

ABSTRACT

It is often assumed that religiosity, or commitment to religion, is the main driver of evolution rejection among biology students, but there are many biology students who are highly religious and accept evolution so religiosity alone cannot be a single causal factor. In this proposed biology education research study, we would like to explore how perceived conflict between religion and evolution may explain the negative relationship between students' religiosity and their evolution acceptance. Further, we want to explore these relationships among religious minorities, students of color, and women. This project has the potential to move the field of evolution education research past religiosity as the main variable of study in our field and instead focus on perceived conflict between religion and evolution. Further, since evolutionary biology is a relatively homogenous group of secular White men, studying how perceived conflict between religion and evolution varies across minority groups may help diversify evolutionary biology as field by highlighting the need for religious cultural competence in evolution education for these groups. **The specific aims of this project are** to (1) determine the relationships between religiosity, perceived conflict between religion and evolution, acceptance of evolution, and understanding of evolution and (2) determine if there are differences in perceived conflict between religion and evolution, acceptance of evolution, and understanding of evolution across different underrepresented/minority groups such as Muslim students, students of color, and women.

Our research questions related to specific aim 1 are: In introductory undergraduate biology courses in the United States, what are students' levels of acceptance and understanding of evolution? What is their level of perceived conflict between their religious beliefs and evolution? What are their levels of religiosity? Does perceived conflict between religion and evolution explain the negative relationship between religiosity and evolution acceptance? **Our research questions related to specific aim 2 are:** Does perceived conflict between religion and evolution explain the negative relationship between religiosity and evolution acceptance? Does perceived conflict between religion and evolution explain the negative relationship between religiosity and evolution acceptance for people from different religious denominations, genders, and race/ethnicities?

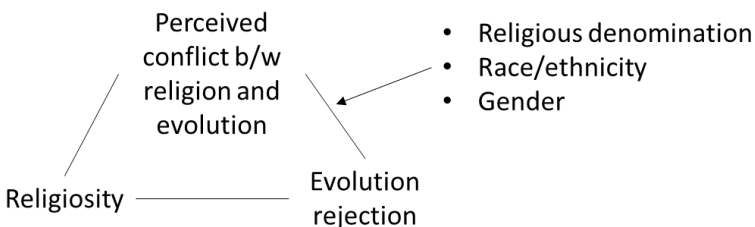


Figure: Theoretical model to be tested for this study.

To answer our research questions, we will survey ~4,000 students in ~25 courses in which the instructors have already agreed to distribute our survey. In our survey we will collect student demographic information, their perceived conflict between religion and evolution, and their evolution acceptance and understanding to run statistical analyses.

PROJECT DESCRIPTION

Introduction

Although evolution is an important part of biology education, undergraduate biology students can be uncomfortable learning evolution and reject evolution as a valid scientific theory. To date, much of the research on rejection of evolution has been focused on White Christians and how their levels of religiosity and/or denomination of Christianity are associated with lower evolution acceptance and understanding of evolution (Barnes et al., 2017; Dunk et al., 2017; Glaze et al., 2014). However, it may not be the strength of one's religiosity that determines acceptance of evolution, but the degree to which these individuals perceive there is conflict between their religious beliefs and evolution that determines their acceptance and understanding. Further, religious minority students (for example, Muslim students), racially minoritized students (for example, Black and Hispanic students) and women may have unique and sometimes more severe struggles with learning and accepting evolution. In this proposal, we describe a study to explore how evolution acceptance, understanding of evolution, religiosity, and perceived conflict between religion and evolution are causally related and to explore how these variables and relationships may differ across demographic groups.

Background

Evolution is important to biology education, yet controversial, misunderstood, and ignored by the public and undergraduate students. Biologists have agreed that “nothing in biology” makes sense except in the light of evolution (American Association for the Advancement in Science, 2011; Dobzhansky, 1973), and yet almost half of the American public doubts the veracity of evolution as a scientific theory that extends to humans (Gallup, 2019). Surprisingly, this controversy extends to our college biology students. Studies have shown that up to half of incoming college biology majors do not accept that life on earth shares a common ancestor (Barnes, Dunlop, et al., 2020), a key tenant of evolution.

In addition to finding large scale evolution implausible, on average, the public and students also have a low understanding of evolution. They do not necessarily know how evolution occurs, what the evidence is for evolution, and many students cannot define evolution accurately (Anderson et al., 2002; Mead et al., 2017; Nehm & Schonfeld, 2008). For instance, many students still maintain the misconception that evolution happens over an individual's lifetime rather than within a population of organisms, they believe that evolution claims humans evolved from chimpanzees, and they maintain that evolution is by nature atheistic with respect to the existence of a God rather than agnostic, which is more accurate according to the nature of science (Barnes, Dunlop, et al., 2020).

Prior research has often focused on how religious commitment (referred to as religiosity) and religious denomination are associated with evolution acceptance and understanding. Research shows that the more religious one is, the more likely they are to reject evolution (Dunk et al., 2017) but this may not be the direct cause of evolution rejection. It may be that the reason students may not accept and/or understand evolution is more accurately because they *perceive a conflict* between their religious beliefs and evolution. This would explain why for instance, we

might not expect a highly religious Buddhist to reject evolution based on their religious beliefs. Buddhists tend to see little conflict between scientific claims and religious claims (Miller et al., 2006). However, highly religious Protestant Christians, on average, have lower acceptance of evolution, but this is not necessarily because they are highly religious. It may be because within the Protestant Christian religion there are more examples of conflict between religion and evolution in their culture, such as an adherence to Biblical Literalism (Chan & Ecklund, 2016).

