# What I know, what I think I know, how I act, & why I don't: Examining students' self-assessed vs. scientific knowledge about climate change

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**Abstract:** The present study examined what undergraduate students thought they knew about climate change, what they actually knew in terms of scientific knowledge, and how these two types of knowledge predicted their pro-environmental intentions and behaviors. We tested these questions using a cross-sectional online survey and data from a subsample of undergraduate student participants who believe in anthropogenic climate change ($N$ = 3,310). Students reported moderate levels of self-assessed knowledge yet objectively lacked an understanding of the causes of climate change. Self-assessed knowledge more strongly predicted pro-environmental intentions and action than actual knowledge. Students' understanding of the consequences of climate change predicted intentions while understanding the causes and climate science predicted action. Students self-identified a lack of knowledge and a lack of prioritization as barriers to climate change mitigating action. Pedagogical implications are discussed.

**Keywords:** climate change, higher education, knowledge, behavioral intentions

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Higher education plays a critical role in educating students about global climate change. However, the belief that climate change is happening and human-caused does not appear to be the only driving force behind climate inaction in college populations. Indeed, one study found that while 75% of college students said they believe climate change is happening and human-caused, only 15% reported having taken any action to reduce global warming (Wachholz, Artz, & Chene, 2014). As members of a large higher education institution, we were interested in

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understanding whether students' understanding of accepted scientific knowledge about climate change (i.e., what students actually know) and self-assessed knowledge (i.e., what students believe they know) were predictors of their self-reported behavioral intentions and actions to mitigate climate change. Further, we explored whether students identified a lack of knowledge as a reason for inaction. In the present work, we explore 1) students' understanding of climate change and self-assessed knowledge of climate change as predictors of climate change mitigating intentions and self-reported behavior and 2) students' self-identified barriers to action.

The current generation of college students is likely to have more knowledge about climate change than any other population in history (Perera & Hewege, 2013). Climate education is related to a variety of important outcomes. For example, individuals with knowledge about climate change are more likely to believe it is occurring (Hornsey, Harris, Bain, & Fielding, 2016), that is it a threat (Sundblad, Biel, & Garling, 2007), and are less likely to be skeptical about climate science (Hibberd & Nguyen, 2013). However, when considering broad environmental awareness, there is a gap between knowledge and behavior (Kollmuss & Agyeman, 2010). While the current generation of college students have some degree of knowledge about climate change, past research suggests that an accurate understanding of climate change may not translate directly to pro-environmental action.

Rather than assessing knowledge broadly, some educational researchers suggest considering several different types of scientific knowledge. For example, Taddicken and colleagues suggest that knowledge about climate change is a complex and multi-faceted concept that includes knowledge about climate change causes, effects, and behavioral interventions (Taddicken, Reif, & Hoppe, 2018). Other work suggests researchers should be examining the public's knowledge of the difference between climate and weather (Bostrom, Morgan, Fischoff, & Read, 1994) as it was linked to climate change policy support (Reynolds, Bostrom, Read, & Morgan, 2010). There are multiple types of climate knowledge, and they may functionally predict unique outcomes.

While some studies explored the relevance of scientific knowledge about climate change regarding pro-environmental action, fewer have considered the role of self-assessed knowledge. While there is some evidence of a modest relationship between actual knowledge and self-assessed knowledge (van der Linden, Maibach, & Leiserowitz, 2015), other work suggests no relationship (Howansky & Cole, 2016). Scientific knowledge and self-assessed knowledge may function independently when predicting pro-environmental outcomes. A survey of university students found that while 63% of students believed their climate change knowledge was moderate or extensive, most did not receive a passing grade on a scientific knowledge quiz (Wachholz et al., 2014). Students may not have an accurate understanding of what they do and do not know about climate change.

