Assessing the Influence of an Educational Presentation on Climate Change Beliefs at an Evangelical Christian College

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ABSTRACT

Despite an overwhelming scientific consensus, a significant proportion of the American public continues to reject anthropogenic climate change. This disparity is particularly evident among evangelical Christians, for whom theological conservatism, general scientific skepticism, political affiliations, and sociocultural influences may impede their acceptance of human-caused climate change. Climate advocates have attempted to engage the evangelical community through various educational initiatives; lacking empirical measurement, however, it is difficult to draw conclusions regarding the efficacy of such programs. Here, we present the results of a study that addresses this lack by adapting questions from the Six Americas of Global Warming survey to measure the climate change beliefs of undergraduate students at an evangelical Christian college before and after attending a lecture by a Christian climate scientist. The 88 participants who successfully completed a pre- and posttreatment survey were divided into three groups: the first attended a live lecture, the second attended a recorded lecture, and the third attended a similar version of the same recorded lecture in which the presenter removed material addressing common misconceptions about climate change. The results demonstrate a significant increase in the proclimate beliefs for students in all three groups. There was no significant difference between the impacts of the live and recorded lectures or between the recorded lectures with and without misconceptions. These findings affirm the value of climate education among evangelicals; highlight the potential utility of such presentations, both recorded and live; and point to opportunities for research in the area of faith-based climate communication. © *2017 National Association of Geoscience Teachers*. [DOI: 10.5408/16-220.1]

Key words: global warming, oral instruction, evangelicals, climate change

INTRODUCTION

Despite overwhelming scientific agreement on the ecological and humanitarian implications of climate change, Americans display some of the lowest concern about global warming of any developed nation in the world (Kvaloy et al., 2012). While many factors influence this reluctance, a culture of skepticism concerning scientific claims about climate change pervades much of the American public (Mooney, 2006; Specter, 2009) and evangelical Christians in particular. For example, a 2008 study found that just 44% of evangelicals believed global warming to be caused mostly by human activities, compared to 64% of nonevangelicals (Smith and Leiserowitz, 2013) while, a 2011 survey found that only 27% of white evangelicals believed there to be a scientific consensus on climate change, compared to 40% of the American public (Public Religion Research Institute, 2011). Many other studies have noted a generally skeptical position on climate change among conservative Christians (Carr et al., 2012; Fusco et al., 2012; Kilburn, 2014; Peifer et al., 2014). There may have been some progress in the "greening" of evangelical protestants from 1993 to 2010, compared to mainline protestants, but this may be because the environmental concern of this group was so low to start with (Clements et al., 2014).

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While identifying the overall percentage of evangelicals in the United States can be challenging for a variety of reasons, the Pew Forum on Religion and Public Life (2008) estimates that evangelicals make up 26% of the U.S. population. Another Pew survey found evangelicals to be among the least educated, with just 21% reporting a college degree in 2014 compared to 27% of the national average (Pew Research Center, 2015). Other researchers have noted that evangelicals wield significant political and cultural influence in the United States (Mead, 2006; Gold and Russell, 2007; Hirschkorn and Pinto, 2012). Given the urgency of climate action and the considerable influence of evangelicals in conservative politics, identifying effective educational practices that can promote an accurate understanding of climate change would enable this strategic demographic to make more informed personal and political choices concerning climate change.

Evangelicals, Political and Social Conservatism, and Skepticism of Climate Science

Research has illuminated what evangelicals believe about climate change, as well as the various worldviews, attitudes, and social influences guiding these beliefs. To a certain extent, climate change is a causality of preexisting conflicts between science and conservative policy in the U.S. Evans (2011) attributes Protestant skepticism about scientific claims to distrust of scientists and the desire to limit the influence of scientists' "questionable moral agenda" on moral issues such as evolution, stem cell research, and global warming. A simultaneous study by Kahan et al. (2011) closes the loop, finding that individuals tended to evaluate the trustworthiness of scientific experts in part based on their position regarding climate change. In other words, individ-

uals tended to trust experts who agreed with their own beliefs about climate change while distrusting those who disagreed.

At least some evangelical distrust of science appears to be rooted in the creation–evolution debate (Wilkinson, 2010; Carr et al., 2012; Jelen and Lockett, 2014; Kilburn, 2014). While evolution deals with the question of human origins and the progression of life on Earth, climate change addresses the impacts of a particular biogeochemical process in the atmosphere. Despite such differences, climate change and evolution share certain commonalities that could be perceived as threatening to evangelical beliefs—in particular, references to geological time frames; challenges to divine control of global, historical events; and implications for sociomoral beliefs and worldviews. While few may make this argument so directly, evolution frequently comes up in discussions about climate change, and the two remain closely associated in the minds of many evangelicals (Nagle, 2008; Carr et al., 2012). Research also identifies fears by conservative Christians that stewardship of God's creation is drifting toward neopagan nature worship as another reason for their antienvironmentalism (Zaleha and Szasz, 2015).

Despite their scientific bases, controversial topics such as evolution and climate change no longer represent matters of science alone for many conservative Christians but have evolved into political battlegrounds. The politics of climate change have become deeply split along partisan lines, with conservative Republicans overwhelmingly skeptical of anthropogenic climate change (Leiserowitz et al., 2011; McCright and Dunlap, 2011) and most liberal Republicans accepting the science (Leiserowitz et al., 2016). Evangelical support for conservative and Republican politics has increased over the past several decades (Mead, 2006; Gold and Russell, 2007; Hirschkorn and Pinto, 2012), concurrent with a weakening independent effect of evangelicalism on voting from 1980 to 2004, suggesting a growing convergence between evangelical and Republican Party identification. Evans and Feng (2013) find that climate skepticism among fundamentalist Protestants is more closely related to age, political conservatism, and Republican Party affiliation than to religious identity or beliefs; this perspective is supported by Wilkinson's (2010) qualitative research revealing significant evangelical fears of climate change being used as a liberal agenda to advance government regulation and impinge free-market ideology. Lewandowsky et al. (2013) likewise found free-market economic beliefs and political conservatism to be strong predictors of climate science rejection.

