Leveraging Higher-Education Instructors in the Climate Literacy Effort
Factors Related to University Faculty's Propensity to Teach Climate Change

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Abstract: In this study, we explored the relationship between university teaching faculty’s knowledge, concern, and feelings of responsibility toward climate change and their propensity to address this topic in their classroom curriculum. We sent surveys containing 30 questions to approximately 3,150 faculty at two state research universities in the southwest United States. We addressed three research questions: Do university teaching faculty and students differ in their knowledge of, concern about, and personal responsibility regarding climate change and what are the differences between teaching faculty’s predictions of students’ perceived knowledge and concern about climate change and students’ actual perceived knowledge and concern? Second, do perceived knowledge, concern, personal responsibility, responsibility to teach about climate change, and comfort with teaching about climate change relate to the degree to which faculty address climate change in their classrooms? Finally, how do faculty rank and discipline differentiate their perceived knowledge, concern, personal responsibility, responsibility to teach about climate change, and comfort with teaching about climate change? In regards to these three questions, we found that teaching faculty showed greater concern and perceived knowledge than their students, though they underestimate their students’ perceived knowledge. Comfort teaching climate change and feeling responsible for teaching climate change were both significant predictors of the degree to which it is currently taught. Professors of the sciences were relatively high in both comfort and responsibility to teach climate change, whereas liberal arts faculty members were less comfortable and felt less responsible to include the topic in their classroom. The study, therefore, reveals opportunities where professional development could be targeted to promote climate literacy.

Keywords: Teaching Climate Change, Barriers to Instruction, Professor Attitudes

Introduction

Climate change education at the university level is a key component of climate literacy. Over the past five years, several federal agencies have called for the development of a more “climate literate” public, and have sponsored education projects and research endeavors to connect schools, universities, and communities to this issue (Climate Literacy Network 2011).

A tremendous opportunity exists in our universities. Past studies have indicated that students have a desire to learn more about the issue of climate change (Gayford 2002; Gayford 1998; Zulauf 2010) and yet tend to be exposed to information in the media more than in the classroom (Gowda et al. 1997). In the Six Americas study, Leiserowitz, Maibach, Roser-Renour, and Smith (2011) surveyed the public’s level of concern, belief, and motivation and segmented the population into categories of Alarmed, Concerned, Cautious, Disengaged, Doubtful, and Dismissive. Overall, only 10% of those surveyed felt very well informed, 51% fairly well informed, 34% not well informed, and 5% not at all informed. Over one third agreed they “could easily change their minds about global warming,” (Leiserowitz et al. 2011, 14) including many individuals in the Disengaged and Cautious categories. Most also indicated they needed at least a little more information to form a firm opinion on the issue, including high proportions of the members of the Concerned and Cautions groups. We have focused on knowledge of climate...
change, concern about climate change, and responsibility regarding climate change as main characteristics of a climate-literate population. We describe these variables below.

Knowledge of Climate Change

If more information is necessary to solidify climate change opinions, then it is important to have a greater depth of understanding about the principles of climate change and the sources of climate education. When asked who the public trusts as sources of information, about 75% of the general public surveyed indicated they trust scientists (Leiserowitz et al. 2011). More specifically, most university students trust university scientists to provide truthful information about climate change (Zulauf 2010). This indicates a tremendous opportunity to reach an audience that is receptive and trusting with effective and motivating climate change curricula.

Currently, however, there are many barriers to the inclusion of climate change in educational settings. For example, studies of K-12 teachers have shown that the vast scope of the topic—combined with its surrounding controversy—present roadblocks (Gayford 2002; Wise 2010). Lombardi and Sinatra (2013) found that elementary and secondary teachers experience anger and hopelessness about the topic of climate change, which may limit the quality and amount of instructional content they present to their students. Other studies found that elementary and secondary educators hold similar misconceptions about climate change found in the general public, for example confusion between stratospheric ozone depletion (e.g., the hole in the ozone) and the greenhouse effect (Bostrom et al. 1994; Boyes and Stanisstreet 1993; Papadimitriou 2004).