Self-assessed knowledge is related to a variety of important climate change relevant outcomes. For example, the more knowledgeable someone feels about climate change, the more likely they are to believe it is occurring (Hornsey et al., 2016), to be concerned about it, and to feel it important to mitigate (Aitken, Chapman, & McClure, 2011; Boyes et al., 2014). Further, the more students believe they know about climate change, the more pro-environmental intentions they formulate and the more climate change limiting behaviors they enact (Howansky & Cole, 2016).

While some work suggests scientific knowledge is a stronger predictor of climate change belief than self-assessed knowledge (Hornsey et al., 2016), little work has directly compared self-assessed and scientific climate change knowledge as predictors of action in one sample.

Further, limited work has explored the role of self-assessed and scientific knowledge in predicting actions and intentions beyond other important predictors of intentions and behavior such as perceived risk (O'Connor, Bord, & Fisher, 1999) and feelings of responsibility (Klöckner, 2013).

The goal of this research was twofold. First, we sought to examine self-assessed and scientific knowledge as predictors of pro-environmental intentions and self-reported behavior beyond other known predictors of climate mitigation, such as risk and responsibility. We predicted that both self-assessed and scientific knowledge would contribute to pro-environmental, climate change-limiting intentions and self-reported behavior. Secondly, we were interested in building upon the recent literature that has examined the factors that promote not just intentions but result in behaviors that reduce or mitigate climate change (e.g., Liu & Lin, 2015) by determining what students perceive as barriers to their action. Specifically, we explored whether students would identify a lack of knowledge as a barrier to their pro-environmental behaviors. All materials and data files are available at https://osf.io/9hn6w/?view_only=020e242f59ee4af5bf1afd3044189d3a.

## Methods

All matriculated graduate and undergraduate students from a large northeastern U.S. university were invited via email and school newspaper advertisements to participate in an online survey about climate change and sustainability in exchange for a chance to win one of 30 gift cards ranging from $30 to $300. The university research office administered the link and identified institutional data, including race/ethnicity, gender, and citizenship.

A sample of 3,444 undergraduates completed the online study. Most students identified as women (60.6%) and U.S. citizens or permanent residents (88.7%). Approximately half of the sample identified as White (46.9%). One hundred and thirty-four students (3.9%) reported they did not believe climate change is occurring and were excluded from subsequent analyses, resulting in a final sample of 3,310 participants.

Students who opened the link for the survey saw an informed consent form before accessing the survey. Students who agreed to participate then read that "The Environmental Protection Agency defines climate change as 'any significant change in the measures of climate lasting for an extended period of time.' In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer." Students were then asked whether they believed climate change was occurring; students that answered "no" were directed to questions about media usage and knowledge of university sustainability practices while students that answered "yes" then completed questions on risk perceptions, knowledge, responsibility, intentions, and behaviors related to climate change before seeing the questions that all other respondents saw at the end of the survey.

The measure of perceptions of climate change risk was obtained by asking students to report their level of concern about climate change on a 3-point scale from "*not at all concerned*" to "*very concerned.*" They also identified how far away they felt climate change is (i.e., psychological distance) on a 100-point slider scale from "*immediate*" to "*very far in the future*".

To measure self-assessed knowledge, students were asked to report their own knowledge of climate change across two items (e.g., "*How would you rate your level of knowledge about global climate change?*"), which were averaged to create a single measure of self-assessed climate change knowledge ($\alpha = .73$). Items were rated on 7-point scales ranging from "*I know almost nothing about this topic*" to "*I am an expert on this topic*."

The 56-item quiz of scientific knowledge (adapted from Bord, Connor, & Fisher, 2000; Bostrom et al., Read, 1994; NOAA, 2009; Reynolds et al., 2010) measured scientific knowledge across four climate change subject areas: causes (13 items), interventions (14 items), consequences (13 items), and general climate science (16 items). Before inclusion in the survey, all measures were reviewed by a panel of three university experts in research on climate change. Experts responded to the scales in a true/false format. If one expert disagreed, the item was excluded from the analysis. Across all items, participant responses were also coded as "true" or "false." Students received one point per response, which coincided with experts. Students who incorrectly answered an item or indicated that they did not know the answer did not receive a point. For each sub-scale, correct responses were summed and divided by the total possible points to create a percent correct score.