The complex interactions among science, politics, and climate change beliefs have led some scholars to suggest that public divisions over climate change may originate from worldview-driven cognitive styles (Kahan et al., 2012; Lewandowsky et al., 2013). In their nationally representative survey, Kahan et al. (2012) found cultural worldviews to be the most significant predictor of climate change risk perceptions, even after controlling for scientific literacy. Kahan (2013) describes this as the tendency of individuals to interpret information through the lens of a specific cultural goal that may not be concerned with the accuracy of the information. Such reasoning works to protect identity and uphold group membership and is even more important when such beliefs convey social meanings (Kahan, 2013). Kahan notes that when specific, ideologically motivated positions become associated with a particular affinity group, it becomes extremely difficult to change individual beliefs about that position, as doing so would jeopardize the individual's standing within the group.

These findings help explain how theological conservatism, scientific skepticism, political affiliation, and sociocultural influences have reinforced one another to instill climate skepticism into the evangelical tribe mentality, thus creating a formidable barrier to climate education efforts. All appear to negatively impact evangelical opinions about climate change, although the extent to which each influences opinions on climate change has not been fully analyzed. Standing against these influences, however, are the actions of many evangelicals.

Evangelical Climate Leadership

Positive influence of Protestant theology and worldview on U.S. environmental policy in general stretches back over a century (Stoll, 2015), and the evangelical climate movement has expanded significantly over the past 25 y since the founding of the Evangelical Environmental Network (EEN). The first important evangelical statement on global warming came from a gathering of Christian scientists in 2000 after the international climate negotiations in The Hague. This was followed by the 2002 Oxford Conference on Climate Change, a forum for Christian leaders convened by Sir John Houghton, a practicing evangelical and the former cochair of the Intergovernmental Panel on Climate Change (IPCC) Working Group I. In the same year, EEN's 2002 "What Would Jesus Drive?" campaign garnered international attention, as have its efforts to frame climate action as a prolife issue.

In 2006, 86 evangelical leaders from across the U.S. signed the Evangelical Climate Initiative (ECI), affirming four key claims: that human-induced climate change is real, that the consequences will be significant and will hit the poor the hardest, that Christian moral convictions demand a response, and that the need to act is urgent (ECI, 2007). While this effort was not the first such document addressing evangelical environmental concern, the ECI stands out for its boldness in tone, its specificity in addressing climate change, and the broad influence of the signatories on the list, which include executives from the National Association of Evangelicals, Christian college and seminary presidents, leaders of prominent evangelical nongovernmental organizations, and well-known, megachurch pastors.

In 2008, a group of church leaders signed the Southern Baptist Declaration on the Environment and Climate Change, pledging to respond to the threat of climate change through personal action and teaching "in accordance with our Christian moral convictions and Southern Baptist doctrines" (Merritt, 2008). Climate scientist Katharine Hayhoe, who delivered the lecture studied here, cowrote a book in 2009 with her husband Andrew Farley, a nondenominational pastor and Christian author, titled *A Climate for Change: Global Warming Facts for Faith-Based Decisions*. This was followed in 2010 by EEN founder Jim Ball's *Global Warming and the Risen Lord* and Katharine Wilkinson's 2012 *Between God and Green: How Evangelicals Are Cultivating a Middle Ground on Climate Change*. Along with a host of other publications on Christian environmental stewardship, these books have established the case for a distinctly Christian response to the problem of climate change.

The evangelical climate movement significantly broadened in 2010 when the Lausanne Movement—a global evangelization movement started by Billy Graham and representing Christians in nearly 200 countries—adopted the Cape Town Commitment with explicit language supporting creation care, environmental advocacy, and efforts to address climate change. The document, which identified climate change as "probably the most serious and urgent challenge faced by the physical world" (Lausanne Movement, 2010, 31), has been affirmed by thousands of evangelical leaders representing nearly every country in the world. In partnership with the World Evangelical Alliance, the Lausanne Movement has issued a formal call to action listing 10 specific steps the church should take in relation to environmental stewardship, including "radical action to confront climate change" (Bliss et al., 2012).

Other recent noteworthy advancements include the founding of Young Evangelicals for Climate Action, an advocacy group that continues to attract media attention from both the secular and the Christian press, and Climate Caretakers, a campaign to mobilize evangelicals to prayer and action on climate change. In addition, in 2013, more than 200 prominent evangelical scientists issued an open letter calling on the U.S. Congress to act on climate change (Ackerman and Boorse, 2013). As a result of these efforts and others, the evangelical climate movement has made important progress in the last 10–15 y, and despite opinion polls showing evangelicals to largely reject climate science, more detailed studies have found evangelicals are not as monolithically opposed to environmental causes as had previously been assumed (Smith and Johnson, 2010; Danielsen, 2013; Smith and Leiserowitz, 2013; Clements et al., 2014). Nevertheless, despite these initiatives, most evangelicals continue to reject anthropogenic climate change (Smith and Leiserowitz, 2013), underlining the importance of further research into climate communication among evangelical audiences.

Influencing Evangelicals on Climate

A vast body of descriptive research has characterized the nature of evangelical engagement with climate change by describing the history, barriers, challenges, and opportunities related to evangelical climate beliefs and communication (e.g., McCammack, 2007; Simmons, 2009; Danielsen, 2013). Some qualitative research provides a more thorough understanding of evangelical perspectives on climate change through interviews and focus groups (Wilkinson, 2010; Carr et al., 2012), many correlational studies have investigated the linkages between specific evangelical beliefs and climate change (Hand and Crowe, 2012; Chesnes and Joeckel, 2013; Kilburn, 2014), and Smith and Leiserowitz (2013) provide a rich explanatory analysis that takes into account such factors as cultural worldviews and affective imagery. Altogether, this body of research has made critical contributions to the literature on evangelical climate perspectives. However, no study has attempted to use empirical evidence to assess the effectiveness of whether specific climate education programs move evangelicals toward acceptance of climate science.