Our hypothesis that perceived conflict, rather than religiosity, drives evolution acceptance has implications for how biology instructors teach evolution. In prior work, college level evolution instructors often say they avoid discussing religion when teaching evolution because they feel uncomfortable trying to change student religious beliefs and they even sometimes have negative stereotypes about religious people (Barnes, Truong, et al., 2020; Barnes & Brownell, 2016). But students say that when evolution instructors avoid the topic of religion it does not necessarily mitigate student discomfort – religious students can assume instructors have negative attitudes towards religion, even when the instructor does not talk about religion (Barnes et al., 2017). It may help instructors to be more comfortable implementing productive discussions about religion and evolution if they can discuss with students ways to reduce personal perceived conflict between religious beliefs and evolution, rather than changing their religious beliefs completely. For instance, teaching students that the nature of science is *agnostic* (does not make a claim about the existence of a God/god(s)) and not *atheistic* (claims there is no existence of a God/god(s)) might help students reduce their perceived conflict with evolution, without changing the students' beliefs about the existence of a God/god(s) (Barnes, Dunlop, et al., 2020).

In addition to exploring if perceived conflict drives the negative relationship between evolution and religiosity, we also will explore differences across non-dominant demographic groups. Evolutionary biologists as a group lack diversity in terms of religion, gender, and racial/ethnic diversity and the combative dialogue around religion in this field may be an important factor to consider for why (O'Brien et al., 2020; Salazar et al., 2019). Famous evolutionary biologists have made themselves well known for their “militant atheism” and regularly denigrate those with religious beliefs (Coyne, 2015; Dawkins, 2009). However, minority students are more likely to identify as religious and use it as a support in their life (Ellison et al., 2008; Pew, 2009). Thus, there may be inequities in student experiences with and perceptions of evolution. Students from minority religions (i.e. Muslim students), students of color, and women may have lower evolution acceptance and understanding and higher perceived conflict between their religious beliefs and evolution compared to secular White male students who make up at least 75% of all PhDs awarded in evolutionary biology (National Science Foundation, National Center for Science and Engineering Statistics, 2017). Thus, considering perceived conflict when teaching evolution may be important for fostering diversity in evolutionary biology.

Specific Aims

The specific aims of this project are (1) explore the relationships between religiosity, perceived conflict between religion and evolution, and acceptance of evolution (2) determine if there are differences in perceived conflict between religion and evolution and acceptance of evolution based on race/ethnicity, denomination, and/or gender.

Research Questions:

- 1.) In introductory undergraduate biology courses in the United States, what are students' levels of acceptance and understanding of evolution? What is their level of perceived conflict between their religious beliefs and evolution? What are their levels of religiosity? (SA 1)
- 2.) In undergraduate biology classes, does acceptance and understanding of evolution vary by religious denomination, gender, and/or student race/ethnicity? (SA 2)
- 3.) Does perceived conflict between religion and evolution explain the negative relationship between religiosity and evolution acceptance? (SA 1)
- 4.) Is this mediation moderated by religious denomination, gender, and/or race/ethnicity? (SA)

Methods

Recruitment and Population

We have already recruited ~25 biology instructors nationwide who have agreed to send our survey to their introductory biology students in spring 2021. We expect ~ 4,000 students will participate, which will give us the sample size needed to conduct analyses on students from minoritized backgrounds, who are often not prevalent enough in education data sets to study quantitatively. We identified instructors of biology courses through their institutional profiles and also recruited instructors via the Society for the Advancement of Biology Education Research (SABER) listserv. To maximize the sample size of Hispanic and Black/African American students for statistical analyses, we wanted to recruit instructors from Minority-Serving Institutions and large-enrollment institutions in the USA in which greater than 5% of the student population identify as Hispanic or Black/African American. We used the directory of biology faculty from each of the institutions that met these criteria, and if the “courses taught” listed on the instructor’s profile included introductory biology, their name, email, and institution were recorded in a spreadsheet. We emailed these instructors and asked them if they would be willing to send out a link to a Qualtrics survey to the students in their class and offer a small amount of extra credit for completing the survey. All activities have been approved by ASU’s Institutional Review Board protocols #8191.

We will collect data on student racial/ethnic identity, their religiosity, religious affiliation, understanding of evolution, perceived conflict between religious beliefs and evolution and their acceptance of evolution. The survey will be administered to students during their first week of classes, before any exposure to evolution instruction.

Measures

We will ask students to self-identify from the following list of racial/ethnic identities: (1) American Indian, Native American, or Alaskan Native, (2) Asian, (3) Black/African American, (4) Native Hawaiian or Other Pacific Islander, (5) Hispanic (6) White, (7) other not listed, and (8) prefer not to answer. Students will be able to check more than one box. We will also ask students to self-identify from the following list of religious affiliations: Agnostic, Atheist, Buddhist, Christian- Catholic, Christian- The Church of Jesus Christ of Latter Day Saints, Christian- Protestant, Christian- Other, Christian- nondenominational, Hindu, Jewish, Muslim,

Nothing in particular, Other faith and Decline to state. We will ask students to report their gender. Finally, we will ask students to report their age and their parent's highest level of education to control for potentially confounding demographic factors, since age and parent level of education are sometimes related to evolution education outcomes (Bailey et al., 2011; Baker, 2013; Rissler et al., 2014; Sbeglia & Nehm, 2018).