The measure of civic responsibility ranged from 1 (*disagree*) to 4 (*agree*) along a 12-item scale (adapted from Furco, Muller, & Ammon, 1998). We averaged responses to create one measure of civic responsibility ($\alpha = .88$). Students also reported the extent to which they felt personally responsible for fixing the climate on a scale from 1 (*not at all responsible*) to 5 (*extremely responsible*).

Pro-environmental intentions were assessed by intentions to engage in 12 activities to reduce climate change via a 10-point scale from "*never*" to "*always*" (e.g., restrict the use of electricity, walk, bike, or use public transit; $\alpha = .87$). Students then indicated whether they engage in 12 climate-change limiting behaviors (e.g., use public transit regularly). Pro-environmental behaviors were summed to create one measure of behavior. Students then reported reasons for why they did not behave pro-environmentally across seven items (e.g., not a priority) from 1 (*strongly disagree*) to 7 (*strongly agree*). Finally, students responded to various items for use in another study (e.g., media use).

## Results

### Descriptive Statistics

We first examined students' self-assessed and scientific knowledge of climate change (Table 1). Students knew the most about climate change interventions, consequences, and general climate science. Students knew the least about the causes of climate change. Students showed the greatest variability in knowledge about the scientifically agreed consequences of climate change and climate science. There was less variability in student's scientific knowledge about climate change interventions and causes. Students' self-assessed knowledge scores were significantly higher than the mid-point of the scale (e.g., "moderate level of knowledge"), $t(2490) = 17.02$, $p < .001$, $d = .31$, yet significantly lower than one unit above the midpoint (i.e., "a lot of knowledge"), $t(2940) = -49.96$, $p < .001$, $d = .93$. Students, on average, believed they have between a moderate amount and a lot of knowledge about climate change.

Table 1. *Descriptive statistics of self-assessed knowledge and objective knowledge subscales*

| Knowledge Measure | *M* | *SD* |
|---|---|---|
| Self-assessed Knowledge | 3.25 | 0.81 |
| Causes | 56.65% | 11.48 |
| Interventions | 75.04% | 11.68 |
| Consequences | 72.59% | 17.33 |
| Climate Science | 70.30% | 20.00 |

### Relationships Among Variables

We then examined the degree to which risk perceptions, responsibility, and knowledge are related to pro-environmental intentions and self-reported behavior (Table 2). Civic responsibility and concern were the strongest predictors of pro-environmental intentions and self-reported behavior such that the more civic responsibility or concern an individual felt, the more intentions and action they reported. Personal responsibility, self-assessed knowledge, and knowledge about the consequences of climate change were also among the strongest predictors of both intentions and reported action. Specifically, the more personal responsibility and knowledge students' felt they had, the more intentions and behavior they reported. Additionally, the more knowledge students had about the consequences of climate change, the more intentions they and behaviors they reported. Knowledge of climate change causes and interventions more weakly predicted both intentions and reported behavior.

Intentions and self-reported behaviors were significantly related such that the more intentions students formed, the more behaviors they reported, $r(2543) = 0.44$, $p < .001$.

Table 2. *Statistically significant (p's < .05) bivariate Pearson correlations with pro-environmental intentions and behaviors*

| Variable | Correlation with Intentions | Correlation with Behavior |
|---|---|---|
| **Demographics** | | |
| Gender | -.06 | -.03 |
| Ethnicity | -.07 | .08 |
| U.S. Citizen | -.10 | .08 |
| **Risk Perceptions** | | |
| Concern | .32** | .35** |
| Psychological Distance | -.15 | -.22* |
| **Responsibility** | | |
| Personal Responsibility | .28* | .22* |
| Civic Responsibility | .41** | .35** |
| **Knowledge** | | |
| Knowledge of Causes | .04 | .12 |
| Knowledge of Interventions | .15 | .14 |
| Knowledge of Consequences | .23* | .21* |
| Knowledge of Climate Science | .12 | .22* |
| Self-assessed Knowledge | .22* | .27* |