This study addresses this data gap by measuring the quantitative effects of an educational presentation on evangelical beliefs and attitudes regarding global climate change. Volunteer study participants were recruited from undergraduate students at Houghton College, a Christian liberal arts college located in western New York that is known as an evangelical institution. The students were randomly assigned to one of three treatment groups of equal size who received (1) a live presentation by Christian climate scientist Hayhoe detailing the case for anthropogenic climate change, as well as the necessity of a Christian response; (2) a recorded version of the same presentation; or (3) an edited version of the presentation from which a short section addressing common misconceptions about climate change had been deleted. Participants completed a pre- and posttreatment survey abbreviated from the Six Americas of Global Warming (Leiserowitz et al., 2013), asking about their opinions and beliefs on climate change.

In the Methods section, we describe the research hypotheses, test instruments, experimental design, instructional materials, and population on which the experiment was conducted. The statistics and main findings of the report are summarized in the Results section, and their implications for the research questions above and for learner understanding in general are discussed in detail in the Discussion section. Finally, main results and future steps are summarized in the Conclusions.

METHODS

Research Hypotheses

We hypothesized that despite the challenges of engaging evangelicals on climate change, a carefully constructed educational presentation about climate change would result in significant shifts in perspectives and opinions consistent with the scientific consensus of anthropogenic climate change among college students at an evangelical institution (Hypothesis 1 [H1]). Given widespread popular misconceptions about climate change, we further hypothesized that this increase would be greater for participants presented with specific information addressing common climate misconceptions compared to those lacking such information (Hypothesis 2 [H2]). Finally, the type of climate education effort used in this study (having a content expert travel a long distance to present a lecture) results in significant greenhouse gas emissions, thus exacerbating the very problem the presentation seeks to address. For that reason, we wanted to test the hypothesis that a live version of an educational presentation on climate change would result in a greater increase in the proclimate beliefs of college students compared to an equivalent recorded version (Hypothesis 3 [H3]).

Population

To test these hypotheses, we recruited a subset of student volunteers at Houghton College, a Wesleyan liberal arts college located in rural, western New York. While not frequently discussed, the prevailing narrative among many students on campus regarding climate change seems to be one of a lack of concern or interest, as evidenced by limited participation in campus activities related to climate change. Houghton has placed increasing emphasis on environmental sustainability throughout the past 6 y. While student engagement in environmental initiatives has increased during this time, anecdotal evidence suggests many students remain largely uninterested in such efforts. The present study took place in February 2015.

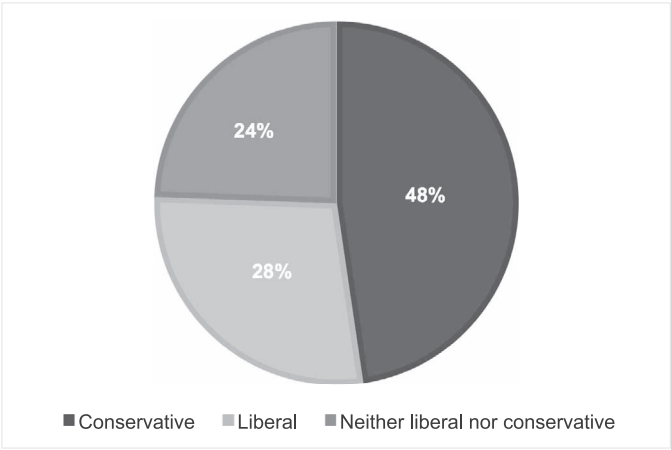

FIGURE 1: Percentage of participants by political ideology (n = 86).

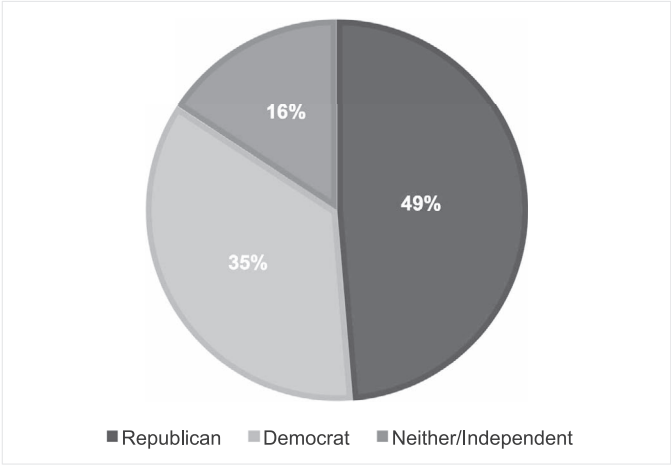

FIGURE 2: Percentage of participants by political party identification (n = 76).

Participants were recruited using standard advertising techniques, including public poster displays, two recruitment e-mails sent to all students, two live announcements at the start of chapel, and voluntary announcements by some faculty members at the beginning of their classes. Recruitment began 3 weeks prior to the presentation, with poster placement and the first campuswide e-mail. The other recruitment efforts were spread out over the course of 2 weeks, with recruitment concluding 8 d before the presentation. All recruitment took place on the Houghton College campus or via electronic communication with Houghton students. To motivate involvement, it was announced that six participants would be randomly selected at the conclusion of the research study to each receive a $25 gift card.

A total of 128 students agreed to participate in the research study. Of these, 91 students completed both the pre- and the posttreatment surveys, though 3 of these were rejected—1 for not listing their treatment group and the others for not taking the surveys within the required time frame—giving n = 88 students who were included in the final analysis. Of the 88 participants, there were 31 from the live treatment group, 27 from the recorded treatment group with misconceptions, and 30 from the recorded treatment group without misconceptions. Of these 88 students, 24 identified as male and 63 as female; 38 were in their first year, while the remainder were distributed throughout their second to fourth years. The participants were spread across a variety of majors.

