# Survey Development to Measure the Gap Between Student Awareness, Literacy, and Action to Address Human-caused Climate Change

**Dr. Tripp Shealy, Virginia Tech**

Tripp Shealy is an assistant professor in the Charles E. Via, Jr. Department of Civil and Environmental Engineering and principal faculty member in the Myers-Lawson School of Construction at Virginia Tech. He received his doctorate from Clemson University. His research is broadly focuses on judgment and decision making for sustainable infrastructure. This includes education for sustainability, specifically, how student understanding and attitude towards climate change effects their motivations and agency to solve complex global problems for a sustainability in their career.

**Dr. Allison Godwin, Purdue University, West Lafayette**

Allison Godwin, Ph.D. is an Assistant Professor of Engineering Education at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. She is the recipient of a 2014 American Society for Engineering Education (ASEE) Educational Research and Methods Division Apprentice Faculty Grant. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and 2016 New Faculty Fellow for the Frontiers in Engineering Education Annual Conference. She also was an NSF Graduate Research Fellow for her work on female empowerment in engineering which won the National Association for Research in Science Teaching 2015 Outstanding Doctoral Research Award.

**Miss Haley Margaret Gardner**

# Survey Development to Measure the Gap Between Student Awareness, Literacy and Action to Address Human Caused Climate Change


## Abstract

The United Nation's Sustainable Development Goals state climate change could irreversibly affect future generations and is one of the most urgent issues facing society. To date, most education research on climate change examines middle and high school students' knowledge without considering the link between understanding and interest to address such issues in their career. In research on students' attitudes about sustainability, we found that half of first-year college engineering students, in our nationally representative sample of all college students at 4-year institutions ($n$ = 937), do not believe climate change is caused by humans. This lack of belief in human-caused climate change is a significant problem in engineering education because our results also indicate engineering students who do not believe in human caused climate change are less likely to want to address climate change in their careers. This dismal finding highlights a need for improving student understanding and attitudes toward climate change in order to produce engineers prepared and interested in solving complex global problems in sustainability. To advance understanding about students' understanding of climate change and their agency to address the issue, we developed the CLIMATE survey to measure senior undergraduate engineering students' Climate change literacy, engineering identity, career motivations, and agency through engineering. The survey was designed for students in their final senior design, or capstone course, just prior to entering the workforce. We developed the survey using prior national surveys and newly written questions categorized into six sections: (1) career goals and motivation, (2) college experiences, (3) agency, (4) climate literacy, (5) people and the planet, and (6) demographic information. We conducted focus groups with students to establish face and content validity of the survey. We collected pilot data with 200 engineering students in upper-level engineering courses to provide validity evidence for the use of these survey items to measure students and track changes across the undergraduate curriculum for our future work. In this paper, we narrate the development of the survey supported by literature and outline the next step for further validation and distribution on a national scale. Our intent is to receive feedback and input about the questions being asked and the CLIMATE instrument. Our objective is to share the nationally representative non-identifiable responses (the estimated goal is 4,000 responses) openly with education researchers interested in students understanding about climate change, their engineering identity, career motivations, and agency through engineering. Ultimately, we want this research to become a catalyst for teaching about topics related to climate change in engineering and its implications for sustainability.


## Introduction

The United Nation's Sustainable Development Goals state climate change could irreversibly affect future generations and is one of the most urgent issues facing society (United Nations, 2015). Results of climate change are likely to include a reduction of global food production and water supplies, sea level rise, and ocean acidification (Karl, 2009). Engineers will play a critical role in solving these challenges. For example, manufacturing processes can reduce greenhouse emissions by developing closed-cycle loops that reduce waste (Clark, 2007), stronger materials to combat roadway buckling from increased temperatures, washouts from precipitation, and settling from thawing permafrost (*Potential Impacts of Climate Change on U.S. Transportation*, 2008).

Education about climate change in engineering should represent these dynamic challenges with implications spanning communities, environment, and economies (*The Climate Change Educational Partnership*, 2014). Engineers exposed to these types of problems through education are more likely to want to address these issues in their career (Klotz et al., 2014; Shealy et al., 2015). Although, there is

little research to assess if engineering students are ready to address such challenges in their career. This is a major shortfall for a workforce who will be charged with solving such important societal challenges.