Research has shown that teachers are more comfortable teaching about content when they feel they have command of the content (Tytler 2003). Therefore, a better understanding of climate change should create greater comfort in teaching it, reducing the insecurity some educators feel about their own climate knowledge. Developing a climate-literate population will therefore require targeting both educators’ and students’ stock of climate knowledge.

Concern about Climate Change

A number of studies have illustrated how climate change education can lead to conceptual and attitude change (Cordero et al. 2008; Devine-Wright et al. 2004, Lester et al. 2006; Pruneau et al. 2003). Shifts in attitudes can lead to a shift in habits, and therefore, knowledge and concern are often studied with climate change action (Fransson and Garling 1999; O’Conner, Bord, and Fisher 1999; Dietz, Dan and Shwom 2007). Whereas the findings on the effects of perceived knowledge on concern vary (for example, see Heath and Gifford 2006; Aitken, Chapman and McClure 2011; Kellstedt, Zahran, and Velditiz 2008; Whitmarsh 2011) actual knowledge is consistently found to be a predictor of concern (Bord, O’Connor, and Fisher 2000; Leiserowitz, Smith, and Marlon 2010; Sundblad, Biel, and Gärling 2007).

Responsibility Regarding Climate Change

Another key variable related to a climate literate population is whether people feel personally responsible for the causes of climate change. Responsibility can be broken down into different forms. First, there is personal responsibility for the causes of climate change, indicating recognition of how individual actions contribute to the greenhouse effect. Only 45% of the population feels the actions of an individual can make a difference (Leiserowitz et al. 2011).

Second, there is the degree of responsibility teachers feel for educating on the topic of climate change. Research has shown that inclinations toward knowledge and topic emotions are related to attitudes and plausibility perceptions about climate change (Sinatra, Kardash, Taasoobshirazi, and Lombardi 2011; Lombardi and Sinatra 2013). Lombardi and Sinatra (2013) specifically found that teachers’ who expressed a strong desire to reach closure (form a quick decision) about a topic find climate change implausible. Interestingly, a higher need for decisiveness, which is an urgent desire to reach closure in a timely fashion, differentiated
teachers who do not currently teach about climate change from those that do. Perhaps the complex nature of climate science and perceptions of uncertainty in predictions of future climate change decreases plausibility for those that desire to reach closure. Furthermore, teachers who find the topic implausible may not be motivated to teach about climate change.

Knowledge, concern, and responsibility to act have been explored through surveys of the general public and K-12 teachers, but a group who also has the potential to contribute significantly to climate literacy is university professors. This population, however, has not been explored as extensively in prior research, nor have they been studied in terms of the alignment between their perspectives and those of their students.

The Present Study

In this study, we explored the relationship between university teaching faculty’s knowledge, concern, and feelings of responsibility toward climate change and their propensity to address this topic in their classroom curriculum. We also recognized that an instructors’ decision to teach climate change could be mitigated by other factors, such as knowledge of, and comfort with the material. We also considered demographics such as faculty rank and discipline. Specifically, we wondered if senior tenured faculty members might feel more comfortable teaching about controversial topics such as climate change, or if junior faculty would be more open to climate change as reflected in different age groups among the general public (Eurobarometer 2008; White and Wall 2008). We hypothesized that faculty members in science and science-related disciplines would be more comfortable with the topic given their experiences.

We focused on teaching faculty at two state research universities located in the southwest United States. The year prior to our study, thousands of students at the same institutions completed a survey of their knowledge, attitudes, and action toward climate change. We designed a survey similar to the student climate change survey for ease of comparison. An inventory of climate change education at these two universities revealed that less than 1% of courses discussed climate change in any capacity (Northrup 2010). Therefore, a better understanding of the teaching faculty’s knowledge, attitudes, and comfort with the material could inform curriculum development for inclusion of climate change topics across disciplines.

Finally, an important consideration for university instructors is how their views align with their students. Instructors are more effective if they understand their students’ knowledge and concerns and tailor their instruction to meet the needs of their students (Bianchini and Cavazos 2007; Hofstein and Lunetta 2003). Therefore, we also examined the alignment of faculty members’ views with their students’ views.