Houghton is affiliated with the Wesleyan Church, and its students come from 30 Christian denominations—primarily those within the evangelical, Protestant tradition. Students tend to be predominantly white, middle-income, largely conservative (both politically and theologically), and between the ages of 18 and 22. In terms of the religious affiliation of study participants, 63% (55 of 87) identified with an evangelical denomination or as nondenominational evangelicals, 14% as "other Christian," 13% as mainline Protestant, 6% as Roman Catholic, and 2% as other. Consistent with generally accepted Christian beliefs, 94% of participants indicated belief that the Bible is the "actual" or "inspired word of God," while 97% of participants believe that God created the world. A large majority (68%) indicated that in creating the world, God "may have used such methods as the Big Bang or long-term evolutionary changes," as opposed to a much smaller percentage (28%) of students who indicated that there have been "no major evolutionary changes over time." Consistent with evangelical demography, more participants identified as conservative than as liberal (Fig. 1) and as Republican than as Democrat (Fig. 2), though by smaller percentages than might normally be expected among evangelicals. This finding provides valuable background information for interpreting the study results—particularly given the strongly negative relationship between Republican Party identification and climate change beliefs.

Instructional Materials

The educational presentation was a lecture by Hayhoe, a prominent evangelical climate scientist and director of the Climate Science Center at Texas Tech University. The lecture aimed to present scientific information in the context of a particular theological tradition in order to increase climate change concern. The primary focus was on communicating scientific information through the lens of the evangelical tradition so that the participants could understand how such knowledge should inform their approach to this issue. Each lecture incorporated a PowerPoint presentation with graphic visuals, text, charts, and graphs. The recorded lectures alternated between the video image and the slides and did not include an audience. Each slide was left on the screen long enough for participants to read any included text and thoroughly examine all charts or graphs.

The three presentations varied somewhat in length due to the nature of the experiment. The first treatment (the live lecture) lasted 52:41; the second treatment (prerecorded lecture using identical slides) lasted 43:51; and the third treatment (prerecorded lecture with information on misconceptions removed) lasted 33:21. While the first and second treatments used the same lecture slides, the live lecture proved to be 9 min longer due primarily to the human tendency to elaborate before a live audience, including extra ad-lib examples of key points, several side stories, and additional elaboration on some points. While this could pose a material difference, the core content remained the same between treatments one and two, and the extra elaboration merely provided additional examples rather than making

new points. Participants in the live-lecture treatment group were dismissed prior to the public question-and-answer time to keep the material content equivalent with that of the treatment group given the recorded version with misconceptions.

The lectures followed a 5-part outline plus a short introduction and conclusion. The introduction focused on the difference between faith and science, highlighting the notion that faith is based on things that are spiritually discerned, whereas science is based on observation. Part 1 addressed the question of whether the climate is changing by focusing on the scientific evidence for climate change. Part 2 identified and refuted common misconceptions about climate change, including that it might be caused by variability in the sun's energy output, by long-term natural cycles, or by long-term changes in Earth's orbit. This section was omitted for the treatment group given the recorded presentation without misconceptions. Part 3 addressed why the climate is changing and included discussion of the greenhouse effect, Industrial Revolution, historic evidence for anthropogenic climate change, and scientific consensus. The presenter avoided discussion of long-term geological time frames, focusing on more recent lines of evidence for human-caused climate change. The primary reason for this omission relates to the controversial role that evolution plays in the minds of many evangelicals. Because long-term geological time frames presume a particular position on the age of Earth, such a perspective would serve as a barrier to engagement by many evangelicals. In addition, long-term time frames are not necessary for establishing sound climate science and a general pattern of global warming. Part 4 discussed why climate change matters by addressing its impacts on people in the United States and around the world. This section also made the link between climate change knowledge and ethical and theological foundations for concern about its impacts. Part 5 focused on solutions, including both personal and societal ways to address climate change and specific examples. The lecture concluded by stating that faith and science, while different, are both necessary for solving climate change. Altogether, 5 min 55 s of the video content was devoted to theology-based ethics (primarily in the introduction and conclusion), representing approximately 14%–18% of the total lecture content. The remainder of the content focused on various aspects of climate change science, evidence, impacts, and solutions. A more complete description of the lecture content may be found in Supplemental Material 2 (available in the online journal and at <http://dx.doi.org/10.5408/16-220s2>).

Test Instruments

Survey questions addressed three topics: demographics, correlated-belief topics, and climate change beliefs. Seven demographic questions asked about gender, year at Houghton, student major, denominational background, citizenship, political ideology, and political party affiliation. Five additional questions asked about participants' beliefs on topics that have been correlated in other studies with climate change beliefs, including the origin of the world, free-market ideology, relationship between truth and science, and influence that their pastor's beliefs' might play in forming their own opinions about climate change. An analysis of these correlated-belief questions remains for future research. The core content for the research study relied on eight questions specifically addressing participants' climate change beliefs, based on "Climate Change in the American Mind" by Leiserowitz et al. (2013). The survey was piloted for clarity and readability the semester before the study with a small group of Houghton students who were graduating and would not be on campus during the study.

Of the eight climate-related questions in the surveys, three formed different parts of the same question, asking participants about their level of certainty regarding whether global warming is, or is not, happening (see the first question below). Jointly coding these first three questions into one results in six total questions that were ultimately used in the statistical analysis. Of the six questions, two contained subquestions and were coded as explained below. The full survey is provided in Supplemental Material 1 (available in the online journal and at <http://dx.doi.org/10.5408/16-220s1>); the jointly coded questions were as follows.

Is Global Warming Happening?

Depending on their response, participants were directed toward either "How sure are you that global warming is happening?" or "How sure are you that global warming is not happening?" Participant responses from these three questions were jointly coded into a 9-point scale ranging from (1) extremely sure global warming is not happening to (9) extremely sure global warming is happening. Participants who answered, "Do you think that global warming is happening?" with "don't know" were coded as (5) and were not asked the follow-up question about certainty.