To help advance understanding, we developed a survey instrument to measure undergraduate engineering students' climate change literacy, their engineering identity, career motivations, and agency to address sustainability through engineering just prior to them entering the workforce. To develop the survey, this research builds on critical engineering agency theory in which students' learning and interest are enhanced when they see an opportunity to make change in their world. The survey was developed using previous studies about climate literacy, meaning students' understanding of the essential principles of Earth's climate system, recognition of scientifically credible information about climate science, and their ability to make informed decisions with regard to actions that may effect Earth's climate (NOAA, 2009; Wibeck, 2014).

The paper begins with a review of misconceptions about climate change and outlines critical engineering agency as our theoretical framework. Followed by, defining the broad research objectives, in which this survey development is the first step. The purpose here is to receive feedback about the survey's questions and its development. Ultimately, we want the survey and our collected nationally representative data to be useful to other researchers. So, this is an opportunity to add additional questions to include of interest to engineering education related to climate change and engineering for sustainability. We provide a narrative about how the survey was developed and supporting literature for each section of the survey and the initial validity tests. Though, more validity of the instrument including psychometric statistical analyses, correlation matrices of theoretically related items for construct validity, and empirically testing the factor structure using maximum likelihood exploratory factor analysis are planned in the coming months. The paper ends with future research steps including validation and distribution across universities in the United States. As mentioned earlier, the hope is that others are able to use and adapt the survey instrument and its supportive literature. While, our goal is specific to measure senior engineer students, the survey could be adapted for recently graduated students early in their professional career.

## Background

### *Misconceptions about Climate Change*

Human influence on the climate system is unequivocal (Stocker et al., 2013), yet only half of Americans believe in human-caused climate change (Leiserowitz et al., 2012) and even fewer can explain the possible global health implications (Leiserowitz et al., 2012). An even lower belief rate than the general public, only three out of ten professional engineers (n = 1077) believe climate change will cause significant public risk (Lefsrud & Meyer, 2012).

One reason for these misconceptions is a lack of education about the impact of climate change. Climate science is not well-understood by middle and high school students in the U.S. highlighting the gap in students' understanding of the pressing issues and scientific support of this problem (Gambro & Switzky, 1996; McNeill & Vaughn, 2010; Shepardson et al., 2010). For example, some middle school students believe climate change is associated with ozone depletion and causes skin cancer (Andersson & Wallin, 2000). Similar aged students said pro-environmental behavior like not littering is appropriately taking action to prevent climate change (Boyes & Stanisstreet, 1993; Shepardson et al., 2009). Later on in their academic careers, high school students were shown to hold overly simplistic conceptual models of the earth's climate system without considering geographical variations. In interviews, these students described the anticipated effect of climate change on wild animals and plants but could not recognize the impact on agriculture crops and livestock (Shepardson et al., 2010). These misconceptions are also evident in first-year college students. From a prior national study, more than half of students intending to major in engineering do not believe in climate change (Shealy et al., 2016).

Suggested educational interventions to address these significant misconceptions are widespread (Anderson, 2010) and studies in classroom (Pruneau et al., 2010) and other environments (Sellmann, 2014) have examined whether specific educational interventions can lead to improved understanding of climate change. However, just knowing about climate change does not guarantee action to address climate change (Skamp et al., 2013). Students must perceive they can bring about change using their own skills and abilities. Their priorities, shaped by their values and attitude, must align with motivation for action to occur (Kollmuss & Agyeman, 2002). The formation of engineers during undergraduate engineering programs is an opportunity to correct conceptions about climate change and help students develop their abilities for career opportunities to solve engineering problems that mitigate climate change and its implications for sustainability.

*Critical Engineering Agency*

Agency refers to an individual's ability to shape the world around them both in their everyday actions (e.g., replacing inefficient lighting in their homes) and in their broader goals (e.g., pursuing a career in the design of more energy-efficient commercial buildings)(Basu & Barton, 2009). Thus, agency in a subject area, in this case, engineering, is directly related to developing students' belief that they can take action to reduce climate change and its implications for sustainability.

Critical engineering agency uses multiple subject-related identities along with students' agency beliefs to examine how students see themselves as a powerful thinker and doer of a particular subject (identity), in this case, engineering, and how they view the world with a critical mindset to advance the world as a more equitable place (agency beliefs) (Basu et al., 2008). This framework has been adapted from a physics context and translated to explore engineering students' identity development with engineering, a deepening understanding of engineering, and viewing engineering as a way to advance their world (Godwin, 2016a; Godwin et al., 2013; Godwin et al., 2013, 2016). This theoretical framework is particularly well-suited to examine our research question of how students' experiences impact engineering identity, conceptual models of climate change, and agency to address these issues in their future careers.

