R., C.B., and M.E.B. analyzed data; B.A.E., J.A.R., S.E.B., and M.E.B. interpreted results of experiments; B.A.E., C.B., and M.E.B. prepared figures; B.A.E. drafted manuscript; B.A.E., S.E.B., and M.E.B. edited and revised manuscript; B.A.E., J.A.R., C.B., S.E.B., and M.E.B. approved final version of manuscript.

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