Gender: 0 = Female, 1 = Male; Ethnicity: 0 = Non-White, 1 = White; U.S. Citizen: 0 = Non-citizen, 1 = Citizen; *moderate effect size, **large effect size (Hemphill, 2003)

## Predicting Intentions and Behavior

We next explored the extent to which risk perceptions, responsibility, and knowledge predict pro-environmental behavioral intentions via a hierarchical linear regression controlling for gender, ethnicity, and citizenship (Table 3). Risk, responsibility, and knowledge each independently predict intentions, accounting for about 26% of the variance in intentions. Of risk variables, concern about climate change predicted intentions, but psychological distance did not. In the next step, we explored the extent to which responsibility predicts intentions beyond risk variables and demographics. Feelings of climate change responsibility and civic responsibility predict intentions, but civic responsibility is a much stronger predictor. Finally, we explored the extent to which knowledge predicts intentions controlling for demographics, risk, and responsibility. Understanding the causes of climate change and the science behind climate

change did not predict intentions. Intervention and consequence knowledge predicted intentions, but not to the same extent as self-assessed knowledge. With all variables included in the model, the strongest predictors of intentions were responsibility, concern, and self-assessed knowledge.

We next explored the extent to which intentions, risk perceptions, responsibility, and knowledge predict self-reported pro-environmental behavior via a hierarchical linear regression controlling for gender, ethnicity, and citizenship (Table 3). Intentions, risk, responsibility, and knowledge each independently predict behavior, accounting for 25% of the variance in behavior. Among risk variables, both concern and psychological distance predicted behavior. In the next step, we explored the extent to which responsibility predicts intentions beyond risk variables and demographics. Feelings of climate change responsibility and civic responsibility predict behavior, but civic responsibility is a much stronger predictor. Finally, we explored the extent to which knowledge predicts behavior controlling for demographics, intentions, risk, and responsibility. Knowledge of climate interventions, causes, and consequences did not predict behavior. Instead, knowledge of climate science and self-assessed knowledge predicted action. Together, beyond demographics and intentions, the strongest predictors of behavior were civic responsibility, concern, and self-assessed knowledge.

Table 3. *Results from a hierarchical regression analysis predicting pro-environmental intentions and behavior*

