RESEARCH ON LEARNING

Differential Impacts of Religious Cultural Competence on Students' Perceived Conflict with Evolution at an Evangelical University

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Abstract

Evolution remains a controversial issue in the United States, particularly for evangelical Christians, who as a group have been a key player in anti-evolution education legislation. Religious cultural competence can be effective in decreasing undergraduate biology students' perceived conflict between religion and evolution. However, the impact on student populations who are particularly resistant to evolution is unknown. We explored the efficacy of culturally competent evolution education practices adapted for biology students in a genetics course at an evangelical Christian university. This included the presence of an instructor as a religious scientist role model who accepts evolution, and the use of the book The Language of God. *We explored how this curriculum affected students' conceptions of religion and evolution using pre- and post-surveys. We found a differential impact of the curriculum: 31% of the students who indicated that there was a conflict between their religious beliefs and evolution changed their conceptions to be more in line with scientific evidence, but the remaining 69% did not. We describe reasons why, including students' perceptions of* The Language of God. *This research indicates the challenges of implementing culturally competent evolution education for evangelical students, given their strong commitment to biblical literalism and their lower likelihood of being convinced by scientific evidence for evolution.*

Key Words: *evolution; nature of science; creationism; evangelical; Christianity; undergraduate.*

○ Introduction

Evolution is foundational to biology (AAAS, 2011), but many individuals struggle with accepting evolution because of their religious beliefs and/or cultures (Rissler et al., 2014; Barnes et al., 2019). Polls show that evangelical Christians have some of the lowest rates of acceptance of evolution, with only 24% of respondents agreeing that evolution is the best explanation for the origins of human life on Earth (Pew Research Center, 2009a). Features of evangelicalism known to promote an anti-evolution stance are a tendency toward a literal interpretation of the Bible, a reinforcement of anti-evolution attitudes by some leaders of evangelical churches (Numbers, 2006), and a long history of political and legislative attempts to remove evolution from the science curriculum (Pew Research Center, 2009b; National Center for Science Education, 2019). Thus, teaching evolution effectively to evangelical students will be important for improving attitudes toward evolution and for preventing future political and legislative attempts to diminish the quality and presence of evolution education in science curricula.

Religious cultural competence has been suggested as a way to implement more effective evolution instruction by attending to students' religious cultures in the context of learning evolution (Barnes & Brownell, 2017). This type of instruction includes a suite of practices that can help religious students feel less conflict with their religious identity when they are learning evolution. These practices can include providing religious role models who accept evolution (Holt et al., 2018), teaching that science is agnostic with respect to a God, and highlighting that evolution and religion can be compatible rather than contradictory (Wiles & Alters, 2011).

Despite the promise of using religious cultural competence for more effective evolution education, there is very little research on the effect of culturally competent evolution teaching practices on evangelical Christian students. Here, we explore the impact of a culturally competent curriculum that was developed for evangelical students in an upper-level genetics course at an evangelical Christian university using a pre- and post-instruction study design.

○ Methods

The Study Site: An Evangelical Christian University

The site for the study was a private, nondenominational, evangelical Christian university in the Midwest. The university's mission statement is consistent with definitions of evangelicalism and states that Christ-centered education is its top priority; all students and instructors must agree to adhere to these ideals. The university requires all students to complete 30 credits in theological studies, and the professor of the genetics course in this study confirmed

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that the university culture includes various expressions of evangelical Christianity, but tends to be theologically conservative. The university does not make an explicit statement on evolution, but the professor described an inherent bias against evolutionary science on the part of many students and employees, making this a unique context to study the impact of evolution education on Christian students.

The Biology Curriculum

Biology students at this university take 55 credits of science courses for their degree. Students must take three introductory biology courses before taking genetics to obtain their degree. During our study, in the first introductory biology course, the instructor taught evolution and revealed himself to students as a special creationist who does not accept macroevolution. In the second course, the instructor did not discuss religion and evolution. In the third course, the instructor taught about evolution and revealed that he accepts evolution.

Genetics Course with Religious Cultural Competence for an Evangelical Christian Population

In the 16-week upper-level genetics course, taught by a single instructor, students learned about the structure and function of DNA; the processes of DNA replication, transcription, and translation; and the principles of inheritance, regulation of gene expression, and molecular evolution. Students met for 65-minute sessions three times a week for the lecture portion of the class, and once a week for 2.5 hours for the lab portion. The course used lecture, group problem solving, and hands-on activities.

Below, to describe how the instruction aligned with religious cultural competence, we italicize components of instruction that specifically aligned with the components of the Religious Cultural Competence in Evolution Education (ReCCEE) framework outlined in Barnes and Brownell (2017). The instructor of the genetics course, who accepts evolution, told students about this personal view and thus served as an evangelical scientist *role model* who accepts evolution. Further, the instructor *acknowledged* potential conflict while maintaining a respectful disposition with all students regarding different views on evolution. The instructor also had students *discuss and explore* their personal views on evolution through discussion boards and reflection essays.