To measure evolution understanding, we will use two subscales from the Evolutionary Attitudes and Literacy Instrument (13 items) (EALS; Hawley et al. 2010) that measure "Evolutionary Knowledge" and "Evolutionary Misconceptions". Students will be asked to decide whether each item is true or false based on their evolution understanding and also give them an "I don't know" option to avoid student correct answers by guessing. We chose to use the because it has been used in other evolution education studies and has shown evidence of reliability and validity among college students (Dunk et al. 2017; Short and Hawley 2015).

To measure acceptance of evolution, we will use the previously published Inventory of Student Evolution Acceptance (I-SEA), which includes 24 statements with which students agree or disagree on a 5-pt scale. The I-SEA measures acceptance of microevolution, macroevolution, and human evolution. We chose to use the I-SEA because it addresses many limitations of other acceptance of evolution measurement tools (Barnes et al., 2019; Sbeglia & Nehm, 2019).

We will use four items from a previously published instrument used in the psychology of religion to measure student religiosity (Cohen et al., 2008). The items measure the intrinsic strength of one's religious identity and participation in religious activities and are similar to other common measures used both in studies of religion (Dingemans & Van Ingen, 2015; Ecklund et al., 2018) and studies of evolution acceptance (Dunk et al., 2017; Rissler et al., 2014). The instrument consisted of four items with which the students agree or disagree on a 5-pt scale.

To measure perceived conflict between religion and evolution, we will use a new survey that we created. This measure consists of four separate but related constructs, perceived conflict with evolution and (1) personal belief in God (2) personal religious beliefs (3) teaching of their and (4) and beliefs within their religious community (e.g., "My religious community does not believe that all of life on Earth evolved from ancient microscopic life."). Each construct consists of five items that inquire about conflict with microevolution, macroevolution, and human evolution as well as the common ancestry of life on earth.

Analyses

Following the recommendation from Sbeglia & Nehm (2018), we will convert all Likert responses into linear interval scale measures (Boone, 2016; Linacre & Wright, 1993) by running three unidimensional Rasch models (acceptance of microevolution, macroevolution and human evolution). We will run Rasch models (Robitzsch et al., 2018) and use a weighted maximum likelihood estimation in TAM to calculate theta values, i.e. person measures using the function `tam.wle`. These person measures will be used as the measures in analyses.

To answer research question 1, we will calculate averages for students' religiosity, evolution acceptance, evolution understanding, and perceived conflict between religion and evolution to

determine average levels of these variable. To answer research question 2, we will run General Linear Models (GLM) to estimate if there are differences in student acceptance and understanding of evolution across different racial/ethnic groups, genders, and religious denominations. To answer research question 3, we will run mediation analyses to determine the extent that perceived conflict between religion and evolution explains the relationship between religiosity and evolution acceptance. Finally, to answer research question number 4, we will run a moderated mediation analysis to determine if mediation effects are different for students from different race/ethnicities, religious denominations, or genders.

Milestones and Timeline

Spring 2021, January: administer survey to students in 25 introductory biology classes nationwide; **February – April:** conduct analyses on survey data and submit results to a science education conference for feedback; **Summer 2021, May – July:** submit results to a science education journal for peer review.

Resources

We have access to 25 biology courses from instructors who have agreed to help us recruit their students through email. We currently have the statistical analysis software (SPSS) to conduct the analyses. We also have a Qualtrics survey account to be the platform for data collection. In order to help coordinate the survey and clean and analyze the data, a Graduate Research Assistant (GRA) is needed. In order to support the faculty member to help conduct the analyses and mentor the graduate student, summer support is also needed for the faculty member.

Future External Funding

This will serve as preliminary data for an NSF Improving Undergraduate STEM education (IUSE) proposal to be submitted in Fall 2021. Particularly, I will be proposing a study to re-design my previously constructed framework of Religious Cultural Competence in Evolution Education (ReCCEE) to take into account the differential evolution education experiences of religious Black, Hispanic, Muslim, and women students.

Dissemination

We will disseminate this work by presenting at science education conferences and publishing the study in a science education journal. This project is *innovative* in that it is the first to focus on perceived conflict as a driver of rejection of evolution as opposed to religiosity. Further, it is the first to explore how variables and their relationships vary across minority demographic groups. The proposal *is significance to the PI's field* because it will extend research aimed at creating more effective evolution education. The proposal *benefits the applicant's long-term goals* by creating new research aimed at reducing inequities in evolution education. *Future plans* will be to use the data from this study to write an NSF IUSE proposal. This study will have direct *impact* on the graduate student I am able to mentor and support at *MTSU* using these funds.