In this study, we sought to answer the following research questions:

* Question 1a: Do university teaching faculty and students differ in their knowledge of, concern about, and personal responsibility regarding climate change? We hypothesized that teaching faculty would show greater perceived knowledge, concern, and personal responsibility than their students. Faculty members are, by definition, more highly educated than their students and also report being more liberal on average. Education level and liberalism are both associated with greater familiarity and acceptance of the subject (Leiserowitz et al. 2011). Because potential impacts from climate change may be dire (Pachauri and Reisinger 2007), we also expected professors to show a greater degree of concern about climate change because they have the highest level of education, and thus may have had the opportunity to learn more about the topic. Similarly, we hypothesized that faculty member’s greater understanding and concern would be related to a greater degree of personal responsibility to address climate change (Sinatra et al. 2012).

* Question 1b: What are the differences between teaching faculty’s predictions of students’ perceived knowledge and concern about climate change and students’ actual perceived knowledge and concern? In past studies, high school science teachers indicated expressed interest among their students to learn more about climate change (Wise 2010; Gayford 2002). Likewise, when the students at our research sites were surveyed, 32.9% indicated they would like
to know a lot more about climate change, with an additional 39.5% indicating they would like to know some more (Zulauf 2010). Given this finding, we hypothesized that the teaching faculty would underestimate the level of knowledge and concern among students.

**Question 2:** Do perceived knowledge, concern, personal responsibility, responsibility to teach about climate change, and comfort with teaching about climate change relate to the degree in which faculty address climate change in their classrooms? Previous studies have shown a lack of knowledge of climate change can be a barrier to its inclusion in the classroom (Wise 2010). Furthermore, our earlier study showed significant connections between attitudes about climate change and expressed willingness to take action (Sinatra et al. 2012) which lead us to hypothesize that these variables (perceived knowledge, concern, personal responsibility, responsibility to teach, and comfort with teaching) would be significant predictors of the degree to which faculty address climate change.

**Question 3:** How does faculty rank and discipline differentiate their perceived knowledge, concern, personal responsibility, responsibility to teach about climate change, and comfort with teaching about change? The causes of climate change are largely seen as a scientific issue; therefore we hypothesize that a greater level of these variables will occur with science faculty compared to other disciplines. We considered that senior faculty may be more comfortable teaching about controversial topics. However, based on past research, which has shown that younger individuals are more accepting of climate change than older individuals (Eurobarometer 2008; White and Wall 2008), we hypothesized that teaching faculty in lower ranks will express a greater level of these variables than higher-ranking faculty, who are typically more senior.

**Method**

**Participants**

We contacted all faculty members who teach at least one course as a regular part of their appointment at two state universities in the southwestern United States and invited them to participate in our study. The students at these same institutions were previously surveyed by Zulauf (2010). Both campuses are research universities of high research activity (Carnegie Foundation 2012) with four-year undergraduate, masters, and doctoral programs. The population of teaching faculty at the northern institution is approximately 950 with a student population of about 17,600: 14,400 undergrads and 3,200 graduates. The population of teaching faculty at the southern campus is approximately 2,200 with a student population of approximately 28,000: 22,500 undergrads and 5,700 graduates. After incomplete submissions were removed, the total was 248 responses; 39% completed from the south and 61% from the north. Respondents were 56% male and 44% female.

In the northern university, the rankings of participants were 19.5% full professor, 28.6% associate professor, 16.2% assistant professor, 2.7% research professor, 1.6% professor emeritus, 17.8% instructor/lecturer, 1.6% faculty in residence, 3.2% postdoctoral scholar, 8.1% adjunct professor and .5% visiting professor. The ethnicity distribution was 88.6% white non-Hispanic, 3.8% Asian, 2.2 % Hispanic, 1.1% American Indian, .5% black, and 2.7% other.

In the southern university, the rankings of participants were 29.5% full professor, 31.8% associate professor, 16.7% assistant professor, 3% research professor, 8.3% instructor/lecturer, 3% faculty in residence, 1.5% postdoctoral scholar, 3% adjunct professor, 1.5% visiting professor and 1.5% graduate teaching assistant. The ethnicity distribution was 86.5% white non-Hispanic, 5.6% Asian, 2.4 % Hispanic, .8% American Indian, 1.6% black, .8% Pacific Islander, and 2.7% other.