How Much Do You Think Global Warming Will Harm…?

The four subquestions were "you personally," "people in the United States," "people in developing countries," and "future generations of people." Responses were recorded as (4) a great deal, (3) a moderate amount, (2) only a little, (1) not at all, and (not coded) don't know. Only one "don't know" response was recorded, and this response was excluded from analysis. Participant responses to each of the four subquestions were summed to create a single coded variable between 4 and 16 to generate an overall scale of perceived harm from global warming.

Priority of Addressing Global Warming

The final question asked, "Do you think addressing global warming should be a low, medium, or high priority for each of the following?" The four subquestions were "you personally," "Houghton College," "Christians in general," and "the U.S. President and Congress." Responses were recorded as (1) low, (2) medium, and (3) high. Participant responses to each of the four subquestions were summed to create a single coded variable between 4 and 12 to generate an overall scale of perceived importance of addressing global warming.

The six survey questions used in this research study include several questions for which we could not assume an equal interval scale between response items. For example, when asked "How worried are you about global warming?" it's not clear whether the distance between "very worried" and "somewhat worried" is equal to the distance between "somewhat worried" and "not very worried." The scales on other questions posed similar challenges, and we thus chose to treat all survey scales as ordinal scales and to corre-

TABLE I: Descriptive statistics for all treatment groups using the Wilcoxon signed-rank test.

Survey Question	W	$N_{s/r}$	z	p
Is global warming happening?	−895	44	−5.22	<0.0001
Is global warming natural or human caused?	−552	40	−3.71	0.0001
Is there a scientific consensus on global warming?	−297	27	−3.56	0.0002
How worried are you about global warming?	−1084	47	−5.73	<0.0001
How much do you think global warming will harm…?	−1976	68	−6.04	<0.0001
Priority of addressing global warming	−1245	54	−5.36	<0.0001

spondingly use nonparametric tests to provide statistical analysis. H1 was analyzed using the Wilcoxon signed-rank test, while H2 and H3 were analyzed using the Kruskal-Wallis *H*-test. The Wilcoxon signed-rank test avoids the problem of not having an equal-interval scale by focusing on the direction between pre- and posttreatment surveys to determine whether there is a significant difference, while the Kruskal-Wallis *H*-test compares the significance of the difference between independent samples. To test H2 and H3, we conducted six comparisons simultaneously, among the three groups, representing the six questions. This suggested we raise the significance level needed to reject the null hypothesis to avoid a Type 1 error (multiple comparisons problem). Therefore, instead of using $p < 0.05$ for any single comparison, we used $p < 0.01$, which is roughly six times more stringent.

Experimental Procedure and Timeline

Students self-selected into the study by responding to standard college campus advertising techniques, such as posters, e-mails, and announcements. One week prior to the treatment, all participants received a personal e-mail assigning them to their randomly proscribed treatment group, explaining the treatment procedures, and containing instructions and a link for completing the pretreatment survey. Participants were also sent a follow-up e-mail 5 d later and again the evening prior to the treatment, reminding them to take the pretreatment survey prior to the start of the treatment. Survey collection was performed using Survey Monkey. The surveys employed a user-generated anonymous identifier in order to match pre- and posttreatment surveys to a specific individual while maintaining participant anonymity.

All three treatments took place simultaneously, in different locations on the Houghton College campus, to control for any one treatment influencing the outcome of another. Immediately following the treatments, all participants were sent a link to the posttreatment survey and asked to complete the survey before 11:00 a.m. on the following day when the same speaker would be presenting in chapel. Participants submitting late survey responses (after the start of the treatment for the pretreatment surveys and after the start of chapel for the posttreatment surveys) were excluded from the research study.

RESULTS

Research Question 1: Does an Educational Presentation Result in a Significant Shift in Student Perspectives and Opinions on Climate Change?

Because the analysis used ordinal rather than continuous data to measure students' responses, we chose the nonparametric Wilcoxon signed-rank test to assess Research Question 1 (RQ1). The Wilcoxon signed-rank test focuses on the directional relationship between pre- and posttreatment survey responses for each participant in order to identify a test statistic (W) that represents the sum of the signed ranks for each survey question. The Wilcoxon signed-rank test only ranks nonzero changes from pre- to posttest, so the total number ($N_{s/r}$) for each survey question reflects only those participants whose responses changed between the two measurements.

The results indicate a significant difference between pre- and posttest measures for all groups on all six assessed questions, with all questions pointing toward an increase in proclimate beliefs (Table I). The questions were coded such that smaller numbers indicate anticlimate beliefs while larger numbers indicate proclimate beliefs. Thus, the negatively signed ranks demonstrate an increase in proclimate beliefs, as reflected by all six questions (Fig. 3). These findings are consistent with H1: that a carefully constructed educational presentation about climate change will result in significant

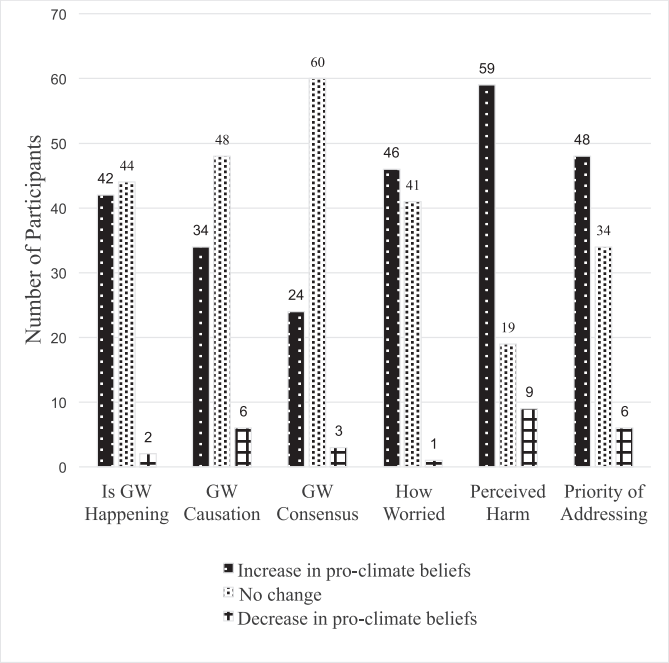

FIGURE 3: Direction of movement from pre- to posttest regarding participants' climate change beliefs for each of six assessed questions.