References

- American Association for the Advancement in Science. (2011). *Vision and change in undergraduate biology education: A call to action*. American Association for the Advancement of Science, Washington, DC.
- Anderson, D. L., Fisher, K. M., & Norman, G. J. (2002). Development and evaluation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching*, 39(10), 952–978. <https://doi.org/10.1002/tea.10053>
- Bailey, G., Han, J., Wright, D., & Graves, J. L. (2011). Religiously expressed fatalism and the perceived need for science and scientific process to empower agency. *The International Journal Science in Society*, 2(3), 55–88.
- Baker, J. O. (2013). Acceptance of Evolution and Support for Teaching Creationism in Public Schools: The Conditional Impact of Educational Attainment. *Journal for the Scientific Study of Religion*, 52(1), 216–228. <https://doi.org/10.1111/jssr.12007>
- Barnes, M. E., & Brownell, S. E. (2016). Practices and Perspectives of College Instructors on Addressing Religious Beliefs When Teaching Evolution. *CBE-Life Sciences Education*, 15(2), 1–19. <https://doi.org/10.1187/cbe.15-11-0243>
- Barnes, M. E., Dunlop, H. M., Holt, E. A., Zheng, Y., & Brownell, S. E. (2019). Different evolution acceptance instruments lead to different research findings. *Evolution: Education and Outreach*, 12(1), 4. <https://doi.org/10.1186/s12052-019-0096-z>
- Barnes, M. E., Dunlop, H. M., Sinatra, G. M., Hendrix, T. M., Zheng, Y., & Brownell, S. E. (2020). “Accepting Evolution Means You Can’t Believe in God”: Atheistic Perceptions of Evolution among College Biology Students. *CBE—Life Sciences Education*, 19(2), ar21. <https://doi.org/10.1187/cbe.19-05-0106>
- Barnes, M. E., Truong, J. M., & Brownell, S. E. (2017). Experiences of Judeo-Christian Students in Undergraduate Biology. *CBE-Life Sciences Education*, 16(1), ar15. <https://doi.org/10.1187/cbe.16-04-0153>
- Barnes, M. E., Truong, J. M., Grunspan, D. Z., & Brownell, S. E. (2020). Are scientists biased against Christians? Exploring real and perceived bias against Christians in academic biology. *PLOS ONE*, 15(1), e0226826. <https://doi.org/10.1371/journal.pone.0226826>
- Boone, W. J. (2016). Rasch Analysis for Instrument Development: Why, When, and How? *CBE-Life Sciences Education*, 15(4), rm4. <https://doi.org/10.1187/cbe.16-04-0148>
- Chan, E., & Ecklund, E. H. (2016). Narrating and Navigating Authorities: Evangelical and Mainline Protestant Interpretations of the Bible and Science. *Journal for the Scientific Study of Religion*, 55(1), 54–69. <https://doi.org/10.1111/jssr.12245>
- Cohen, A. B., Shariff, A. F., & Hill, P. C. (2008). The accessibility of religious beliefs. *Journal of Research in Personality*, 42(6), 1408–1417. <https://doi.org/10.1016/j.jrp.2008.06.001>

- Coyne, J. A. (2015). *Faith Versus Fact: Why Science and Religion Are Incompatible*. Penguin Publishing Group.
- Dawkins, R. (2009). *The god delusion*. Random House.
- Dingemans, E., & Van Ingen, E. (2015). Does Religion Breed Trust? A Cross-National Study of the Effects of Religious Involvement, Religious Faith, and Religious Context on Social Trust. *Journal for the Scientific Study of Religion*, 1–17. <https://doi.org/10.1111/jssr.12217>
- Dobzhansky, T. (1973). Nothing in Biology Makes Sense except in the Light of Evolution. *The American Biology Teacher*, 35(3), 125–129. <https://doi.org/10.2307/4444260>
- Dunk, R. D. P., Petto, A. J., Wiles, J. R., & Campbell, B. C. (2017). A multifactorial analysis of acceptance of evolution. *Evolution: Education and Outreach*, 10, 4. <https://doi.org/10.1186/s12052-017-0068-0>
- Ecklund, E. H., Scheitle, C. P., & Peifer, J. (2018). The Religiosity of Academic Scientists in the United Kingdom: Assessing the Role of Discipline and Department Status. *Journal for the Scientific Study of Religion*, 57(4), 743–757. <https://doi.org/10.1111/jssr.12552>
- Ellison, C. G., Musick, M. A., & Henderson, A. K. (2008). Balm in Gilead: Racism, Religious Involvement, and Psychological Distress Among African-American Adults. *Journal for the Scientific Study of Religion*, 47(2), 291–309. <https://doi.org/10.1111/j.1468-5906.2008.00408.x>
- Gallup. (2019). *40% of Americans Believe in Creationism*. Gallup.Com. <https://news.gallup.com/poll/261680/americans-believe-creationism.aspx>
- Glaze, A. L., Goldston, M. J., & Dantzler, J. (2014). Evolution in the Sotheastern USA: Factors Influencing Acceptance and Rejection in Pre-service Science Teachers. *International Journal of Science and Mathematics Education*, 13(6), 1189–1209. <https://doi.org/10.1007/s10763-014-9541-1>
- Linacre, J. M., & Wright, B. D. (1993). *A user's guide to BIGSTEPS: Rasch-model computer program*. Mesa Press San Diego, CA.
- Mead, R., Hejmadi, M., & Hurst, L. D. (2017). Teaching genetics prior to teaching evolution improves evolution understanding but not acceptance. *PLOS Biology*, 15(5), e2002255. <https://doi.org/10.1371/journal.pbio.2002255>
- Miller, J. D., Scott, E. C., & Okamoto, S. (2006). Public Acceptance of Evolution. *Science*, 313(5788), 765–766. <https://doi.org/10.1126/science.1126746>
- National Science Foundation, National Center for Science and Engineering Statistics. (2017). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017. Special Report NSF 17-310*. www.nsf.gov/statistics/wmpd/.
- Nehm, R. H., & Schonfeld, I. S. (2008). Measuring knowledge of natural selection: A comparison of the CINS, an open-response instrument, and an oral interview. *Journal of Research in Science Teaching*, 45(10), 1131–1160. <https://doi.org/10.1002/tea.20251>