| | Intentions | | | | | | Behavior | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | B | β | t | R | $R^2$ | $\Delta R^2$ | B | β | t | R | $R^2$ | $\Delta R^2$ |
| Step 1 | | | | .13 | .02 | .02 | | | | .12 | .01 | .01 |
| Gender | -0.20 | -.06 | -2.54* | | | | -0.27 | -.07 | -3.26** | | | |
| Ethnicity | -0.18 | -.05 | -2.34* | | | | 0.33 | .09 | 3.84*** | | | |
| U.S. Citizen | -0.47 | -.08 | -3.68*** | | | | 0.27 | .04 | 1.90 | | | |
| Step 2 | | | | .34 | .12 | .10 | | | | .39 | .15 | .14 |
| Gender | -0.18 | -.05 | -2.47* | | | | -0.25 | -.07 | -3.24** | | | |
| Ethnicity | -0.21 | -.06 | -2.78** | | | | 0.28 | .07 | 3.54*** | | | |
| U.S. Citizen | -0.58 | -.10 | -4.74*** | | | | 0.09 | .01 | 0.70 | | | |
| Concern | 0.91 | .31 | 13.19*** | | | | 1.06 | .32 | 14.33*** | | | |
| Psychological Distance | -0.000 | -.03 | -1.16 | | | | -0.01 | -.10 | -4.61*** | | | |
| Step 3 | | | | .50 | .25 | .13 | | | | .48 | .23 | .08 |
| Gender | -0.15 | -.05 | -2.28* | | | | -0.26 | -.07 | -3.45** | | | |
| Ethnicity | -0.18 | -.05 | -2.63** | | | | 0.28 | .07 | 3.75*** | | | |
| U.S. Citizen | -0.52 | -.09 | -4.55*** | | | | 0.17 | .03 | 1.33 | | | |
| Concern | 0.57 | .19 | 8.52*** | | | | 0.78 | .23 | 10.55*** | | | |
| Psychological Distance | 0.000 | .002 | 0.10 | | | | -0.01 | -.08 | -3.94*** | | | |
| Personal Resp. | 0.19 | .14 | 6.72*** | | | | 0.11 | .07 | 3.51** | | | |
| Civic Responsibility | 1.05 | .32 | 15.81*** | | | | 0.99 | .27 | 13.43*** | | | |
| Step 4 | | | | .51 | .26 | .01 | | | | .50 | .25 | .02 |
| Gender | -0.19 | -.06 | -2.74** | | | | -0.41 | -.11 | -5.32*** | | | |
| Ethnicity | -0.18 | -.05 | -2.66** | | | | 0.20 | .05 | 2.58** | | | |
| U.S. Citizen | -0.48 | -.09 | -4.28*** | | | | 0.21 | .03 | 1.68 | | | |
| Concern | 0.45 | .15 | 6.29*** | | | | 0.58 | .17 | 7.50*** | | | |
| Psychological Distance | 0.001 | .02 | 0.74 | | | | -0.004 | -.06 | -2.71** | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Personal Resp. | 0.19 | .14 | 6.61*** | 0.10 | .07 | 3.30** |
| Civic Responsibility | 0.98 | .30 | 14.42*** | 0.91 | .25 | 12.29*** |
| Knowledge of Causes | -0.003 | -.02 | -0.88 | 0.01 | .04 | 1.81 |
| Knowledge of Interventions | 0.01 | .05 | 2.20* | 0.003 | .02 | .71 |
| Knowledge of Consequences | 0.01 | .06 | 2.69** | 0.002 | .02 | 0.80 |
| Knowledge of Climate Science | -0.001 | -.01 | -0.38 | 0.01 | .09 | 4.37*** |
| Self-assessed | 0.16 | .08 | 3.22** | 0.24 | .10 | 4.46*** |

Gender: 0 = Female, 1 = Male; Ethnicity: 0 = Non-White, 1 = White; U.S. Citizen: 0 = Non-Citizen, 1 = Citizen;
*$p < .05$, **$p < .01$, ***$p < .001$

## Barriers to Action

We conducted a series of one-sample t-tests to explore whether students' ratings of various barriers to pro-environmental action significantly differed from four, the midpoint on the scale (Table 4; Figure 1). Values significantly below the mid-point indicate that students did not identify that variable as a barrier to their pro-environmental behavior. Values above the mid-point indicate that students believe these factors are reasons why they do not behave pro-environmentally. Students' responses were significantly below the scale mid-point on lack of importance, efficacy, belief, climate science knowledge, and finances, indicating that students do not believe these are reasons for their inaction. However, students reported significantly higher than the mid-point of the scale on personal prioritization and intervention knowledge, suggesting they identified a lack of personal prioritization and a lack of knowledge about climate interventions as reasons for inaction. Students' beliefs that a lack of intervention knowledge caused their inaction was not significantly related to their actual intervention knowledge, $r(2498) = -0.04$, $p = .06$. Rather, beliefs that inaction stemmed from a lack of knowledge was more strongly correlated with their self-assessed knowledge, $r(2594) = -0.18$, $p < .001$, $Z = -5.06$, $p < .001$. Similarly, the degree to which students felt a lack of climate science knowledge prevents their pro-environmental behavior was more strongly correlated with their self-assessed knowledge, $r(2596) = -0.47$, $p < .001$, than their actual climate science knowledge, $r(2484) = -.23$, $p < .001$, $Z = -26.50$, $p < .001$.