**Materials**

An earlier student survey (Zulauf 2010) asked questions to assess students’ knowledge, concern and responsibility. To allow for comparisons between the two populations, the faculty survey
followed a similar but shortened version. It consisted of thirty questions and took approximately twenty minutes to complete.

The survey was broken down into three sections. First we asked faculty a set of questions about their perceived knowledge, concern, and level of responsibility for climate change. Second, we asked their predictions of their students’ knowledge, concern, and level of responsibility. Finally, we asked demographic questions, including the degree to which faculty currently teach about climate change in their classrooms (1 = never addressed to 4 = often addressed). Almost all of the questions followed a four-point Likert scale from 1 = strongly disagree to 4 = strongly agree. For example, to measure concern, we used the question, “I am worried about climate change.” However, the question gauging personal responsibility (i.e., “Currently, how much do you think everyday citizens should be doing to address climate change?”) had a five-point Likert scale from 1 = much less to 5 = much more. All questions had a “decline to answer” option.

Knowledge questions included: “We are in a period of climate change.” “Human activity is playing a role in recent climate change.” “I personally do things that might contribute to climate change.” “Greenhouse gas emissions from burning coal, oil, and other materials cause average global temperatures to rise.” Score reliability of this four item knowledge measure was very good, with Cronbach’s alpha = .87. We measured all other variables based on one item each; therefore, we could not calculate reliability for these other variables.

We rephrased questions used in the first section to determine teaching faculties’ perceptions about students’ knowledge of and concern about climate change. For example, the concern question was re-worded as, “How worried do you feel your students are about climate change?” Using the same Likert scale as above to understand knowledge and concern, we used this data to identify if faculty members’ assumptions regarding what students know and want to know are different than what students reported in the student survey.

We also asked specific questions regarding faculty members’ feeling of comfort and responsibility toward teaching climate change and the degree to which they teach about climate change in their classes. To measure feelings of comfort, we asked participants to indicate their level of agreement with, “I feel comfortable educating students on the topic of climate change.” For responsibility, we asked, “Is it my responsibility to educate students on the topic of climate change.” We then asked them to indicate the degree to which climate change was addressed in their classroom.

We followed these questions by asking the educators to indicate which subjects they teach so we could compare these variables across disciplines. A demographics section allowed us to compare these variables by teaching experience, campus, and rank.

**Procedure**

We designed and implemented the survey using an online survey tool. We sent a link to the survey in an email message through each campus’s respective faculty listservs via the administration in charge of managing those lists. The invitation email was signed by the Associate Vice President for Interdisciplinary Research and described the background of the study and instructions for accessing the online survey link. Once participants clicked the link, the survey opened in a new window. The first page asked participants for their consent. By clicking “consent,” they agreed to participate and were taken to the instructions page. If they did not consent, they were directed to an exit page that thanked them for their time.

The survey was distributed to the northern campus early in the spring semester of 2011, and approximately two weeks later, it was distributed to the southern campus. A follow up and “thank you” message was sent to the north approximately one month after original invitation. Faculty in the south were sent a reminder and “thank you” email approximately two weeks after the original email. We closed the survey after six weeks.
Results

Descriptive Statistics, Data Screening, and Associations

Table 1 shows the means, standard deviations, skewness, kurtosis and bivariate correlations for faculty members (a) perceived knowledge of climate change, (b) concern about climate change, (c) personal responsibility regarding climate change, (d) predictions of students’ perceived knowledge about climate change, (e) predictions of students’ concern about climate change, (f) responsibility to teach about climate change, and (g) feelings of comfort about teaching about climate change. Many of the variables (i.e., knowledge, concern, and personal responsibility) are negatively skewed and highly kurtotic indicating that faculty responses were not normally distributed. Furthermore, there were several univariate outliers in these data, with $z$-values $\geq 3$. However, because of the controversial nature of the topic, we decided to retain outliers because these data provide meaningful information about more extreme perceptions. We therefore proceeded with nonparametric analyses that are robust to outliers and data distributions that lack normality in order to address our research questions.