- O'Brien, L. T., Bart, H. L., & Garcia, D. M. (2020). Why are there so few ethnic minorities in ecology and evolutionary biology? Challenges to inclusion and the role of sense of belonging. *Social Psychology of Education*. <https://doi.org/10.1007/s11218-019-09538-x>
- Pew. (2009, January 30). A Religious Portrait of African-Americans. *Pew Research Center's Religion & Public Life Project*. <http://www.pewforum.org/2009/01/30/a-religious-portrait-of-african-americans/>
- Rissler, L. J., Duncan, S. I., & Caruso, N. M. (2014). The relative importance of religion and education on university students' views of evolution in the Deep South and state science standards across the United States. *Evolution: Education and Outreach*, 7(1), 24. <https://doi.org/10.1186/s12052-014-0024-1>
- Robitzsch, A., Kiefer, T., & Wu, M. (2018). TAM: Test analysis modules. *R Package Version*, 2, 9–35.
- Salazar, E. S., Vaidyanathan, B., Ecklund, E. H., & Garcia, A. (2019). Challenging Evolution in Public Schools: Race, Religion, and Attitudes toward Teaching Creationism. *Socius*, 5, 2378023119870376. <https://doi.org/10.1177/2378023119870376>
- Sbeglia, G. C., & Nehm, R. H. (2018). Measuring evolution acceptance using the GAENE: Influences of gender, race, degree-plan, and instruction. *Evolution: Education and Outreach*, 11(1), 18. <https://doi.org/10.1186/s12052-018-0091-9>
- Sbeglia, G. C., & Nehm, R. H. (2019). Do you see what I-SEA? A Rasch analysis of the psychometric properties of the Inventory of Student Evolution Acceptance. *Science Education*, 103(2), 287–316. <https://doi.org/10.1002/sce.21494>

Biographical sketch

Dr. M. Elizabeth Barnes is a Discipline Based Education Researcher in Biology. She brings unique insight into the perceptions of evolution and religion within biology, religious students' experiences in biology, and the intersection of race/ethnicity and religion on student attitudes towards evolution. Her work has documented the obstacles that religious students encounter in biology classes.

As a PhD student at Arizona State University, she successfully obtained NSF funding through the NSF Graduate Research Fellowship Program (DGE-1311230; \$150,200 total stipend and tuition support awarded, 2015-2018) and as a post-doc at she obtained funding from the NSF as a Co-PI of the project "*A Large-scale Systematic Exploration of the Impact of Culturally Competent Biology Education*" (NSF IUSE #1818659; awarded \$423,003, 2018 - 2021). Funding for the GRF and NSF-IUSE was used to identify, document, and test instructional practices meant to be inclusive for religious undergraduate biology students. Dr. Barnes was the researcher primarily responsible for the study design, data collection, analyses, and dissemination of results. She is now motivated to continue this research productivity at MTSU as a PI lead of her own projects.

Intellectual Merit: During her time as a GRF, Dr. Barnes explored, described, and tested instructional practices that were inclusive for religious STEM students. She uniquely documented that differences between the religious cultures of college biology instructors, who are often secular, and their students, who are often Christian, can lead to evolution education that is not culturally competent for religious students (Barnes & Brownell, 2016; Barnes & Brownell, 2017; Barnes, Truong et al., 2017). The research done during the GRF also included studies which documented instructional practices that decreased students' perceived conflict between their religious beliefs and evolution (Barnes, Elser et al., 2017; Barnes, Truong et al., 2018; Barnes, Werner, et al., 2020), culminating in a new instructional framework for teaching evolution called "Religious Cultural Competence in Evolution Education (ReCCEE)" (Barnes & Brownell, 2017). As a post-doc and Co-PI on *A Large-scale Systematic Exploration of the Impact of Culturally Competent Biology Education* Dr. Barnes has been exploring the efficacy of her novel instructional framework in introductory biology courses nationwide.

Broader Impacts: The research for both the GRF and *A Large-scale Systematic Exploration of the Impact of Culturally Competent Biology Education* has contributed to the broader scientific community's goals of benefiting science and societal relations, improving the ability of scientists to successfully communicate to religious audiences and increasing participation of religious groups in learning and accepting evolution, a core concept of biology (American Association for the Advancement in Science, 2011).