Part of critical engineering agency is also learning to analyze engineering, and the world, critically as well as becoming familiar with the tools and practices of their field (e.g., learning to "do" engineering). The development of such perspectives may lend to an individual's growing professional identity and attachment to their practice as an engineer. So, identity encompasses a set of self-beliefs held by an individual in relation to their perceptions of a specific role; for example, that of a good chemical engineer. To measure engineering role identity, an individual's identity is composed of their beliefs in three sub-domains: their interest in engineering, their self-beliefs about the recognition that they receive from others in the role of an engineer, their perceived performance/competence in understanding and successfully carrying out the tasks related to engineering (Brickhouse et al., 2000; Hazari et al., 2010; Johnson et al., 2011). For students entering engineering in college, physics and math identities, along with agency beliefs were found to predict choice engineering careers over other STEM career choices (Godwin, 2016b; Potvin et al., 2013).These three aspects of students' role identities as engineers can be used to better understand how identity, along with agency, are developed during the undergraduate experience and impact students' desire to address climate change in their careers.

**Research Question**

The guiding question is how do engineering students develop critical engineering agency and beliefs in college to address climate change in their careers. In response to the research question, the general objective is to investigate engineering students' conception of climate change, if students' engineering agency is informed by their beliefs about climate change, and they see opportunities to address climate change and related topics for sustainability in their careers through their undergraduate experiences.

Survey development is the first step towards answering these research questions. In the following sections, we explain how the survey was developed, building from and merging of previous surveys and literature about engineering agency, climate change literacy, and sustainability. Again, the purpose of this paper is to outline the methods for survey development and open an opportunity for discussion within the engineering education community about the survey instrument questions and sections. The subsequent step is for survey validation and distribution. The expectation is to distribute the survey to over 40 universities and collect more than 4000 student responses. We will make non-identifiable data available to others interested in answering questions about students' agency, climate literacy, or sustainability just prior to entering the workforce.

**Survey Development**

The purpose of the survey is to identify quantitative relationships between undergraduate engineering seniors' understanding of climate change, how this develops critical engineering agency to address these topics, and translates to career plans. To develop the survey, we drew from existing knowledge on topics including belief about climate change (Leiserowitz et al., 2012), engineering course content and standards (ABET, 2013; Allenby et al., 2009), sustainability (Davidson et al., 2007; Huntzinger et al., 2007; Mihelcic et al., 2006), critical engineering agency (Godwin et al., 2013; McNeill & Vaughn, 2010), and career choice (Hazari et al., 2010; Kaminsky et al., 2012; Shealy et al., 2015). The survey was model on prior national surveys such as Sustainability and Gender in Engineering (Klotz et al., 2010), the Yale Project on Climate Change Communication (Leiserowitz et al., 2012; Leiserowitz et al., 2010) and the climate literacy survey from Clarkson University (DeWaters et al., 2012). The survey includes anchored, numerical, multiple choices, and categorical questions divided into six sections: (1) career goals, (2) college experiences, (3) about you, (4) climate science, (5) people and the planet, and (6) demographic information. Questions included in each section are described further with supporting literature.

*Section 1: Career goals*

Our survey tests the extent to which these influencing factors impact students' career expectations and motivations. Questions in this category include job characteristics like the importance of making money, having personal/family time, solving societal problems, etc. Students may begin college in an engineering major with expectations or beliefs about their career options. Questions will investigate how these expectations and beliefs change from freshman to senior year. Do engineering students recognize more or fewer opportunities? And do these opportunities include addressing climate change and, more broadly, sustainability in their careers.

*Section 2: College experiences*

This section includes exposure and frequency to problems related to climate change and sustainability in formal class settings. As well as variables about college organizations, clubs, and also, informal learning, such as participation in competition teams, service learning, and internships. The methods used to teach about topics and student perceptions of climate and sustainability education are also included. These questions are modeled from previous surveys (Watson et al., 2013) to include whether topics related to sustainability were covered in their previous classes.