Students were assigned to read *The Language of God* by Francis Collins (2006). This book was chosen because it was designed to help evangelicals reconcile faith and evolution. Collins is the current director of the National Institutes of Health, former director of the Human Genome Project, and an evangelical Christian. The book describes the *bounded nature of science*, specifically that science does not test for the existence of God and is not atheistic. Collins also describes a *spectrum of viewpoints* on the relationship between religion and evolution, from conflict to compatibility. Together, these components show evangelicals that there is *potential compatibility* between their religion and their acceptance of evolution.

Instruments

Acceptance of common ancestry. To determine students' views of religion and evolution before and after the genetics course, we used a survey developed by Yasri and Mancy (2016). Students chose from the options shown in Table 1 both before and after evolution instruction. We categorize Literal, Progressive, Genera, and Human Creationism as in direct conflict with scientific evidence; and Theistic, Deistic, Agnostic, and Atheistic Evolution as not necessarily in conflict with scientific evidence (Figure 1).

Table 1. Before and after the genetics course, students chose from different views of the relationship between religion and evolution to indicate which was closest to their personal view.

Views in Direct Conflict with Scientific Evidence	
Literal Creationism	All forms of life were first brought into being at the same time by a deity, in more or less their present form.
Progressive Creationism	All forms of life were gradually created over time by a deity, in more or less their present form.
Genera Creationism	Some forms of life evolved from earlier forms created by a deity, but higher taxonomic groups such as reptiles, birds, and mammals were created in more or less their present form.
Human Creationism	Some forms of life evolved from earlier forms created by a deity, but human beings were created in more or less their present form.
Views Not Necessarily in Direct Conflict with Scientific Evidence	
Theistic Evolution	All forms of life evolved from earlier forms, but a deity intervenes from time to time to shape or override the evolutionary processes.
Deistic Evolution	All forms of life evolved from earlier forms, but life and evolution were first set in motion by a deity and then left running without any additional intervention.
Agnostic Evolution	Life emerged from nonliving particles and then all current forms evolved from these earlier forms. A deity may exist; however, this is out of the scope of evolutionary theory.
Atheistic Evolution	Life emerged from nonliving particles and then all current forms evolved from these earlier forms. No deity has ever played any role in the evolution of life on Earth.

Open-ended student responses on views of evolution and final written reflection. To further explore students' perceived conflicts between their religious beliefs and evolution before and after the genetics course, we asked them to respond to one open-ended question (prompt: "Do you see a conflict between evolution and your personal beliefs? Yes/No/Unsure. Explain why you gave the answer you did. Why do you feel there is a conflict or why don't you feel there is a conflict or why are you unsure?"). We also analyzed students' final essay after they had read the entire book (prompt: "How has *The Language of God* challenged or advanced your thinking about the integration of science and faith?").

Analyses

We examined whether students' responses to the "acceptance of common ancestry" survey changed from pre- to post-course. Figure 2 illustrates how we ranked each option in terms of level of conflict with acceptance of evolution. Students' choices were triangulated with their written reasoning for why they did, did not, or were unsure if they perceive conflict between their beliefs and evolution. The final reflection essays were analyzed to explore how students' conceptions of evolution changed in response to *The Language of God*. Qualitative data were analyzed using constant comparative methods to identify themes in student responses (Glaser & Strauss, 1967). A subset of data was initially coded together by three researchers to identify themes in student responses. Following the initial identification of these codes, the first author reviewed the data again and identified additional codes. Codes were then grouped into broader themes. The two other researchers reviewed the final themes to confirm agreement on all themes. All names are pseudonyms used to protect subject identity. The study was approved by the university's institutional review board.

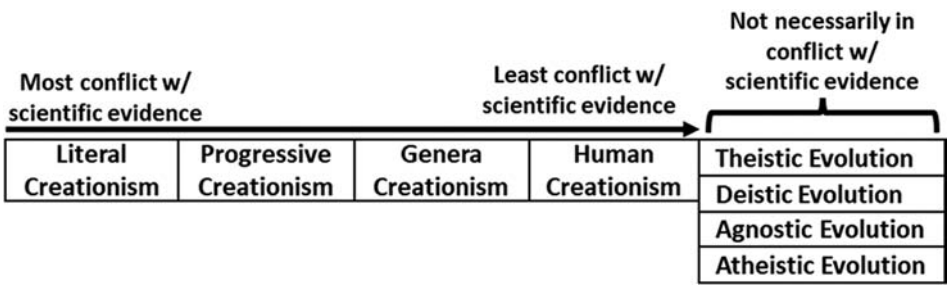

Figure 1. Ranking of positions on religion and evolution by level of conflict with evolution.