Table 4. *Self-reported barriers to inaction*

| | *M* | *SD* | *t*-test | *d* |
|---|---|---|---|---|
| Not Important | 2.36 | 1.55 | -53.86** | 1.06 |
| Not a Priority | 4.69 | 1.83 | 19.36** | 0.38 |
| Lack Intervention Knowledge | 4.06 | 1.66 | 1.73* | 0.04 |
| Lack of Efficacy | 3.50 | 1.84 | -13.72** | 0.27 |
| Lack of Belief | 1.81 | 1.37 | -81.20** | 1.60 |
| Lack of Climate Science Knowledge | 3.53 | 1.84 | -13.13** | 0.26 |
| Too Expensive | 3.66 | 1.77 | -9.81** | 0.19 |

*$p < .10$, **$p < .001$

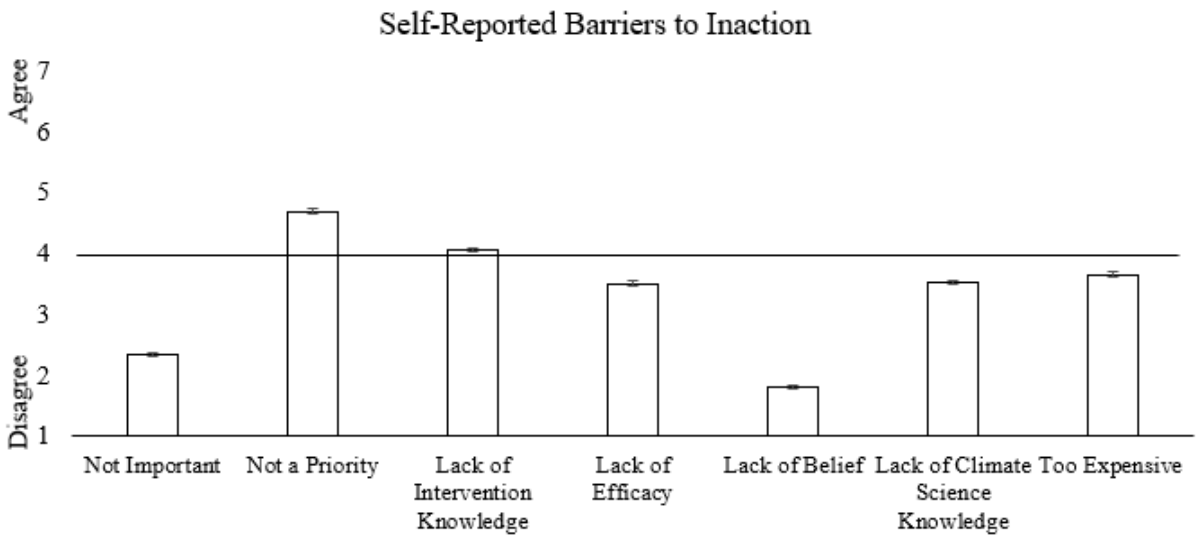


*Figure 1*. Students' self-reported barriers to inaction.

## Discussion

In the present study, we examined students' self-assessed and scientific knowledge about climate change. Further, we considered the roles self-assessed and scientific knowledge play in predicting pro-environmental intentions and self-reported behaviors beyond other known predictors (i.e., concern, risk, demographics). Students subjectively reported moderate climate change knowledge. In terms of actual scientific knowledge, students exhibited the highest scientific understanding about climate change interventions, the consequences of climate change, and climate science. However, students struggled most with identifying the causes of climate change. Additionally, there was high variability in students' knowledge about climate science and the consequences of climate change.