*Section 3: About you (agency)*

The questions are based on leading organizations regarding engineers' role in climate change and its implications for sustainability (NAE, 2005; National Academy of Engineering, 2008; National Research Council, 2010). Questions gauge students' level of understanding of their roles as engineers (identity) and their empowerment to make change within the world (agency). Some of these questions combine

into a pair of measures of agency using factor analysis: global engineering agency (beliefs in the ability of engineering to change the world in a global sense) and personal engineering agency (beliefs engineering to change one's life). These combinations of questions and agency follow previous study findings (Godwin, 2016b; Godwin et al., 2013). We will build on these to identify if students within engineering sub-disciplines are more or less distinct in their identity and feeling of empowerment.

*Section 4: Climate science*

Both global warming and climate change are used within the survey, though these terms are not the same. Global warming refers to the increase in Earth's near-surface air and ocean temperatures (Hall et al., 2013). It only describes the increase in global average not fluctuation in local temperatures. Global warming comes from the increase in greenhouse gases, which make it difficult for long wave radiation to pass through the atmosphere (United States Global Change Research Program, 2009). Climate change is how regions around the globe respond to global average temperature increase. The changes may include the water cycle, ice cover on land and in the polar oceans (Hall et al., 2013). Climate change means more than just a change in temperature but a change in global weather patterns, which could affect precipitation averages and extreme events. The effects of climate change to ecology, sea level rise, ocean circulations and societal impacts are defined as the global change and are typically measured by the disruption in the expected climate or ecology.

Students' conception of both global warming and climate change, including their understanding of natural variability, human activities, and earth's systems. These questions also investigate engineering students' recognition of the global variability. The section covers essential climate science, weather, and knowledge about climate research. More specifically, the section about essential climate science probes students' understanding of the principles of climate, their ability to connect greenhouse effect with emissions and to differentiate between natural warming cycles and human caused cycles.

*Section 5: People and the planet*

This section includes questions about students' understanding of climate change, implications for themselves, their family, community, and others. Questions ask whether global warming is an engineering issue, how to best solve the issue, what actions should be taken, whether or not they believe they can make a difference, and what sources of information influence their opinions about climate change the most. The questions were modeled from prior national surveys such as the Yale Project on Climate Change Communication (Leiserowitz et al., 2012; A. Leiserowitz et al., 2010) and the climate literacy survey from Clarkson University (DeWaters et al., 2012).

*Section 6: Demographic information*

We considered gender, race, ethnicity, parental education, and academic background (e.g. grades), and political affiliation. Gender was considered because males are more likely than females to report climate change denial (McCright, 2010; McCright & Dunlap, 2011). Races were considered because previous research suggests that both hispanics and blacks are more concerned about climate change (Enten, 2014; Krogstad, 2015) than whites. Although, additional studies found only a higher percentage of people concerned about climate change when grouped as minority groups (Schuldt & Pearson, 2016). Academic performance was considered because knowledge is a driver of concern about climate change, even when values are controlled (Shi et al., 2016). Political affiliation is also a highly correlated variable for the general population about climate change belief (Hornsey et al., 2016). Though, concern about climate change increases with education among Democrats, but decreases with education among Republicans

**Survey validation and distribution**

Ultimately the plan is to collect data through a national survey and advanced statistical techniques for analysis. This study is the first of its kind to explore how experiences in college impact students' sustainability beliefs. While this approach can provide generalizable trends about what happens during college and how it affects students' self-beliefs and long-term goals, it cannot provide causal information. Though it can give powerful information about the most influential experiences on students' attitudes at the end of college through multilevel models and effect size calculations.

We have currently conducted focus groups with students and STEM education experts to establish face and content validity of the survey. Also, we are currently pilot testing the survey with 200 students to establish evidence for reliability and validity conducting a test-retest study, allowing a two-week delay between administrations. The final step, will be a psychometric analysis of the survey for validity of latent constructs including calculating Cronbach's alpha, correlation matrices, and exploratory factor analysis. The current version of the survey is provided in the appendix of the paper.

**Conclusion**

Engineers play a vital role in developing more robust systems to address climate change. For example, manufacturing processes can reduce greenhouse emissions by developing closed-cycle loops that reduce waste (Clark, 2007), and stronger materials are needed to combat roadway buckling from increased temperatures, washouts from precipitation, and settling from thawing permafrost (*Potential Impacts of Climate Change on U.S. Transportation*, 2008). As the population continues to grow and place demands on the current environment, engineers are an essential part of solving the effects of climate change and must not only be aware of the issues related to this phenomena but empowered to make change to reduce and shift the impact of humans on the planet.