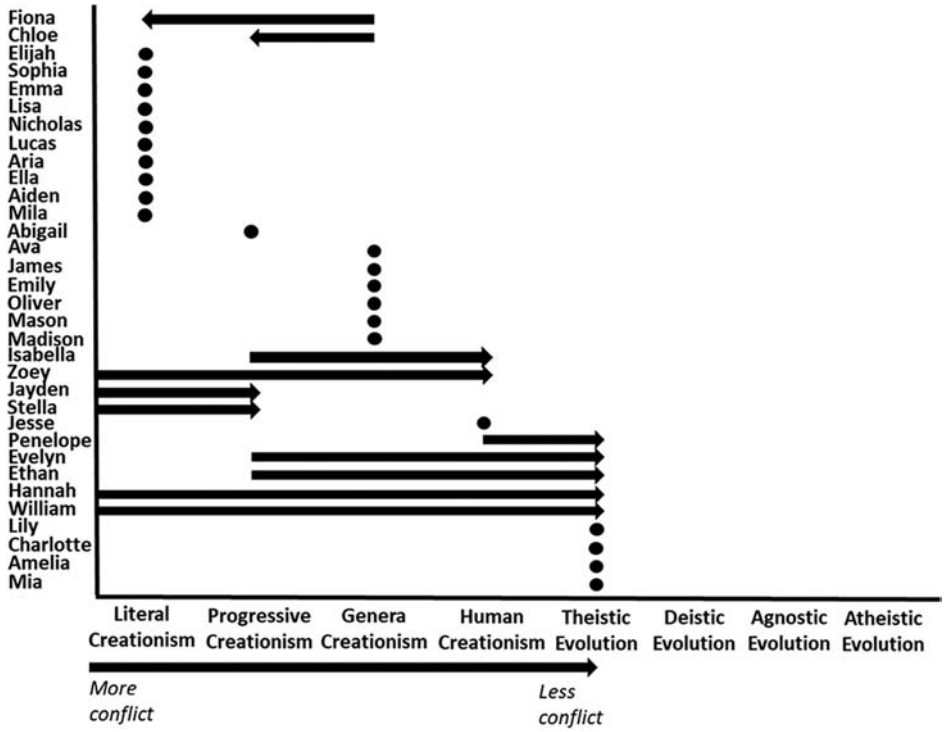

Figure 2. Students' personal views on religion and evolution before and after the genetics course. The head of the arrow represents the view that students changed to at the end of the course. Dots represent students who did not change their views. No students chose Deistic, Agnostic, or Atheistic Evolution on either the pre- or post-survey, further illustrating the unique religiosity of this population.

○ Results

Participants

The study population consisted of 33 students in the upper-level genetics course, 32 of whom were biology majors; 33% were male and 67% were female. Twenty-four students identified as pre-health, three planned to go into conservation-related careers, four planned to go into research or academic careers, and two had unknown career aspirations. All students identified as Christian.

Pre-course & Post-course Acceptance of Common Ancestry

At the beginning of the course, 19 of the 33 students (58%) did not accept common ancestry in any form; 10 (30%) accepted only some aspects of common ancestry; and four (12%) fully accepted common ancestry in the form of Theistic Evolution. No students chose Deistic, Agnostic, or Atheistic Evolution.

At the end of the course, 15 of the 33 students (45%) did not accept common ancestry in any form. Nine of the 33 students (27%) accepted only some aspects of common ancestry, and another nine (27%) fully accepted common ancestry in the form of Theistic Evolution. Again, no students chose Deistic, Agnostic, or Atheistic Evolution.

Overall, among the students who did not already accept Theistic Evolution at the beginning of the course, 31% made a positive shift toward less

conflict with evolution, 62% did not change, and 7% made a negative shift to more conflict. Figure 2 shows each individual student's pre- and post-instruction choices.

Qualitative Results

Through triangulation of closed-ended pre- and post-survey data, qualitative open-ended survey data, and written reflections, we identified four main qualitative categories of students based on the development of their views on evolution and religion over the genetics course. Each category is outlined below, and illustrative quotes from students are given in Tables 2 and 3.

Stayed with Theistic Evolutionism

Students in this category already accepted evolution at the start of the genetics course. Four students were in this category. These students chose Theistic Evolution on both the pre-survey and post-survey and did not indicate that the course had influenced their beliefs. For instance, in Mia's pre- and post-survey

Table 2. Examples of students' statements before and after the genetics course. These students either had already reconciled their religious beliefs with evolution before taking the course, made a positive shift toward less conflict, or became more uncertain of their special creationist beliefs.