The present work corresponds to past work suggesting that university students believe they have a moderate understanding of climate change (Wachholz et al., 2014). However, the present findings contradict past work, which found students struggled most in their knowledge of climate science (Lombardi & Sinatra, 2012; Schreiner, Henriksen, & Hansen, 2005; Zimmer & Draeger, 2009), as our sample found students knew more about climate science than the causes of climate change. Further, while some work suggests students show a relatively high understanding of the causes and consequences of climate change (Kromer, Hartwagner, & Rauscher, 2007; Ojala, 2012), other work suggests individuals lack understanding in these areas (Dos Santos, 2012). In the present study, we find that students do show moderate levels of understanding about climate science and the consequences of climate change but lack understanding of climate change causes.

We also explored self-assessed and scientific knowledge as predictors of pro-environmental intentions and self-reported behavior. Across all knowledge measures, self-assessed knowledge was the strongest predictor of both intentions and action. Knowledge about climate change interventions and the consequences of climate change were significant scientific knowledge predictors of pro-environmental intentions. Indeed, students also identified a lack of knowledge about climate change interventions as a barrier to their pro-environmental behavior. While knowledge about climate change interventions and consequences did significantly predict intentions, they did not significantly predict self-reported pro-environmental action.

Knowledge about the consequences of climate change may result in intentions but not behavior due to disengagement due to the dramatic and fear-inducing way the issue of climate change has been represented (O'Neill & Nicholson-Cole, 2009). According to terror management theory (Goldenberg, Pyszczynski, Greenberg, & Solomon, 2000), individuals may be motivated to disengage from climate change because it is a reminder of their own mortality (Vess & Arndt, 2008). Mortality salience is likely to activate self-regulatory fear controls such as apathy (Lorenzoni et al., 2007).

Understanding climate science was the only scientific knowledge predictor of self-reported pro-environmental action. However, students themselves did not identify a lack of climate science as a barrier to their pro-environmental action. This finding highlights a disconnect from students' perceptions of what type of knowledge predicts pro-environmental action. Indeed, students identified a lack of intervention knowledge as a barrier to action. Yet, there was no significant relationship between scientific knowledge about climate change interventions and actual self-reported behaviors. Future work should further explore the disconnect between the types of scientific knowledge students believe they need to motivate action and the types of knowledge they actually need. Across this study, there appears to be a disconnect between what students believe they know, what they actually know, the types of knowledge they believe are an important predictor of action and the types of knowledge that actually predict action. Future work should explore the origins of these discrepancies as well as their consequences.

While knowledge of consequences may influence concern and intentions (Aitken et al., 2011), in the present study, it is self-assessed knowledge and a scientific understanding of what climate change is that predict action. Self-assessed knowledge proved to be a significant predictor of both intentions and action, while no single measure of scientific knowledge predicted both. We also replicated an array of past work suggesting self-assessed risk and responsibility are predictors of intention (Klöckner, 2013; O'Connor et al., 1999). The work highlights the importance of considering the unique role that different areas of knowledge may play in instigating intentions compared to action.

Self-assessed knowledge may more directly lead to action compared to scientific knowledge in several ways. Individuals who believe they lack knowledge, whether or not they genuinely do, tend to abstain from engaging with a topic for fear of embarrassment (Miller & McFarland, 1987). Additionally, knowledge is power. Individuals who believe they understand climate change report lower feelings of powerlessness (Aitken et al., 2011). Indeed, feelings of powerlessness concerning climate change are associated with decreased engagement (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). Even if students understand climate change, they may feel powerless and disengage from mitigation strategies if they do not feel as though they understand it.

Finally, we explored students' self-identified barriers to pro-environmental behavior. Students identified a lack of personal prioritization as the reason for inaction. These findings are consistent with the results of a Pew Research Center poll that reported that while most Americans said climate change was an important issue, they placed it 20$^{th}$ out of 20 issues surveyed ("Warming to the topic," 2009). Students also reported a lack of knowledge was another barrier to their pro-environmental behavior. Importantly, students' self-identified lack of knowledge weakly corresponded to their true scientific knowledge and rather more closely reflected their self-assessed knowledge. While students cited their lack of knowledge as a reason for inaction, their feelings of inadequacy did not correspond with an actual lack of knowledge.