TABLE II: Nonparametric ANOVA for comparing three independent samples of ordinal data using the Kruskal-Wallis *H*-test (df = 2).

Survey Question	Mean Ranks for T-1	Mean Ranks for T-2	Mean Ranks for T-3	*H*	*p*
Is global warming happening?	45.9	50.4	37.7	3.64	0.162
Is global warming natural or human caused?	40.3	46.6	46.9	1.29	0.525
Is there a scientific consensus on global warming?	44.9	35.1	45.1	2.92	0.232
How worried are you about global warming?	44.9	44.5	44.1	0.002	0.990
How much do you think global warming will harm…?	35.5	47.4	49.9	5.55	0.062
Priority of addressing global warming	44.3	48	41.6	0.90	0.638

increases in proclimate beliefs among college students at an evangelical Christian college.

Research Questions 2 and 3: Does Including Information on Misconceptions Increase the Effectiveness of the Presentation? Is a Live Lecture a More Effective Presentation Than a Recorded Lecture?

Research Questions 2 and 3 (RQ2 and RQ3) were analyzed using the Kruskal-Wallis *H*-test, a nonparametric analysis of variance (ANOVA) test that may be used to compare two or more independent samples. In this case, the Kruskal-Wallis *H*-test was used to determine whether significant differences exist among Treatment Group 1 (T-1, live presentation with misconceptions), Treatment Group 2 (T-2, recorded presentation with misconceptions), and Treatment Group 3 (T-3, recorded presentation omitting misconceptions). The results showed that there was no statistically significant difference in the pre- and posttreatment gains experienced by the different treatment groups for all six survey questions (Table II). Thus, all six survey questions failed to provide support for either H2 or H3.

In summary, the combined data of all three treatment groups showed a significant change in global warming beliefs, moving in the direction of an increase in the proclimate beliefs among the subjects in all six questions regarding belief in the existence of global warming, its causation, the scientific consensus, personal concern over the issue, the perceived degree of harm caused by global warming, and the perceived priority of addressing global warming. This strongly supports the validity of H1. Conversely, there was no statistical support for H2, that addressing common misconceptions about climate change would result in a greater increase in proclimate beliefs, or for H3, that a live presentation would result in a greater increase in proclimate beliefs compared to a recorded presentation. While the results of this study do not provide causal evidence for the influence of educational presentations on the climate change beliefs of college students at an evangelical institution, they do provide data to support H1, to reject H2, and to reject H3.

DISCUSSION

RQ1 asked whether a carefully constructed educational presentation will result in significant increases in proclimate beliefs among college students at an evangelical Christian college. While the research design does not allow for a causal analysis, the results from RQ1 do demonstrate a measurable change in participants' beliefs about climate change following an educational presentation. Comparisons among these findings and others in the literature remain limited given the lack of research on the influence of climate change presentations among religious participants. More generally, however, several studies have shown reading passages focused on climate education to be effective at producing conceptual change in participants' beliefs about and understanding of climate change (Ranney et al., 2012; Guy et al., 2014; McCuin et al., 2014), and a study of high school students found a significant increase in proclimate beliefs and behaviors after participating in a 1-h climate education program (Flora et al., 2014). Thus, the results of this study are consistent with previous research assessing the influence of climate education efforts among secular audiences.

A broader look at the literature points to two important findings that could provide additional insight into these results. First, several studies have shown that consensus messaging—demonstrating the scientific agreement on climate change—influences climate beliefs in a positive direction (Ding et al., 2011; Lewandowsky et al., 2012; McCright et al., 2013). Some have even referred to consensus messaging as a "gateway belief" for influencing opinions about climate change (van der Linden et al., 2014). Hayhoe's lecture devoted approximately 2.5 min to establishing the scientific consensus on climate change through both verbal lecture and visual graphics. While the influence of consensus messaging was not independently analyzed, previous research (Ding et al., 2011; Lewandowsky et al., 2012; McCright et al., 2013) would suggest that the observed increase in proclimate beliefs would be consistent with the research on consensus messaging.

Second, some researchers have proposed that using Christian experts to communicate climate change to evangelicals may be effective at influencing their climate beliefs (Wilkinson, 2010; Carr et al., 2012). Kahan's (2010) research on cultural cognition supports such suggestions by demonstrating that ordinary people evince greater trust in experts who share their same cultural values when confronted with controversial scientific issues. This study was designed specifically to account for these findings by incorporating a speaker whose religious background and values corresponded with those of the audience. To accentuate such shared religious values, the speaker included biblical text and spiritual commentary in the presentation and employed theological language commonly accepted within evangelical circles. As with consensus messaging, the effect of this element has not been measured