Category	Before Genetics Course	After Genetics Course
Stayed with Theistic Evolutionism	Mia: "Many people I know think [evolution] is wrong, and if you have the slightest interest in evolution you are a bad Christian. I strongly disagree."	Mia: "I strongly believe that evolution was part of God's plan when he created."
Changed to Theistic Evolutionism	Penelope: "For the majority of evolution, there is no conflict. I believe in microevolution. I believe that there is evidence for some larger scale macroevolution. I don't think we can be certain about how long a "day" is in Genesis, and if we should take it as a literal day or a figurative day. I think of it more in a figurative stance. I still believe the days represent phases of creation, but not the literal 24-hour days. I don't think God would leave evidence when it wasn't true and even though evidence is often subjective, I do not believe it was initially meant to contradict religion."	Penelope: "I don't feel like there is a conflict between evolution and my personal beliefs. I don't think there could be. It is one of my fundamental beliefs that God would not lay false evidence into creation for us to find. If we are getting things wrong, then we are interpreting evidence wrong . . . nor do I believe that the evidence for evolution is coincidental . . . I think when you combine this information with the other evidence that scientists have found, I lean towards believing in an evolutionary process."
Became More Uncertain about Special Creationism	Elijah: "I know, based on my knowledge of biology, that cells cannot arise from non-cells. This rule, which science has never been able to break, limits the ability of evolution to account for life. Knowing this, I believe God must have been instrumental in creation . . . (but) my faith is not resting on an explanation for creation."	Elijah: "I was very surprised by how challenged I was feeling [by the book]. After Collins presented his evidence, like the chimp chromosomes or the AREs (Ancient Repetitive Elements), I couldn't seem to find a hole in this logic. After reading this book, I cannot say I am completely convinced of evolution's presence, but I am far more uncertain than I was at the beginning of the book. I haven't been convinced, but I can understand the opposite opinions."
	Stella: "Though there are many individuals who are proponents of theistic evolution, I have always found myself taking a more literal approach regarding the creation account. This may be due, in part, to a familiarity and comfort that comes along with the '7 day' creation story I have heard since being a young child in Sunday school. Yet, as the years have gone on and I have learned more about the spectrum of positions regarding creation, I still tend to cling to a more literal approach of the Scriptures. It seems to me that God created plant and animal, as well as male and female, as whole and complete."	Stella: "I believe that I am left with more questions than answers [after the course] . . . I am weighing the evidence for both sides with a critical eye and genuine heart. To be honest, I would say that I would tend to side with a more literal or progressive creation account. Maybe it is partially to do with the fact that this is the way I was raised; however, I have also found myself with more questions about my faith when contemplating theistic evolution. I do read Genesis as more of a narrative story, and struggle to take the accounts of Adam and Eve and the flood as only symbolic . . . though the genetic and scientific evidence does indeed seem to support evolutionary origins. . ."

Table 3. Examples of students' statements before and after the genetics course. These students did not make a positive shift toward less conflict and did not become more uncertain of their special creationist beliefs.

Category	Before Genetics Course	After Genetics Course
No Change (Wavered)	Sophia: "The mere probability of evolution occurring is so extraordinarily impossible. The more science classes I take, the more stupefied I am: all life is arranged perfectly all the way down to atomic detail. I don't have enough faith in random chance to believe evolution, while believing that an all-powerful deity brought about the world is much more plausible."	Sophia: "Reading this book was quite difficult in the beginning . . . The more I considered a theistic evolution perspective, the more I realized it was a much more founded theory than I had ever believed . . . After the first few chapters, I was almost converted to theistic evolution because I did not have answers or rebuttals to Collins' questions and facts. It took a few weeks of searching and analyzing my creationist views to come to peace about my own views. While I have concluded that I cannot accept Collins' viewpoint, my mind has been opened to new ideas and ways of thinking."
	Lisa: "There is a spectrum of belief between theistic evolution and literal creationism. I lean much farther towards the literal creation side of this spectrum. I believe that Adam and Eve were real individuals who existed at a defined point in time. I believe that approximately 6,000 years ago, there was a global flood that destroyed every living thing except for the people and animals aboard the ark built by Noah and his sons."	Lisa: "I will freely admit that the biological evidence for macroevolution presented was compelling . . . and yet, after having read and processed all of the arguments in the book, I still must fall back on the worldview that I had at the beginning of the semester. At the end of the day, I would far rather be a mediocre scientist who holds some antiquated scientific beliefs than be a cutting-edge scientist who is respected . . . but has squishy theological beliefs."
No Change (Did Not Waver)	Aria: "I disagree with evolution simply because I believe that science does not support evolution."	Aria: "I just do not think there is enough compelling evidence to support evolution."
	Oliver: "I would call myself an old earth creationist. To deny that the earth is old is to completely throw away science. I don't think that can be denied, but I can deny macroevolution."	Oliver: "I do believe in microevolution between species. That is observable science and can be observed happening today."
	James: "What I struggle with is how macroevolution changes an organism on a scale where not only the species changes, but also its genus and family . . . that is difficult to observe . . . so it makes it difficult to run experiments that follow the scientific process."	James: "After reading *The Language of God*, I have found that my beliefs have not really changed . . . I am one who looks at it from a microevolutionary perspective rather than macroevolutionary."

responses (Table 2), she indicated that she had already accepted evolution and did not experience a conflict. Their responses indicate that these students had already reconciled their religious beliefs with evolution before taking the genetics course.