## Limitations

While the present work explores discrepancies between self-assessed and scientific knowledge, it is imperative to note the scientific measure of knowledge utilized may not be exclusively objective. The scientific measures of knowledge about the interventions, causes, consequences, and science of climate change were obtained from reputable sources (adapted from Bord et al., 2000; Bostrom et al., 1994; NOAA, 2009; Reynolds et al., 2010); nonetheless, we felt it necessary for three additional experts to review the items to ensure there was a consensus for which responses were correct. Despite consistency between surveyed experts and the developers of the test questions for most items (93.75%), six items fostered disagreement (four items about interventions, two items about consequences). While we intended to use a truly objective measure of knowledge, there is some debate about whether certain activities are adequate climate change interventions and the potential consequences of climate change. For example, experts disagree about whether replacing fossil fuels with natural gas is an effective climate change intervention. Natural gas produces approximately half of the carbon dioxide emissions as coal (U.S. Energy Information Administration, 2016); however, natural gas is primarily methane which is 25x more potent than carbon dioxide at trapping heat (IPCC, 2007).

There is an ongoing debate about the effectiveness of some interventions and the extent of climate change consequences. Therefore, in the present work, we only included items in these measures that demonstrated consensus among test creators and resident experts. Further, while it is important to recognize that scientific knowledge of climate change may change over time, the scientific measure included in the present work is certainly more objective than the self-assessed knowledge measure.

Importantly, the present work recorded self-assessed measures of behavior rather than observational measures. Students' self-reported behaviors may not be entirely reflective of their actual behaviors. Memories tend to be altered to support the self-concept (Conway, 2005; Greenwald, 1980; Wilson & Ross, 2003). The students in this sample all believed anthropogenic climate change is occurring. As such, these students may be motivated to overestimate their climate change limiting behaviors to bolster their self-concepts. Future work should utilize direct or observational measures of climate mitigating behavior.

## Prescriptions for Educators

In this study, undergraduate students' perceptions of their own climate change knowledge more strongly predicted their self-reported pro-environmental behaviors and intentions than their scientific understanding of climate change interventions, causes, consequences, or climate science. The purpose of this work is certainly not to suggest scientific understanding is unimportant. The present study did not explore *where* perceptions of knowledge originate. It is possible, and likely that students' perceptions of knowledge come from past learning experiences. Indeed, students in our sample who had taken a course that included discussions of climate change reported higher self-assessed knowledge ($M = 3.49$, $SD = 0.76$) than those who did not ($M = 3.07$, $SD = 0.80$), $t(2740) = 13.99$, $p < .001$ and self-assessed and scientific knowledge are related with $r$'s between .14 and .34. Future work should explore how self-assessed knowledge of climate change develops and the role of the classroom in empowering students to believe they have the knowledge necessary to mitigate climate change.

We started this research to understand the roles of scientific and self-assessed knowledge as predictors of students' behavioral intentions and self-reported actions to mitigate climate

change. Ultimately, we hoped this information would help us refine our courses and programs to achieve improved knowledge and behavioral outcomes. Based on our findings, we recommend that educators focus classroom efforts in educating students about climate change in several ways: 1) focus not just on the causes and drivers of climate change, but make sure to emphasize and include knowledge about behaviors that can mitigate climate change, 2) encourage reflection on evidence to help students recognize that they know enough about climate change to act – you know enough, and because you know enough, you can do something about climate change, and 3) incorporate climate change education across disciplines to emphasize its personal prioritization value.

Beyond scientific understanding, self-assessed knowledge about climate change was a predictor of pro-environmental intentions and behaviors for university students who believe in climate change. Further, students identified their perceptions of a climate science and intervention knowledge deficiency as a reason for their inaction. Students yearn for climate education and require confidence in that knowledge to promote engagement (Wachholz et al., 2014). Taken together, this work suggests that what students *think* they know may play an important role in empowering students to tackle the issue of global climate change.

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