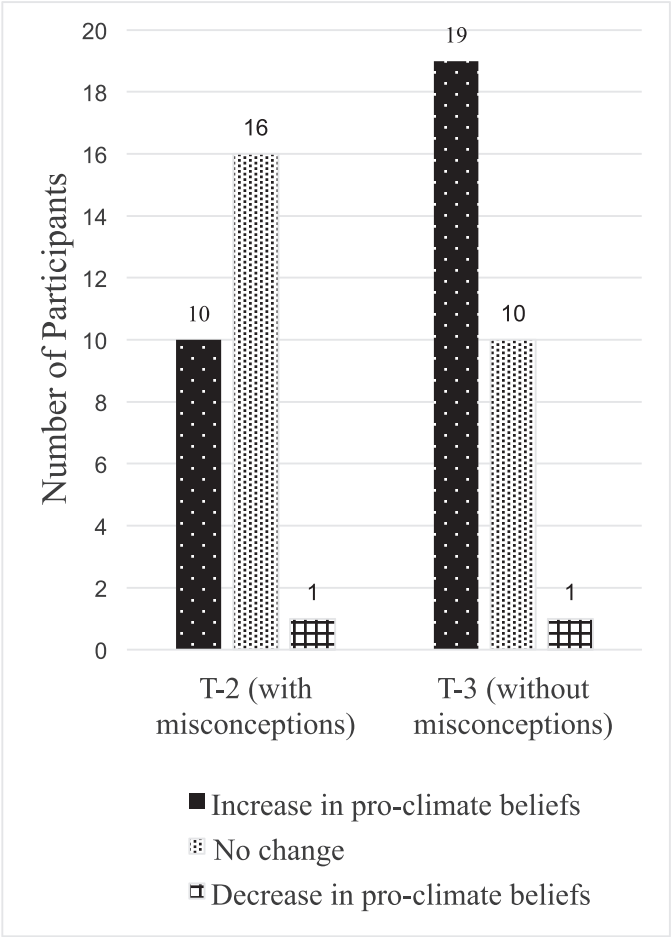

FIGURE 4: Changes from pre- to posttest for T-2 and T-3 participants related to the question, "Is global warming happening?"

independently. Nevertheless, the resulting increase in proclimate beliefs shows consistency with what would be expected based on the above research. The authors of this report are planning a subsequent study to address the question of whether the presenter's personal faith background and use of religious language might be linked to changes in participants' beliefs.

While the ability to extend these findings to a broader population remains limited, several indicators suggest important commonalities between this study's population and evangelicals in general. First, while not all participants self-identified as evangelical, most associated themselves with an evangelical denomination or with a nondenominational evangelical background. Second, as with the larger evangelical population, the participants in this study aligned more closely with conservative ideology and the Republican Party when compared to liberal ideology and the Democratic Party. Given that numerous researchers have identified political ideology and party affiliation as key predictors of climate skepticism (Wilkinson, 2010; Evans and Feng, 2013; Lewandowsky et al., 2013), this linkage represents an important finding. Third, most study participants echoed classically Christian positions in their support for the authority of scripture and the belief that God created the world. However, on the question of human origins, far more participants selected a position that allowed for the possibility of theistic evolution (God using evolutionary methods to create the world) compared to a traditional creationistic position. Given the frequency with which evolution appears in evangelical climate discussions, this unusual level of openness to a more nuanced position on human origins could play an important role in interpreting this study's outcomes.

In contrast to the H1, the research failed to provide support for H2, which hypothesized that presenting participants with information specifically addressing common misconceptions about climate change would result in a greater increase in proclimate beliefs compared to those not receiving such information. This result represents a potentially important finding but should be interpreted with caution for several reasons. First, as seen in Fig. 4, both treatment groups saw large gains in proclimate beliefs compared to the number of decreases. Second, whereas 44% of T-2 participants (12 of 27) answered the pretest as being "extremely sure global warming is happening," just 13% of T-3 participants (4 of 30) answered the pretest with this response. As a result, T-2 (those viewing the presentation with misconceptions) had much less room for an increase in proclimate beliefs compared to T-3, given the higher number of participants starting already at the top. For these reasons, this conclusion should be viewed cautiously.

An alternate explanation could relate to the influence of consensus messaging, which has been shown to influence climate change beliefs (Ding et al., 2011; Lewandowsky et al., 2012; McCright et al., 2013), and/or the use of a culturally appropriate communicator (Kahan, 2010). Gains in proclimate beliefs that might normally be attributed to a misconception-based approach could have already been achieved through education about the scientific consensus and/or through the speaker's perceived shared cultural values. For example, whereas 56% of pretest participants indicated that most scientists agree that global warming is happening, this percentage rose to 85% on the posttest, demonstrating a high level of acceptance of the scientific consensus for all treatment groups. Whether scientific consensus and/or cultural framing rendered instruction about misconceptions unnecessary remains unknown but could at least partially explain this result, given its influence on climate beliefs and the relatively high participant responses to this question.

Finally, as to H3, this question was added primarily to determine whether a recorded lecture could effectively substitute for a live version in order to reduce the environmental impact of the presentation. The hypothesis held that a live version would result in a greater increase in the proclimate beliefs of college students compared to an equivalent recorded version. As with H2, this hypothesis was not supported by the data, thus implying that the physical presence of the communicator did not appear to influence participants' beliefs about climate change to a significant degree.

While numerous studies have been conducted on the influence of an instructor's physical presence during classroom instruction, little research has been done on optional, extra-classroom instruction, such as a visiting guest lecture. This hypothesis was largely experimental, with the goal of testing the role of physical presence for such guest lectures. Given the noncompulsory nature of this type of

presentation and the controversial nature of the content, it was thought that the live presence of a communicator might yield greater influence on participants' beliefs about climate change. This assumption was based on research that demonstrated student preference for live presentations over recorded versions (Ward et al., 2006; Schreiber et al., 2010).

Instead, the research demonstrated consistency with other studies that found no significant difference in knowledge retention between live and recorded lectures inside a classroom setting (Ellis and Mathis, 1985; Solomon et al., 2004; Schreiber et al., 2010). The rejection of H3 therefore extends their work to demonstrate that the physical presence of the communicator in an optional, extra-classroom lecture does not necessarily influence participants' climate change beliefs more effectively than a recorded video by the same presenter, given that the two presentations (i.e., slides and commentary) are the same.

What remains to be seen, however, is the role that an instructor's physical presence may have in attendance at such lectures. With the current research, physical presence of a guest lecturer was not examined, because participants knew they were being randomly assigned to either an in-person or a recorded lecture. Part of the attraction in attending optional lectures by guest speakers is the opportunity to meet the individual in person. Without such an opportunity, event planners may find attendance lower, though this remains to be tested.