Changed to Theistic Evolutionism

Students in this category changed from a special creationist belief to a belief in theistic evolution over the course. Five students were in this category. The open-ended responses on the pre-survey indicated that these students were questioning aspects of their creationist beliefs even before taking the genetics course. In their pre-course responses, many of these students questioned their literal interpretation of Genesis and wondered if their religious beliefs needed to conflict with evolution; in their post-course responses, they indicated that they perceived no conflict (Table 2). The course thus had a positive impact on the acceptance of evolution by these students who were already questioning their special creationist beliefs.

Became More Uncertain about Special Creationism

Students in this category started and ended the genetics course believing in some form of special creationism, but they became more uncertain about these beliefs over time. Seven students were

in this category. Sometimes this uncertainty reflected a change in the students' beliefs about special creationism. For instance, although Zoey started and ended the course believing in a form of special creationism, she changed from believing in Literal Creationism to accepting all of evolution except for human evolution (Figure 2); previous studies have shown that human evolution is particularly challenging for students to accept (Barnes et al., 2019). Other students ended the course with the same creationist beliefs they had at the beginning of the course. However, in their post-survey responses, they indicated that they had become less confident about those beliefs. For instance, although Elijah chose Literal Creationism both pre- and post-course (Figure 2), he indicated that he was more uncertain of these beliefs than at the beginning of the course (Table 2).

Almost all of these students attributed their uncertainty to two factors. First, they were willing to admit that at least some of the evidence for evolution was compelling. Second, they said they were unsure if they had rejected evolution only because of the sociocultural norms established by their upbringing (see Stella's comment in Table 2).

These students' responses indicate that although it did not change their acceptance enough for them to choose Theistic Evolution on the evolution survey, the course did have a positive impact on their acceptance by making them more uncertain about their special creationist beliefs.

No Change

Students in this category showed no evidence of reducing their perceived conflict by the end of the semester. A subset of students in this category indicated in their post-course survey responses that during the course they had wavered about their creationist beliefs, but they ended the course with a confident belief in the same form of special creationism. Three students were in this subset. These students admitted that the evidence for evolution was compelling, but ultimately they still rejected evolution. Sophia illustrates this in her reflection on reading *The Language of God* (Table 3).

The reasons for their continued rejection of evolution, even in the face of evidence they found compelling, seemed to be that they valued evidence from religious texts more than they valued scientific evidence. These students said that even though the evidence for evolution was compelling, they were unwilling to sacrifice their literal interpretation of the Bible. Mainly, they saw sacrificing a literal interpretation of the Bible as undermining a staple of their religious beliefs, the story of Adam and Eve. Further, these students all ultimately said that their faith in religion is greater than their trust in science, so when the two conflict, they will always choose their faith (e.g., see Lisa's post-course statement in Table 3). These data illustrate that even when the evidence for evolution is compelling, it will not always be enough to change a student's mind about evolution if they ultimately place higher value on what they perceive to be evidence from religious texts.

Other students in the No Change category did not indicate that they had wavered at all during the semester. Fourteen students were in this subset. The main difference between these students and those who wavered was that these non-wavering students did not report ever finding the evidence for evolution compelling. When they discussed evidence for evolution in their responses, it was to refute the evidence. While all students who wavered admitted that their "faith was more important than evidence from science," most of these students did not make such a claim, because they maintained that their creationist beliefs were supported by the scientific evidence and that they had scientific questions that were not sufficiently answered by Collins's book or the genetics course (Table 3). Two students, Chloe and Fiona, chose special creationist views that were less compatible with evolution at the end of the course than at the beginning. Unfortunately, their open-ended responses did not provide information as to why they chose these views instead of their original special creationist views.

The most cited reason among these students that the evidence for evolution was not compelling was the thought that evolution cannot be observed. In fact, many students said that they accepted microevolution because it was observable but did not accept macroevolution (see James's statements in Table 3).

These data indicate that upper-level biology majors at this institution maintained misconceptions about evolution and the nature of science, and used these misconceptions to assert that scientific evidence supports special creationism and not evolution.

Student Reactions to *The Language of God*

Student reflections and surveys indicate that their reactions to reading *The Language of God* were primarily positive. In their survey responses, only three of the 33 students had exclusively negative reactions to the book; 20 had exclusively positive reactions; seven had both positive and negative reactions; and three did not say anything distinctively positive or negative about the book. Themes in the positive reactions include students' perception that the book encouraged self-reflection about their own views, forced them to think critically about evolution and faith, and made them more open to others' points of view. The students also discussed how they liked learning new evidence for evolution. The most-reported examples of scientific evidence from the book that the students found compelling were Collins's discussion of ancient repetitive elements and the ape chromosome fusion event that happened during the evolution of the human lineage. Additionally, students mentioned that they appreciated the arguments presented by Collins for a nonliteral interpretation of the Bible. One point that was mentioned repeatedly was Collins's discussion of how the Bible was "written for ancient people" before the scientific discoveries of the past few thousand years, and therefore the stories in the Bible were written in a way "that made sense to the people of Moses' time." Further, some students appreciated that Collins argued for compatibility between science and religion and that he was a good role model because he is a religious scientist who argues for both faith and science.