Table 1: Bivariate correlations and descriptive statistics for teaching faculties’ responses; 
N = 248.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived knowledge of CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Concern about CC</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Personal responsibility regarding CC</td>
<td></td>
<td></td>
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<tr>
<td>4. Predictions of students’ knowledge about CC</td>
<td></td>
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<td></td>
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<tr>
<td>5. Predictions of students’ concern about CC</td>
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<td></td>
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<tr>
<td>6. Responsibility to teach about CC</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7. Feelings of comfort about teaching about CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>3.53a</td>
<td>3.42a</td>
<td>4.10b</td>
<td>2.97a</td>
<td>2.79a</td>
<td>2.75a</td>
<td>2.98a</td>
</tr>
<tr>
<td>$SD$</td>
<td>.73</td>
<td>.94</td>
<td>.90</td>
<td>.54</td>
<td>.64</td>
<td>.99</td>
<td>.97</td>
</tr>
<tr>
<td>Skewness</td>
<td>-2.05</td>
<td>-1.54</td>
<td>-1.31</td>
<td>-7.77</td>
<td>-7.70</td>
<td>-2.77</td>
<td>-6.4</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.59</td>
<td>1.21</td>
<td>2.30</td>
<td>1.67</td>
<td>1.02</td>
<td>-9.7</td>
<td>-5.8</td>
</tr>
</tbody>
</table>

Note. CC = climate change.

*p < .05, **p < .01.

*aResponse range was from 1 to 4.

*bResponse range was from 1 to 5.
We conducted a nonparametric analysis using Kendall’s τ-b to determine bivariate correlations. Faculty members’ perceived knowledge of, concern about, and personal responsibility regarding climate change were moderately correlated with each other, with all Kendall’s τ-b > .44. These correlations were all positive indicating an increasing level of one variable was associated with an increasing level in the other two. Responsibility to teach about climate change had moderately weak, but significant positive correlations with these three variables (Kendall’s τ-b values between 0.2 and 0.3), revealing that increased levels of knowledge, concern, and personal responsibility were associated with greater feelings of responsibility to teach about the topic. Responsibility to teach was also moderately and positively correlated with the level of comfort about teaching about climate change, with (Kendall’s τ-b = .14). Personal responsibility regarding climate change also had a weak, but significant positive correlation to the level of comfort about teaching about climate change (Kendall’s τ-b = .14). Therefore, a greater comfort with teaching was associated with increased personal responsibility. Moderately positive correlations existed between faculties’ predictions of students’ knowledge about climate change and faculties’ predictions of students’ concern about climate change, with Kendall’s τ-b = .50. Interestingly, faculties’ predictions of students’ knowledge and concern were not significantly correlated to any of the other variables.

Table 2: Bivariate correlations and descriptive statistics for actual students’ responses; N = 2856.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students’ perceived knowledge of CC</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2. Students’ concern about CC</td>
<td>.683**</td>
<td>–</td>
</tr>
<tr>
<td>M</td>
<td>3.16</td>
<td>2.88</td>
</tr>
<tr>
<td>SD</td>
<td>.76</td>
<td>.99</td>
</tr>
<tr>
<td>Skewness</td>
<td>-1.03</td>
<td>-0.62</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.43</td>
<td>-0.60</td>
</tr>
</tbody>
</table>

Note. CC = climate change. Response range for both variables was from 1 to 4.

*p < .05, **p < .01.

Table 2 shows the means, standard deviations, skewness, kurtosis, and bivariate correlations for students’ perceived knowledge of and concern about climate change. Note that these are students’ reported perceived knowledge and concern levels derived from Zulauf (2011) as opposed to faculties’ predictions of students’ knowledge and concern, which are listed in Table 1. Skewness and kurtosis values are less than or equal to an absolute value of about 1, indicating that we could assume normality in these student data. Because we can assume normal data distributions, we used Pearson bivariate correlations that revealed a moderate to strong positive correlation between students’ knowledge and concern about climate change (r = .68), with greater perceived knowledge associated with greater concern.

**Research Question 1: Teaching Faculty and Student Differences**

We used the nonparametric median test to examine differences between teaching faculty and students in both perceived knowledge of and concern about climate change. The median test examines differences in medians between two groups and compares them to the median of the two groups combined. Furthermore, the median test does not rely on the assumption of identical
distributions between these two groups. Therefore, the median test was an appropriate analysis because student responses were normally distributed and the faculty responses were not.