Education about climate change in engineering should represent these dynamic challenges with sustainability implications spanning communities, environment, and economies(*The Climate Change Educational Partnership*, 2014). Based on prior work we expect to identify strong relationships between students' college experience and critical engineering agency. When topics related to sustainability are included in these settings we expect to find an increase in student willingness to take action on climate change (McNeill & Vaughn, 2010). Peers are also likely to influence ones' own beliefs. We expect classroom pedagogy, for example, including opportunities for peer discussions to enhance engineering students' connection to understanding of global implications for sustainability. Out-of-classroom experiences including extracurricular activities and internships to strongly influence student learning outcomes. Positive experiences related to engineering (e.g., a community service project or an enjoyable internship) may lead to strong identity within engineering and shape student attitude that engineering can make an impact in their world and lead to a desire to solve climate and sustainability-related challenges in their career.

College experiences that strengthening the relationship between awareness of climate change and action to address its implications for sustainability will further develop the "T-shaped" engineer (i.e., engineers with both broad knowledge and deep technical expertise) and increase the number of U.S. educated students ready to tackle complex socio-technical challenges of national importance. This type of education closely fits the recommendations of leading organizations including the American Society for Engineering Education (ASEE, 1999), the National Academies of Engineering (NAE, 2005), the Environmental Protection Agency (EPA, 2007), and ABET (ABET, 2013). Knowing which experiences empower students to want to address climate change and its related issues will help U.S. educators attract and retain more students to the engineering profession. Training students to meet these challenges will provide a competitive advantage of U.S. engineering workforce over a growing population of lower-priced competitors with more narrow technical backgrounds (Friedman, 2008; Pink, 2005).

Our long-term vision is that this research becomes a catalyst for teaching about topics related to climate change and its implications for sustainability. Teaching will support students' critical engineering agency (e.g., empowerment and identity in engineering contexts) and beliefs about sustainability. Students' agency and beliefs may influence their career choice and expected career outcomes. As a result, we hypothesize that more engineering students will pursue careers to solve societal challenges that mitigate and prepare for climate change and its global implications for sustainability. Attached below is the survey instrument developed and currently undergoing validating and reliability testing.

**Acknowledgements**

This material is based upon work supported by the National Science Foundation under Grant No. 1635534. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

**References**

ABET. (2013). Criteria for accrediting engineering programs, 2014 - 2015. Retrieved from http://www.abet.org/eac-criteria-2014-2015/

Allenby, B., Murphy, C., Allen, D., & Davidson, C. (2009). Sustainable engineering education in the United States. *Sustainability Science*, *4*(1), 7–15. https://doi.org/10.1007/s11625-009-0065-5

Anderson, A. (2010). Combating climate change through quality education. Retrieved from http://dspace.cigilibrary.org/jspui/handle/123456789/29684

Andersson, B., & Wallin, A. (2000). Students' understanding of the greenhouse effect, the societal consequences of reducing CO2 emissions and the problem of ozone layer depletion. *Journal of Research in Science Teaching*, *37*(10), 1096–1111. https://doi.org/10.1002/1098-2736(200012)37:10<1096::AID-TEA4>3.0.CO;2-8

ASEE. (1999). ASEE Statement on Sustainable Development Education. Retrieved February 12, 2009, from http://www.asee.org/about/Sustainable_Development.cfm

Basu, S. J., & Calabrese Barton, A. (2009). Critical physics agency: further unraveling the intersections of subject matter knowledge, learning, and taking action. *Cultural Studies of Science Education*, *4*(2), 387–392.

Basu, S. J., Calabrese Barton, A., Clairmont, N., & Locke, D. (2008). Developing a framework for critical science agency through a case study in a conceptual physics context. *Cultural Studies of Science Education.*, *4*(2), 373–378. https://doi.org/10.1007/s11422-008-9135-8

Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change? *Public Understanding of Science*, *9*(3), 205–218. https://doi.org/10.1088/0963-6625/9/3/301

Boyes, E., & Stanisstreet, M. (1993). The "Greenhouse Effect": children's perceptions of causes, consequences and cures. *International Journal of Science Education*, *15*(5), 531–552. https://doi.org/10.1080/0950069930150507

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What Kind of a Girl Does Science? The Construction of School Science Identities. *Journal of Research in Science Teaching*, *37*(5), 441–458. https://doi.org/10.1002/(SICI)1098-2736(200005)37:5<441::AID-TEA4>3.0.CO;2-3

Brundtland, G. H. (1987). *Our common future*. Oxford University Press, USA.