However, students also had several negative reactions to reading the book. The most frequent negative response was that students felt, at times, that Collins took an unnecessarily "harsh tone" against views that reject common ancestry and seemed to be "judgmental of students who are young-Earth creationists." These students felt as though Collins was not open enough to points of view other than his own. Several students brought up an excerpt in the book in which Collins says that "no serious biologist today doubts the theory of evolution to explain the marvelous complexity and diversity of life" (p. 99), and this seemed to be particularly offensive to some of the students who rejected common ancestry. These results are summarized in Table 4 with example quotes from students.

Table 4. Emergent themes from data regarding students' reactions to reading *The Language of God* (Collins, 2006).

Student Reactions	Example Statements	
Positive reactions		
Encouraged self-reflection	Charlotte: "Francis Collins' The Language of God has forced me to think beyond what I have in the past regarding . . . science and faith."	Olivia: "I felt like with every chapter I read, it challenged me to reflect on my own faith and look inside myself to see what I believed."
Became more open to others' points of view	Mia: "This book also made me more open-minded about other ideas and perspectives."	Ella: "I think (the book) has made me more open to at least listening to other theories about creation/evolution."
Learned new evidence for evolution	Evelyn: "Reading about the scientific evidence for evolution was eye-opening to me."	Ethan: "Through this book I became aware of strong evidence for evolution."
Learned new evidence for a nonliteral interpretation of the Bible	Zoey: "I now understand that some of the Bible may be a metaphor or meant in a slightly different way. For instance, yes God could have created the Earth in six 24-hour days if he wanted to, but he could have also used multiple years to complete his work."	Emily: "Prior to reading this book, I had always approached Genesis as a literal writing, but I can see how it is possible that the language used in Genesis was not meant to be a complete scientific account of creation. Rather, it could be more of a simplified explanation for creation that made sense to the people of Moses' time."
Collins taught compatibility between science and religion	Emily: "Often, as this book highlights, there is a misconception that scientists cannot also be Christians. It was encouraging to read about a man who is clearly a brilliant scientist but also a fearless lover of the Lord."	Mila: "I didn't even really know that there was such a large group of people who believed in God and evolution, I simply thought that the two are completely incompatible. However, since reading the book, I have learned that the two can in fact coexist."
Negative reactions		
Collins was too harsh toward special creationists	James: "I struggled with the language used by Collins . . . especially towards those who are young-Earth creationists. His language appeared almost hostile and judgmental, which I did not respect."	Ava: "This book was very challenging for me. I did not appreciate Collins' attitude throughout the book, which made it difficult for me to take him seriously."
Evidence for evolution is not compelling	Ava: "Collins did not present much evidence in favor of his position, which was frustrating to me."	Emma: "When reading about how certain genes in chimpanzees are also found in humans, I couldn't help but think that was just a coincidence."

○ Discussion

We found that a genetics course at an evangelical Christian university that incorporated religious cultural competence and *The Language of God* into its curriculum had a differential effect on students. We found that students who changed from rejecting to accepting common ancestry were questioning their special creationist beliefs at the beginning of the course. This supports the idea that changing from rejecting to accepting evolution is not an immediate event, but a process that takes time (Winslow et al., 2011). We also found that some students became more uncertain of their creationist beliefs over the semester. Although these students did not change their viewpoint by the end of the semester, they may have moved further on a path toward accepting evolution in future years.

We documented that students who either changed to accepting evolution or became more uncertain of creationist beliefs often cited that the evidence for evolution is compelling, whereas those who did not change at all also cited evidence in their reasoning but said the evidence was not sufficient. This calls into question whether or not evidence for evolution is generally sufficient for changing students' views on evolution. The only students who changed to accepting evolution or became more uncertain about their special creationist beliefs were ones who not only cited

evidence for evolution, but also recognized that evolution could be compatible with their religious beliefs. Perhaps presenting evidence alone is an effective change agent only if there is no "identity barrier" present (Kahan & Stanovich, 2016).

Student reactions to *The Language of God* [1] indicated that using religious cultural competence effectively may depend on one's ability to maintain a perception of openness and respect for all beliefs. The most common negative reactions to the use of the book were specific passages in which Collins made remarks that were perceived as disrespectful, closed-minded, and too forceful. This is in line with our past research in which students said they decreased their perceived conflict between religion and evolution when the instructor communicated that they were respectful of student beliefs and would not force students to accept evolution (Truong et al., 2018). If an instructor incorporates some culturally competent practices (e.g., showing examples of religious biologists) but students perceive hostility, judgment, or intolerance of their own religious beliefs in certain statements by the instructor, the culturally competent practices may be less effective.