The results of the median test showed that faculty members (median = 3.75) had significantly greater perceived knowledge about climate change than students (median = 3.25), with $\chi^2(1) = 83.2$, $p < .0001$. The effect size was small as indicated by Cramer’s $V = .16$ (Volker 2006). Similarly, faculty (median = 4) had significantly greater concern about climate change than students (median = 3), with $\chi^2(1) = 141$, $p < .0001$. The effect size was small to medium with Cramer’s $V = .20$ (Volker 2006).

We also conducted a median test to examine differences in faculty members’ predictions about perceived student knowledge and students’ reported knowledge, as well as differences in faculty members’ predictions of students’ concern about climate change and actual student concern. The results showed that faculty members’ predictions (median = 3.00) significantly underestimated students’ reported perceived knowledge (median = 3.25), with $\chi^2(1) = 74.4$, $p < .0001$. The effect size was small with Cramer’s $V = .16$ (Volker 2006). On the other hand, faculty members’ predictions about students concern about climate change were equivalent to students’ actual concern, with both median values = 3.

**Research Question 2: Factors Relating to Addressing Climate Change in the Classroom**

We examined how the following predictive factors related to the degree to which faculty address climate change in their classrooms: (a) perceived knowledge of climate change, (b) concern about climate change, (c) personal responsibility regarding climate change, (d) responsibility to teach about climate change, and (e) feeling comfortable teaching about climate change. Because some of these variables had high skewness and kurtosis values—specifically, knowledge, concern, and personal responsibility—we first developed a generalized linear model to analyze the relationship of these variables. Generalized linear models offer the flexibility of specifying non-normal distributions (i.e., distributions with high skewness and kurtosis). For this analysis, we specified an ordinal logistic regression model, which is appropriate for the ordered categorical data we collected. The ordinal logistic regression revealed that responsibility to teach about climate change and feeling comfortable teaching about climate change are the only significant predictors of the degree to which faculty address climate change in their classrooms, with both generalized scores $\chi^2(3) > 15$ and both $p$-values $\leq .002$. Interestingly, these two significant predictors are normally distributed; therefore, to ease interpretation, we conducted a follow-up linear multiple regression analysis.

The multiple regression analysis overall predictive model was significant, $F(4,290) = 46.0$, $p < .0001$, with $R^2 = .39$ (i.e., a moderate effect size). The linear model also confirmed that both responsibility to teach ($\beta = .41$, $p < .01$) and feeling comfortable about teaching ($\beta = .28$, $p < .01$) were the only significant predictors of the degree to which faculty members addressed climate change in their classrooms. In both cases, a higher level of responsibility to teach about climate change and a greater feeling of comfort with teaching about climate change predicted a greater degree of addressing the topic in the classroom. Perceived knowledge of, concern about, and personal responsibility regarding climate change were not significant predictors.

**Research Question 3: Faculty Differences Based on Rank and Discipline**

We used median tests to examine differences in several dependent variables—perceived knowledge of, concern about, and personal responsibility regarding climate change; as well as responsibility to teach about, feeling comfortable teaching about, and whether they are currently teaching about climate change. In our analyses the grouping (independent) variables were faculty discipline and rank.

We developed four categories of teaching faculty rank: (a) full and emeritus professor, (b) associate professor, (c) assistant professor, and (d) other. The results of the median tests did not
reveal any significant difference in any of the dependent variables based on faculty rank, with all p-values > .11.

We developed six categories of faculty discipline based on domain similarity: (a) science, agriculture, and natural resources, (b) engineering, (c) business and hotel management, (d) health sciences and dental, (e) education and educational outreach, and (d) liberal arts and other. Table 3 shows the means and standard deviations for the dependent variables by discipline, as well as results of the median tests for each variable. As shown in Table 3, we found statistically significant differences in the dependent variables based on faculty discipline, with all p-values < .05, except for personal responsibility to address climate change, with p = .27. Effect sizes, as indicated by Cramer’s V, were small to medium. We conducted post-hoc median tests to provide greater details on differences between faculty disciplines. Because we ran multiple comparisons for each variable, we used a conservative alpha value of .01 to gauge significance (i.e., only p-values ≤ .01 were considered to be statistically significant). In the interest of conciseness, we have summarized these post-hoc results in Figures 1 through 6.