Key Findings and Research Products: During her GRF period, Dr. Barnes published nine first author manuscripts, gave eight peer-reviewed talks and presented 15 posters at national and international conferences. Her research was highlighted twice in *Scientific American* and in *The Smithsonian*, reaching wide audiences. *A Large-scale Systematic Exploration of the Impact of Culturally Competent Biology Education* has yielded one published manuscript (Barnes et al., 2020), one in press, and three that are in preparation after data collection and analyses. Findings thus far indicate that instructors teaching evolution at the college level often do not address students' religious beliefs when teaching evolution and some address religion in an antagonistic way; religious students perceive evolution instructors as antagonistic towards religion even when the instructors avoid talking about religion (Barnes, Truong, et al., 2017). However, providing religious scientist role models, giving students autonomy over their decision to accept evolution, and highlighting the

potential compatibility of religion and science can increase religious students' comfort in the biology classroom, decrease their perceived conflict between their religious beliefs and evolution, and increase their acceptance of evolution (Barnes, Elser, et al., 2017; Barnes, Truong, et al., 2018; Barnes, Werner, et al., 2020).

Professional Preparation

Arizona State University	Biological Sciences	B.S., 2013
Arizona State University	Biology Education Research	M.S., 2014
Arizona State University	Biology Education Research	Ph.D., 2018

Appointments

Middle Tennessee State University	Assistant Professor of Biology Ed	Present
Arizona State University	Postdoctoral Scholar, Biology Ed	2018 - 2020

Example Products

Barnes, M.E., & Brownell, S.E. (2018). A Call to Use Cultural Competence When Teaching Evolution to Religious College Students: Introducing Religious Cultural Competence in Evolution Education (ReCCEE). *CBE-Life Sciences Education*, 16 (4).

<https://doi.org/10.1187/cbe.17-04-0062>.

Barnes, M.E., Truong, J.M., Brownell, S.E. (2018). Can Six Minutes of Culturally Competent Evolution Education Reduce Students' Level of Perceived Conflict between Evolution and Religion? *The American Biology Teacher*, 80(2), 106-

115. <https://doi.org/10.1525/abt.2018.80.2.106>.

Barnes, M. E., & Brownell, S. E. (2017). Experiences and Practices of Evolution Instructors at Christian Universities that can Inform Culturally Competent Evolution Education. *Science Education*, 101(6), 1-24. <https://doi.org/10.1002/sce.21317>.

Barnes, M. E., Elser, J., & Brownell, S. E. (2017). Impact of a Short Evolution Module on Students' Perceived Conflict between Religion and Evolution. *The American Biology Teacher*, 79(2), 104-111. <https://doi.org/10.1525/abt.2017.79.2.104>.

Barnes, M. E., Truong, J. M., & Brownell, S. E. (2017). Experiences of Judeo-Christian Students in Undergraduate Biology. *CBE-Life Sciences Education*, 16(1), 15.

<https://doi.org/10.1187/cbe.16-04-0153>.

Barnes, M. E., Evans, E. M., Hazel, A., Brownell, S. E., & Nesse, R. M. (2017). Teleological Reasoning, not Acceptance of Evolution, Impacts Students' Ability to Learn Natural Selection. *Evolution: Education and Outreach*, 10(7). <https://doi.org/10.1186/s12052-017-0070-6>.

Barnes, M. E., & Brownell, S. E. (2016). Practices and Perspectives of College Instructors on Addressing Religious Beliefs When Teaching Evolution. *CBE-Life Sciences Education*, 15(2), 18. <https://doi.org/10.1187/cbe.15-11-0243>.

Appendix

Measures

UNDERSTANDING OF EVOLUTION:

Please choose whether each statement is true or false based on your **understanding of evolution**:

	True	False	I don't know
Individuals don't evolve, species do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evolution is a progression towards more advanced species.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mutations occur all the time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Species evolve to be <i>perfectly</i> adapted to their environments.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In most groups of organisms, more offspring are born than survive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mutations can be passed down to the next generation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More genetic variability makes a population more resistant to extinction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural selection is the same thing as evolution.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The characteristics an organism acquires during their lifetime are often genetically passed down to their offspring.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural selection is the only cause of evolution.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The more recently species share a common ancestor, the more closely related they are.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evolution means progression towards perfection.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Natural selection is a random process.

Natural selection means that only the smartest and physically strongest organisms survive.

MICROEVOLUTION ACCEPTANCE:

Please indicate whether you agree or disagree with the following statements, **based on your personal opinion.**

	strongly disagree	disagree	undecided	agree	strongly agree
I think that organisms, as they exist now, are perfectly adapted to their natural environments and so will not continue to change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think all groups of organisms will continue to change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think there are a large number of examples of organisms that have undergone evolutionary <i>changes within the species</i> (i.e., antibiotic resistance in bacteria, production of new strains of the flu virus).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that species were created to be perfectly suited to their environment, so they do not change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't accept the idea that a species of organism will evolve new traits over time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think there is an abundance of observable evidence to support the theory describing how <i>variations within a species</i> can happen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that <i>species</i> exist today in exactly the same <i>shape and form</i> in which they always have.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think there is overwhelming evidence supporting the theory of evolution to explain <i>how variations in a species develop</i> over time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

MACROEVOLUTION ACCEPTANCE:

	strongly disagree	disagree	undecided	agree	strongly agree
I think that new species <i>evolved</i> from ancestral species.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that the fossil evidence that scientists use to support evolutionary theory is weak and inconclusive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think there are a large number of fossils found all around the world that support the ideas that organisms <i>evolve into new species</i> over time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think all complex organisms evolved from single celled organisms.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that new species evolve from a lot of small changes occurring over relatively long periods of time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think there is little or no observable evidence to support the theory that describes how one species of organism evolves from a <i>different</i> ancestral form.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the forms and diversity of organisms have changed dramatically over time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that all organisms come from a single common ancestor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