This research indicates that even conservative, evangelical college biology students, whom we would expect to be the most resistant to evolution, can change their minds in response to evolution education using religious cultural competence (Barnes & Brownell, 2017). The instruction in this course did not have as great an impact on changing students' perceptions of evolution as what has been reported previously (Barnes et al., 2017; Truong et al., 2018). However, those prior studies were done with first-semester biology students at a secular liberal university and did not measure students' change in acceptance of evolution, but only their views on whether evolution and religion could be compatible. In the present study, the students were advanced biology majors who had already been in college learning about evolution and religion for several semesters, so many of them had firm views coming into this upper-level class. Further, these evangelical students were especially resistant to evolution compared to students in our prior studies, with the majority of students choosing a young-Earth creationist view at the beginning of the course. Therefore, although the impact on students is smaller in this context than in other studies, the success we did see here is encouraging – it indicates that instruction can have an impact on these particularly resistant students. However, the limited effect also indicates that more research is needed to increase the efficacy of these interventions among conservative evangelical Christian students.

Limitations

This study looked at one population of students at one university, and the results are not intended to be generalized to other populations. Additional research should explore other populations of evangelical biology students to see if similar results are obtained. Further, while the survey used in this study was chosen because of its prior use in the literature, it may not have captured nuances of students' views due to differing definitions of theistic evolution.

Conclusion

In this study, we found that using a religious scientist role model instructor who accepted evolution and the use of the book *The Language of God* in the context of a genetics course at an evangelical university decreased the perceived conflict with evolution for nine out of 28 students who did not already fully accept evolution, but did not have an impact on the other 19 students. This research indicates that evangelical Christian students may have a particularly difficult time decreasing their perceived conflict with evolution. Culturally competent instruction may be effective for some evangelical students, but future research could explore how to increase its efficacy among this population of students.

Notes

1. Given the religious nature of *The Language of God*, assigning this book for students to read in a biology course at a public university would not be appropriate. However, the book could serve as a potential resource for public college instructors to (1) learn about the views their evangelical Christian students may have and how these students might reconcile their religious beliefs and evolution and (2) recommend the book to evangelical Christian students who may be struggling with accepting evolution. However, our results indicate that it will not be effective for all students, particularly among students who are unwilling to question a literal interpretation of the Bible.

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ABT AUTHORS & PHOTOGRAPHERS Guidelines

We encourage our readers, biologists with teaching interests, and biology educators in general, to write for *The American Biology Teacher*. This peer-reviewed journal includes articles for teachers at every level, with a special focus on high school and post-secondary biology instruction.

Revised August 2018

General Categories

The general categories of articles are:

Feature Article (up to 4000 words) are those of general interest to readers of *ABT*. Consider the following examples of content that would be suitable for the feature article category:

a. Research on teaching alternatives, including evaluation of a new method, cooperative learning, concept maps, learning contracts, investigative experiences, educational technology, simulations and games, and biology and life science education standards

b. Social and ethical implications of biology and how to teach such issues as genetic engineering, energy production, pollution, agriculture, population, health care, nutrition, sexuality and gender, and drugs

c. Reviews and updates of recent advances in the life sciences in the form of an "Instant Update" that brings readers up-to-date in a specific area

d. Imaginative views of the future of biology education and suggestions for adjusting to changes in schools, classrooms, and students

e. Other timely, relevant and interesting content like discussions of the role of the Next Generation Science Standards in biology teaching, considerations of the history of biology with implications for the classroom, considerations of the continuum of biology instruction from K-12 to post-secondary teaching environments, or contributions that consider the likely/ideal future of science and biology instruction.

Research on Learning (up to 4000 words) includes reports of original research on innovative teaching strategies, learning methods, or curriculum comparisons. Studies should be based on sound research questions, hypotheses, discussion of appropriate design and procedures, data and analysis, discussion on study limitations, and recommendations for improved learning.

Inquiry and Investigations (up to 3000 words) is the section of *ABT* that features discussion of innovative laboratory and field-based strategies. Strategies in this section should be original, engaging, focused at a particular grade/age level of student, and include all necessary instructions, materials list, worksheets and assessment tools, practical, and related to either a particular program such as AP and/or linked to standards like NGSS. The most appropriate contributions in this category are laboratory experiences that engage students in inquiry.

Tips, Tricks and Techniques (up to 1500 words but may be much shorter) features a range of suggestions useful for teachers including laboratory, field and classroom activities, motivational strategies to assist students in learning specific concepts, modifications of traditional activities, new ways to prepare some aspect of laboratory instruction, etc.