Table 3: Means and standard deviations for the study variables in different academic disciplines (N = 248), along with median test p-values and Cramer’s V.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Science Means (Standard Deviations)</th>
<th>Engineering</th>
<th>Business</th>
<th>Health Sciences</th>
<th>Liberal Arts</th>
<th>Education</th>
<th>p-values (Cramer’s V)</th>
</tr>
</thead>
</table>
| Knowledge
a                | 3.7 (0.56)                          | 3.3 (0.83)  | 3.1 (1.0) | 3.5 (0.84)       | 3.7 (0.50)   | 3.5 (0.60) | .001                 |
| Concern
a                 | 3.5 (0.90)                          | 3.0 (1.2)   | 2.9 (1.2) | 3.4 (0.89)       | 3.7 (0.70)   | 3.4 (0.89) | .047                 |
| Personal Responsibility
b | 4.1 (0.82)                          | 3.7 (1.1)   | 4.1 (1.1) | 4.0 (0.96)       | 4.3 (0.83)   | 4.3 (0.88) | .270                 |
| Responsibility to Educate
a  | 3.2 (0.92)                          | 2.5 (1.1)   | 2.6 (1.1) | 2.2 (1.0)        | 2.6 (0.89)   | 2.7 (0.96) | < .001               |
| Comfort with Educating
a   | 3.5 (0.75)                          | 3.2 (0.75)  | 2.8 (1.3) | 2.3 (0.96)       | 3.0 (0.81)   | 2.4 (1.2)  | < .001               |
| Currently Teaching
a     | 2.7 (0.93)                          | 2.1 (0.87)  | 2.5 (0.99) | 1.6 (0.72)       | 2.3 (0.85)   | 2.2 (1.1)  | < .001               |

Note. Science includes agriculture and life science, business includes hotel management, health science includes dental, education includes educational outreach, and liberal arts includes all other disciplines.

aResponse range was from 1 to 4.

bResponse range was from 1 to 5.
Figure 1: Differences in perceived knowledge about climate change by faculty discipline.

*Science, agriculture and natural resources faculty had significantly greater perceived knowledge than engineering, business & hotel management, and education & educational outreach faculty, with $p \leq .01$.

Figure 2: Differences in concern about climate change by faculty discipline.

*Liberal arts and other faculty had significantly greater concern than engineering, and business & hotel management faculty, with $p \leq .01$. 
Figure 3: Differences in responsibility regarding climate change by faculty discipline. There were no statistically significant differences among any of the disciplines.

![Bar chart showing differences in personal responsibility to address climate change by faculty discipline.]

**Figure 4: Differences in responsibility to teach climate change by faculty discipline.**

- Science, agriculture, and natural resources faculty had significantly greater feelings of responsibility to teach than health sciences & dental, and liberal arts & other, with $p \leq .01$.
- Engineering faculty had significantly greater feelings of responsibility to teach than health sciences & dental, with $p \leq .01$.
- Education & educational outreach faculty had significantly greater feelings of responsibility to teach than health sciences & dental, with $p \leq .01$. 

*Science, agriculture and natural resources faculty had significantly greater feelings of responsibility to teach than health sciences & dental, and liberal arts & other, with $p \leq .01$. **Engineering faculty had significantly greater feelings of responsibility to teach than health sciences & dental, with $p \leq .01$. ***Education & educational outreach faculty had significantly greater feelings of responsibility to teach than health sciences & dental, with $p \leq .01$. 

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Figure 5: Differences in feeling comfortable teaching about climate change by faculty discipline.

*Science, agriculture and natural resources faculty had significantly greater feelings of comfort teaching than business & hotel management, health sciences & dental, liberal arts & other, and education & educational outreach with all $p \leq .01$.
**Engineering faculty had significantly greater feelings of comfort teaching than health sciences & dental, with $p \leq .01$.
***Liberal arts & other faculty had significantly greater feelings of comfort teaching than health sciences & dental, with $p \leq .01$.