Clark, G. (2007). Evolution of the global sustainable consumption and production policy and the United Nations Environment Programme's (UNEP) supporting activities. *Journal of Cleaner Production*, *15*(6), 492–498. https://doi.org/10.1016/j.jclepro.2006.05.017

Davidson, C. I., Matthews, H. S., Hendrickson, C. T., Bridges, M. W., Allenby, B. R., Crittenden, J. C., … Austin, S. (2007). Adding sustainability to the engineer's toolbox: a challenge for engineering educators. *Environmental Science & Technology*, *41*(14), 4847–4850.

DeWaters, J., Powers, S., Dhaniyala, S., & Small, M. (2012). Evaluating Changes in Climate Literacy among Middle and High School Students who Participate in Climate Change Education Modules. *AGU Fall Meeting Abstracts*, *13*. Retrieved from http://adsabs.harvard.edu/abs/2012AGUFMED13C0791D

Enten, H. (2014, September 23). The Racial Gap On Global Warming. Retrieved from http://fivethirtyeight.com/datalab/the-racial-gap-on-global-warming/

EPA. (2007). What is green engineering. Retrieved February 28, 2009, from http://www.epa.gov/oppt/greenengineering/pubs/whats_ge.html

Friedman, T. L. (2008). *Hot, Flat, and Crowded: Why We Need a Green Revolution--and How It Can Renew America* (1st ed.). Farrar, Straus and Giroux.

Gambro, J. S., & Switzky, H. N. (1996). A National Survey of High School Students' Environmental Knowledge. *The Journal of Environmental Education*, *27*(3), 28–33. https://doi.org/10.1080/00958964.1996.9941464

Godwin, A. (2016a). The Development and Measurement of Engineering Identity. In *American Society for Engineering Education Annual Conference & Exposition* (p. 13). New Orleans, LA.

Godwin, A. (2016b). The Development and Measurement of Engineering Identity. In *Proceedings from ASEE 2016: American Society for Engineering Education Annual Conference & Exposition* (p. submitted). New Orleans.

Godwin, A., Potvin, G., & Hazari, Z. (2013). The Development of Critical Engineering Agency, Identity, and the Impact on Engineering Career Choices. In *American Society for Engineering Education Annual Conference & Exposition* (pp. 1–14). Atlanta, GA: ASEE.

Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2013). Understanding Engineering Identity Through Structural Equation Modeling. In *Frontiers in Education Conference (FIE)* (p. 7). Oklahoma City, OK.

Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, Critical Agency, and Engineering Careers: An Affective Model Engineering Choice. *Journal of Engineering Education*, In Press.

Gross, N., & Simmons, S. (Eds.). (2014). *Professors and Their Politics*. Baltimore, Maryland: Johns Hopkins University Press.

Hall, M., Mckemy, D., & Lee, A. (2013). Global Warming vs. Climate Change | Climate Education Modules for K-12. Retrieved February 5, 2017, from http://climate.ncsu.edu/edu/k12/.gwvcc

Hamilton, L. C. (2011). Education, politics and opinions about climate change evidence for interaction effects. *Climatic Change*, *104*(2), 231–242. https://doi.org/10.1007/s10584-010-9957-8

Hart. (2012). *2012 Survey Of America's College Students*. Washington, D.C.: Panetta Institute For Public Policy.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching.*, *47*(8), 978–1003. https://doi.org/10.1002/tea.20363

Hoffman, A. J. (2011). Sociology: The growing climate divide. *Nature Climate Change*, *1*(4), 195–196. https://doi.org/10.1038/nclimate1144

Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change*, *6*(6), 622–626. https://doi.org/10.1038/nclimate2943

Huntzinger, D. N., Hutchins, M. J., Gierke, J. S., & Sutherland, J. W. (2007). Enabling sustainable thinking in undergraduate engineering education. *International Journal of Engineering Education*, *23*, 218–230.

Hurtado, S. (2012). *Your First College Year Survey 2011*. Higher Education Research Institute: UCLA. Retrieved from http://www.heri.ucla.edu/PDFs/pubs/briefs/YFCYBrief2011.pdf

Johnson, A., Brown, J., Carlone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, *48*(4), 339–366. https://doi.org/10.1002/tea.20411

Kaminsky, J., Casias, C., Javernick-Will, A., & Leslie, C. (2012). Expected Outcomes of a Construction Career: Gender Identity and Engineers Without Borders-USA. In *Construction Research Congress 2012* (pp. 2071–2080). American Society of Civil Engineers.