This research contains several important limitations. First, the lack of a control group prevented the researcher from identifying causal relationships between the presentations and the outcomes. While the results for RQ1 demonstrate statistical significance in a direction that is consistent with the primary hypothesis, further research should consider including a control group to test for a causal relationship between climate change presentations and evangelical climate beliefs. Second, the study's small sample size limits the statistical significance of the findings. This limitation probably did not affect H1, which assessed the combined effect of all three treatment groups, but it could have influenced the results of H2 or H3, each of which compared individual treatment groups against one another. Third, the research was designed to assess a convenience sample of self-selected students at an evangelical college. Self-selection limits the diversity and size of the population and risks selection bias. In basing the study on a self-selected sample, some could argue that the results were influenced by a sample population with a higher-than-average concern for climate change. Future studies would benefit by finding other methods of participant selection that mitigate this concern. Fourth, the study population was composed entirely of students at one particular liberal arts college that share certain commonalities, including similar experiences, age, beliefs, and geography. These limitations could be addressed simultaneously by simply replicating the research methodology at other evangelical colleges. This would both expand and diversify the sample size while leading to greater generalizability of the findings. Fifth, the use of a nonparametric test limits the strengths of these findings, because parametric tests are generally considered to provide a more robust analysis. Nevertheless, the authors felt that the survey scales more closely approximated ordinal data and that an equal interval between response items could not be assumed, thus making a nonparametric test more appropriate. This could be addressed in future studies by reframing survey questions and respond items to more closely align with an interval scale.

Finally, it remains unknown whether the observed changes in participants' climate change beliefs will persist over time or whether their responses were merely short-term changes of opinion. This limitation could be addressed with a delayed posttest to follow up on participants' beliefs at a later time. Future opportunities should consider this as an option to provide additional understanding about long-term influences.

CONCLUSIONS

This study assessed the influence of a common method employed by climate educators: using a stand-alone climate education lecture to influence beliefs. The results of this research demonstrate that a lecture-based educational presentation can influence the climate change beliefs of college students at an evangelical institution, with a significant increase in proclimate beliefs on all six measured questions. The results of this research, which extend the findings of previous studies (e.g., Ranney et al., 2012; Flora et al., 2014; Guy et al., 2014; McCuin et al., 2014) to a new demographic, reveal important implications for climate education efforts among evangelicals. First, a carefully designed educational presentation on climate change can influence evangelicals toward an increase in proclimate beliefs. Given the relative influence of evangelicals in American cultural and political discourse, as well as their current skepticism toward climate change, this finding holds tremendous import. Furthermore, it affirms the efficacy of climate education efforts, such as those used in this research study, and suggests that expanding such efforts may prove effective.

A second implication of the research suggests that specifically addressing common misconceptions about climate change may not be necessary in order to influence climate change beliefs. Specifically, the data demonstrated no significant effect for the interaction between the group receiving instruction about misconceptions and the group omitting such instruction on five of six questions. Possible explanations for this discrepancy include potential backfire effects, the loaded nature of the term "global warming," or masking effects from other aspects of the presentation, such as consensus messaging or the use of a culturally contextual communicator.

While further research may help shed additional light on this finding, the results of the current study indicate misconceptions-based instructional methods to be at best no more effective than instruction omitting misconceptions. In order to avoid potential backfire effects, climate communicators may therefore want to limit time spent discussing misconceptions during educational programs. This also implies that other elements of the presentation likely proved more valuable for influencing participants' beliefs. Of particular interest for future research would be to assess the roles of shared cultural values and consensus messaging among evangelical audiences.

A third and final implication of this research is that there is no significant difference in terms of the efficacy of a live versus a recorded presentation. This implies that the physical presence of the communicator may not be necessary in order

to influence climate change beliefs. Given the carbon footprint associated with such guest lectures—which often involve long-distance air travel by a content expert—this finding holds important value. However, caution should be exercised when considering the full implications of substituting in-person lectures with recorded versions. In particular, research should be done to assess how such a change may impact lecture attendance and participant learning, because the possibility of meeting and interacting personally with the speaker may be an important driver in mobilizing attendance at such lectures. In addition, many such educational programs include other avenues for interaction outside the lecture, such as meals with the speaker, casual interactions before or after the talk, guest appearances in classroom settings, or other speaking opportunities. Each of these additional interactions holds potential to further influence the climate beliefs of those participating.

In conclusion, this research demonstrates that climate education programs targeting evangelicals can be effective for influencing beliefs. Moreover, the research shows that neither instruction about misconceptions nor the physical presence of the communicator plays an important role in such changes. These results provide an important contribution to the literature, which has been lacking in quantitative analysis on the efficacy of climate education efforts among evangelical audiences. This study appears to be the first to quantify the influence of an educational presentation on evangelical climate beliefs.

While providing a valuable starting point for extending existing research into this demographic, the findings leave numerous opportunities for future research. Many scholars have noted the potential for the burgeoning evangelical climate movement to influence the national climate conversation (McCammack, 2007; Nagle, 2008; Simmons, 2009; Wilkinson, 2010; Smith and Leiserowitz, 2013). A messaging study by the progressive evangelical group Sojourners found 25% of evangelicals to be in the "movable middle" on climate change—that is, not firmly entrenched in a position on the issue (Schmitt, 2014, 10). Because of their strategic political influence and currently shifting and diversifying views on climate change, at least one scholar has asserted that evangelical Christians may represent "America's greatest hope for instituting climate change legislation" (McCammack, 2007, 645).

Future efforts to replicate this study at other evangelical colleges and churches would broaden the sample size and diversity of the population, while new opportunities for future research would be to assess the influence of the speaker's perceived shared values on participants' climate beliefs. While many obstacles to engaging evangelicals on climate change remain, we hope that this research will provide climate educators and activists with a better understanding of the impacts that different approaches to climate education may have on evangelical beliefs.

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