HUMAN EVOLUTION ACCEPTANCE:

	strongly disagree	disagree	undecided	agree	strongly agree
I think there is reliable evidence to support the theory that describes how humans were derived from ancestral primates.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- I think that humans adapt, but they have not/do not evolve.
- I think that the physical structures of humans are too complex to have evolved.
- I think that humans and apes share an ancient ancestor.
- I think that humans evolve.
- I think that humans do not evolve; they can only change their behavior.
- I think the many characteristics that humans share with other primates (i.e., chimpanzees, gorillas) can be best explained by our sharing a common ancestor.
- I think physical variations in humans (i.e. eye color, skin color) were derived from the same processes that produce variation in other groups of organisms.

RELIGIOUS AFFILIATION:

I most closely identify as:

- Buddhist
- Christian
- Hindu
- Jewish
- Muslim
- I don't identify with a religion

Option not available, please describe

Prefer not to answer

With what denomination of Christianity do you most closely identify? (If Christian is chosen as religion)

Catholic

Jehova's witness

Orthodox

Nondenominational

Protestant

The Church of Jesus Christ of Latter Day Saints

Option not available, please describe

Do you identify as Evangelical Christian? (If Christian is chosen as religion)

Yes

No

I'm not sure

I most closely identify as: (If don't identify with a religion is chosen)

Atheist (believes that God does not exist)

Agnostic (does not have a definite belief about whether God exists or not)

Option not available, please describe:

RELIGIOSITY

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

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I attend religious services regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe in God	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I consider myself a religious person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I consider myself a spiritual person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

PERCEIVED CONFLICT BETWEEN RELIGIOUS BELIEFS AND EVOLUTION (student only gets these questions if they identify with a religion)

My belief in God makes it harder to believe that all of life on Earth evolved from ancient microscopic life.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My belief in God makes it harder to believe that humans evolved from ancient ape ancestors.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My belief in God makes it harder to believe that non-human life evolved from previous different species.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My belief in God makes it harder to believe that humans have changed over time due to evolution.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My belief in God makes it harder to believe that non-human life has changed over time due to evolution.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

The teachings of my religion contradict that all of life on Earth evolved from ancient microscopic life.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

The teachings of my religion contradict that humans evolved from ancient ape ancestors.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

The teachings of my religion contradict that non-human life evolved from previous different species.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

The teachings of my religion contradict that humans have changed over time due to evolution.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

The teachings of my religion contradict that non-human life has changed over time due to evolution.

- strongly disagree
- disagree
- neutral

agree

strongly agree

My religious community does not believe that all of life on Earth evolved from ancient microscopic life.

strongly disagree

disagree

neutral

agree

strongly agree

My religious community does not believe that humans evolved from ancient ape ancestors.

strongly disagree

disagree

neutral

agree

strongly agree

My religious community does not believe that non-human life evolved from previous different species.

strongly disagree

- disagree
- neutral
- agree
- strongly agree

My religious community does not believe that humans have changed over time due to evolution.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My religious community does not believe that non-human life has changed over time due to evolution.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My personal religious beliefs make it harder to believe that all of life on Earth evolved from ancient microscopic life.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My personal religious beliefs make it harder to believe that all of life on Earth evolved from ancient microscopic life.

- strongly disagree
- disagree
- neutral
- agree
- strongly agree

My personal religious beliefs make it harder to believe that non-human life evolved from previous different species.

- strongly disagree
- disagree
- neutral

agree

strongly agree

My personal religious beliefs make it harder to believe that humans have changed over time due to evolution.

strongly disagree

disagree

neutral

agree

strongly agree

My personal religious beliefs make it harder to believe that non-human life has changed over time due to evolution.

strongly disagree

disagree

neutral

agree

strongly agree

DEMOGRAPHICS:

How old are you?

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

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

I most closely identify as:

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

What is your race/ethnicity? Please select all that apply.

- American Indian, Native American, or Alaskan Native
 - Asian (East Asian, Southeast Asian, South Asian, West Asian, Middle Eastern)
 - Black and/or African American
 - Latinx
 - Native Hawaiian or Other Pacific Islander
 - White or European American
 - Decline to state
 - Option not available, please describe:
-

Please select all that apply (if Asian is chosen):

- East Asian (Chinese, Japanese, Mongolian, North or South Korean, Taiwanese)
 - Southeast Asian (Cambodian, Laotian, Myanmar/Burmese, Malaysian, Bruneian, Indonesian, Thai, Timorese, Vietnamese, Bruneian, Singaporean)
 - South Asian (Afghan, Bangali, Indian, Maldivian, Nepali, Pakistani, Sri Lankan)
 - West Asian/Middle Eastern (Armenian, Azerbaijani, Bahraini, Cypriot, Georgian, Iranian, Iraqi, Israeli, Jordanian, Kuwaiti, Lebanese, Omani, Palestinian, Qatari, Saudi Arabian, Syrian, Turkish, Emirati, Yemeni)
 - Filipino
 - Option not available, please describe:
-

**IRB/IACUC STATUS
FRCAC APPLICATION**

No protocol submitted to IRB/IACUC

Protocol submitted to IRB IACUC
on:

Compliance Office Protocol #

IRB IACUC Approval Received on:

FRCAC comments (for committee use only):



IRBN007 – EXEMPTION DETERMINATION NOTICE

Monday, September 28, 2020

Protocol Title **Examining student beliefs about evolution**
Protocol ID **21-1031 2q**

Principal Investigator **Maryann Elizabeth Barnes (Faculty)**
Co-Investigators NONE
Investigator Email(s) *liz.barnes@mtsu.edu*
Department/Affiliation Biology
Funding NONE

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category **(2) Educational Tests, surveys, interviews or observations of public behavior (Qualtrics Survey)**. A summary of the IRB action and other particulars of this protocol are shown below:

<i>IRB Action</i>	EXEMPT from further IRB review***		
<i>Date of Expiration</i>	12/31/2021	<i>Date of Approval:</i> 9/28/20	<i>Recent Amendment:</i> NONE
<i>Sample Size</i>	TWO THOUSAND (2,000)		
<i>Participant Pool</i>	Healthy adults (18 or older) - MTSU Students		
<i>Exceptions</i>	Online consent followed by internet-based survey using Qualtrics is permitted (Qualtrics links on file).		
<i>Type of Interaction</i>	<input checked="" type="checkbox"/> Virtual/Remote/Online Interview/survey <input type="checkbox"/> In person or physical– Mandatory COVID-19 Management (refer next page)		
<i>Mandatory Restrictions</i>	1. All restrictions for exemption apply. 2. The participants must be 18 years or older. 3. Mandatory ACTIVE informed consent. Identifiable information including, names, addresses, voice/video data, must not be obtained. 4. NOT approved for in-person data collection.		
<i>Approved IRB Templates</i>	<i>IRB Templates:</i> Online informed consent and recruitment Email <i>Non-MTSU Templates:</i> NONE		
<i>Research Inducement</i>	NONE		
<i>Comments</i>	NONE		

***Although this exemption determination allows above defined protocol from further IRB review, such as continuing review, MTSU IRB will continue to give regulatory oversight to ensure compliance.

Summary of the Post-approval Requirements: The PI must read and abide by the post-approval conditions (Refer “Quick Links” in the bottom):

- **Final Report:** The PI must close-out this protocol by submitting a final report before **12/31/2021**; if more time is needed to complete the data collection, the PI must request an extension by email. **REMINDERS WILL NOT BE SENT. Failure to close-out (or request extension) may result in penalties** including cancellation of the data collected using this protocol or withholding student diploma.
- **Protocol Amendments:** IRB approval must be obtained for all types of amendments, such as:
 - Addition/removal of subject population and sample size
 - Change in investigators
 - Changes to the research sites – appropriate permission letter(s) from may be needed
 - Alternation to funding
 - Amendments must be clearly described in an addendum request form
 - The proposed change must be consistent with the approved protocol and they must comply with exemption requirements
- **Reporting Adverse Events:** Research-related injuries to the participants and other events , such as, deviations & misconduct, must be reported within 48 hours of such events to compliance@mtsu.edu
- **Research Participant Compensation:** Compensation for research participation must be awarded as proposed in Chapter 6 of the Exempt protocol. The documentation of the monetary compensation must Appendix J and MUST NOT include protocol details when reporting to the MTSU Business Office.
- **COVID-19:** Regardless whether this study poses a threat to the participants or not, refer to the COVID-19 Management section for important information for the FA.

COVID-19 Management:

The PI must follow social distancing guidelines and other practices to avoid viral exposure to the participants and other workers when physical contact with the subjects is made during the study.

- The study must be stopped if a participant or an investigator should test positive for COVID-19 within 14 days of the research interaction. This must be reported to the IRB as an “adverse event.”
- The MTSU’s “Return-to-work” questionnaire found in Pipeline must be filled by the investigators on the day of the research interaction prior to physical contact.
- PPE must be worn if the participant would be within 6 feet from the each other or with an investigator.
- Physical surfaces that will come in contact with the participants must be sanitized between use
- **PI’s Responsibility:** The PI is given the administrative authority to make emergency changes to protect the wellbeing of the participants and student researchers during the COVID-19 pandemic. However, the PI must notify the IRB after such changes have been made. The IRB will audit the changes at a later date and the PI will be instructed to carryout remedial measures if needed.

Post-approval Protocol Amendments:

The current MTSU IRB policies allow the investigators to implement minor and significant amendments that would not result in the cancellation of the protocol’s eligibility for exemption. **Only THREE procedural amendments will be entertained per year (changes like addition/removal of research personnel are not restricted by this rule).**

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Post-approval IRB Actions:

The following actions are done subsequent to the approval of this protocol on request by the PI or on recommendation by the IRB or by both.

Date	IRB Action(s)	IRB Comments
NONE	NONE.	NONE

Mandatory Data Storage Requirement:

All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application.

The data must be stored for at least three (3) years after the study is closed. Additionally, the Tennessee State data retention requirement may apply (*refer "Quick Links" below for policy 129*). Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects. **The IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this notice.** Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: <http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php>
- Exemption Procedures: <https://mtsu.edu/irb/ExemptPaperWork.php>
- MTSU Policy 129: Records retention & Disposal: <https://www.mtsu.edu/policies/general/129.php>