Submission Guidelines

All manuscripts must be submitted online at http://mc.manuscriptcentral.com/ucpress-abt

- Authors will be asked to register the first time they enter the site. After receiving a password, authors can proceed to upload their manuscripts through a step-by-step process. Assistance is always available in the "Author Help" link found in the menu on the left side of the page. Additional assistance is available from the Managing Editor (managingeditor@nabt.org).
- Manuscripts must be submitted as Word or WordPerfect files.
- Format manuscripts for 8.5 × 11-inch paper, 12-point font, double-spaced throughout, including tables, figure legends, and references.
- Please place figures (including photos) and tables where they are first cited in the text along with appropriate labels. Make sure to include figure and table citations in the text, as it is not always obvious where they should be placed. At the time of initial submission, figures, tables and images should be low resolution so that the final file size remains manageable.
- If your article is accepted, the editors will require that figures be submitted as figure files in higher resolution form. See below for file format and resolution requirements.
- **NOTE:** Authors should be aware that color is rarely used within the journal so all artwork, figures, tables, etc. must be legible in black and white. If color is important to understanding your figures, please consider alternative ways of conveying the information.
- Authors are encouraged to submit multimedia files to accompany their articles. Acceptable file formats include MP3, AVI, MOV, WMV, and FLV.

Editorial Procedures

- Communications will be directed to only the first author of multiple-authored articles.
- At least three individuals who have expertise in the respective content area will review each article.
- Although the editors attempt to make decisions on articles as soon as possible after receipt, this process can take six to eight months, with the actual date of publication to follow. Authors will be emailed editorial decisions as soon as they are available.
- Accepted manuscripts will be forwarded to the Copy Editor for editing. This process may involve making changes in style and content. However, the author is ultimately responsible for scientific and technical accuracy. Page proofs will be sent to authors for final review before publication at which time, only minor changes can be made.

continued

Writing & Style Guidelines

The *Chicago Manual of Style, 14th Edition* is to be used in regards to questions of punctuation, abbreviation, and style. List all references in alphabetical order on a separate page at the end of the manuscript. References must be complete and in *ABT* style. Please review a past issue for examples. Use first person and a friendly tone whenever appropriate. Use concise words to emphasize your point rather than capitalization, underlining, italics, or boldface. Use the SI (metric) system for all weights and measures.

NOTE: All authors must be current members of NABT or a charge of $100 per page must be paid before publication.

Several times a year the *ABT* has issues that focus on a specific area of biology education. Future focus issues will be published in the *ABT* and online at www.NABT.org. The editors highly encourage potential authors to consider writing their manuscripts to align with the future focus topics.

Thank you for your interest in *The American Biology Teacher.*
We look forward to seeing your manuscripts soon.

William McComas, Editor-in-Chief, ABTEditor@nabt.org
Valerie Haff, Managing Editor, managingeditor@nabt.org

Preparing Figure Artwork

General Requirements

- When your article is accepted, we will require that figures be submitted as individual figure files in higher resolution format. See below for file format and resolution requirements.
- **NOTE:** Authors should be aware that color is rarely used within the journal so all artwork, figures, tables, etc. must be legible in black and white. If color is important to understanding your figures, please consider alternative ways of conveying the information.

Halftone (photographic) figures

Digital files must meet the following guidelines:

- Minimum resolution of 300 DPI, though 600 DPI is preferred.
- Acceptable file formats are TIFF and JPEG.
- Set to one-column (3.5" wide) or two-column size (7" wide).
- If figure originates from a website, please include the URL in the figure caption. Please note that screen captures of figures from a website are normally too low in resolution for use.

Line art figures

- Minimum resolution of 600 DPI, though 1200 DPI is preferred.
- Acceptable file formats are TIFF, BMP, and EPS.
- Set to one-column (3.5" wide) or two-column size (7" wide).

If you have any questions, contact Valerie Haff at managingeditor@nabt.org.

Submitting *ABT* Cover Images

Submissions of cover photographs from NABT members are strongly encouraged. Covers are selected based on the quality of the image, originality, composition, and overall interest to life science educators. *ABT* has high standards for cover image requirements and it is important for potential photographers to understand that the required size of the cover image generally precludes images taken with cell phones, point-and-shoot cameras, and even some older model digital SLR cameras.

Please follow the requirements listed below.

1. Email possible cover images for review to Assistant Editor, Kathleen Westrich at kmwestrich@yahoo.com.
2. Choose images with a vertical subject orientation and a good story to tell.
3. Avoid cropping the subject too tightly. It is best to provide an area of background around the subject.
4. Include a brief description of the image, details of the shot (i.e., circumstances, time of day, location, type of camera, camera settings, etc.), and biographical information in your email message.
5. Include your name, home and email addresses, and phone numbers where you can be reached.
6. Please ensure that the image meets the minimum standards for publication listed below and has not been edited or enhanced in any way. The digital file must meet the minimum resolution of 300 pixels per inch (PPI)—preferred is 400 PPI—and a size of 8.5 x 11.25". We accept TIFF or JPEG images only.
7. For exceptional images, the editors will also accept sharp, clear, color 35 mm slides. Submit only the original; duplicates will not be accepted. Be sure to clearly label slides with your name and contact information in ink. Contact Assistant Editor Kathy Westrich beforehand to discuss the possibility of submitting a 35mm slide or other non-digital format for consideration as an *ABT* cover.