Figure 6: Differences in degree to which faculty are currently teaching climate change by discipline.

*Science, agriculture and natural resources faculty had a significantly greater degree to which they are currently teaching climate change than health sciences & dental, and education & educational outreach with $p \leq .01$.
**Business & hotel management faculty had a significantly greater degree to which they are currently teaching climate change than health sciences & dental, with $p \leq .01$.
***Liberal arts & other faculty had a significantly greater degree to which they are currently teaching climate change than health sciences & dental, with $p \leq .01$. 
Figures 1 through 6 generally show that science faculty have relatively high values in all the dependent variables—perceived knowledge of, concern about, and personal responsibility regarding climate change; as well as responsibility to teach about, feeling comfortable teaching about, and whether they are currently teaching about climate change. Liberal arts and faculty members in the “other” category also have relatively high values in perceived knowledge, concern, and personal responsibility, but not in responsibility to teach and comfort with teaching. On the other hand, business and hotel management faculty generally have relatively low values in all the dependent variables, except for responsibility to teach about climate change. Values associated with faculty from other disciplines are mixed.

Discussion

Higher education is a critical component of any climate change literacy effort. Our study revealed a number of insights into the current state of university faculty members’ response to climate change and teaching about climate change. Teaching faculty showed greater concern and a greater level of perceived knowledge about climate change than their students. This positions them well to be effective educators; but it will take both a strong understanding and strong commitment to effectively communicate the subject. Faculty members did underestimate their students’ perceived knowledge. It is unclear whether students overestimated their actual knowledge, or if faculty are not accurately accounting for their students’ background knowledge. Several studies have documented how students are commonly overconfident in their understanding about a particular topic (Dunlosky and Lipko 2007) and this may certainly be the case for climate change.

We found that comfort teaching climate change and feeling responsible for teaching climate change were both significant predictors of the degree to which it is currently taught. If climate change education initiatives are to be successful at covering the broad physical, social, and economic components of the problem, it will require a large set of educators across the many disciplines in higher education to feel comfortable with the subject. Therefore, professional development efforts are needed to better prepare university faculty to incorporate climate change into their curriculum.

Finally, this study revealed where best to devote these professional development efforts. As anticipated, those in the sciences are relatively high in feelings of both comfort and responsibility to educate on climate change. Engineers, on the other hand, feel comfortable but less responsible, providing an opportunity to promote a greater sense of awareness in this critical population. Liberal arts faculty members, who teach in disciplines such as sociology and political science, feel less comfortable than engineers with the same low level of responsibility (see Figure 7). Because so many socio-political factors are involved in any potential climate change mitigation or adaptation policy initiatives, liberal arts faculty members’ expertise is sorely needed for comprehensive and effective climate change education.
Business faculty rated themselves low in knowledge, concern, responsibility, and comfort with teaching about climate change. Since climate change is likely to have major economic impacts on a wide range of economic sectors for years to come, this population would be well served by professional development on the topic.

Higher education systems across the country are devoting resources to climate change education (Farrington and Feder 2010). For the universities in our study, we have identified where discomfort and low responsibility are creating opportunities to provide faculty with support. We hope university administrators might find this information useful in targeting professional development. With ever tightening budgets, the effective and efficient allocation of professional development resources to those faculty who might benefit the most, would benefit university wide climate literacy efforts for both faculty and their students.

**Acknowledgement**

We want to thank the National Science Foundation and the Nevada System of Higher Education for funding this research, which is part of the Nevada Infrastructure for Climate Change Science, Education, and Outreach project (Agreement No. EPS- 0814372). Amy Northrup provided the initial pilot study on professor’s perspective on students’ climate change knowledge from which this study evolved. Finally, we thank Jenna (Zulauf) Findlay for her work on the student survey and providing the student data, as well as her assistance writing the professor survey.
REFERENCES


Sinatra, Gale M., CarolAnne M. Kardash, Gita Taasoobshirazi, and Doug Lombardi. 2012. "Promoting Attitude Change and Expressed Willingness to Take Action toward Climate Change in College Students." Instructional Science 40: 1-17.


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