Karl, T. R. (2009). *Global Climate Change Impacts in the United States*. Cambridge University Press.

Klotz, L., Hazari, Z., & Potvin, G. (2010, 2013). GSE/RES:Sustainability topics as a route to female recruitment in engineering (#1036617). Retrieved from http://www.nsf.gov/awardsearch/showAward?AWD_ID=1036617

Klotz, L., Potvin, G., Godwin, A., Cribbs, J., Hazari, Z., & Barclay, N. (2014). Sustainability as a Route to Broadening Participation in Engineering. *Journal of Engineering Education*, *103*(1), 137–153. https://doi.org/10.1002/jee.20034

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/13504620220145401

Krogstad, J. (2015, February 27). Hispanics more likely than whites to say global warming is caused by humans. Retrieved from http://www.pewresearch.org/fact-tank/2015/02/27/hispanics-more-likely-than-whites-to-say-global-warming-is-caused-by-humans/

Lefsrud, L. M., & Meyer, R. E. (2012). Science or Science Fiction? Professionals' Discursive Construction of Climate Change. *Organization Studies*, *33*(11), 1477–1506. https://doi.org/10.1177/0170840612463317

Leiserowitz, A., Maibach, E., Roser-Renouf, C., & Hmielowski, J. D. (2012). *Climate change in the American Mind: Americans' global warming beliefs and attitudes in March 2012, Yale University and George Mason University, New Haven, CT: Yale Project on Climate Change Communication,[web document](2012)*.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., & Smith, N. (2010). Climate change in the American Mind: Americans' global warming beliefs and attitudes in January 2010. *Yale University and George Mason University. New Have: CT. Yale Project on Climate Change. Available at: Http://Environment. Yale. Edu/Uploads/AmericansGlobalWarmingBeliefs2010. Pdf Accessed 4th June*. Retrieved from http://e360.yale.edu/images/digest/AmericansGlobalWarmingBeliefs2010.pdf

Leiserowitz, A., Maibach, E. W., Roser-Renouf, C., Feinberg, G. D., & Rosenthal, S. (2016). *Politics and Global Warming, Spring 2016*. Yale. Retrieved from http://climatecommunication.yale.edu/publications/politics-global-warming-spring-2016/

Mariani, M. D., & Hewitt, G. J. (2008). Indoctrination U.? Faculty Ideology and Changes in Student Political Orientation. *PS: Political Science and Politics*, *41*(4), 773–783.

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, *32*(1), 66–87. https://doi.org/10.1007/s11111-010-0113-1

McCright, A. M., & Dunlap, R. E. (2011). Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environmental Change*, *21*(4), 1163–1172. https://doi.org/10.1016/j.gloenvcha.2011.06.003

McNeill, K. L., & Vaughn, M. H. (2010). Urban High School Students' Critical Science Agency: Conceptual Understandings and Environmental Actions Around Climate Change. *Research in Science Education*, *42*(2), 373–399. https://doi.org/10.1007/s11165-010-9202-5

Mihelcic, J. R., Phillips, L. D., & Watkins Jr, D. W. (2006). Integrating a global perspective into education and research: Engineering international sustainable development. *Environmental Engineering Science*, *23*(3), 426–438.

NAE. (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. Washington, D.C.: The National Academies Press.

Nagel, J. (2011). Climate Change, Public Opinion, and the Military Security Complex. *Sociological Quarterly*, *52*(2), 203–210. https://doi.org/10.1111/j.1533-8525.2011.01200.x

National Academy of Engineering. (2008). *Grand challenges for engineering*. Washington, DC: National Academy of Engineering.

National Research Council. (2010). *Adapting to the Impacts of Climate Change*. Washington D.C.: The National Academies of Sciences, Engineering, and Medicine. Retrieved from http://www.nap.edu/catalog/12783/adapting-to-the-impacts-of-climate-change

NOAA. (2009). *Climate Literacy: The Essential Principles of Climate Sciences*.

Pink, D. H. (2005). *A Whole New Mind: Moving from the Information Age to the Conceptual Age*. Riverhead Hardcover.

*Potential Impacts of Climate Change on U.S. Transportation*. (2008). Transportation Research Board.

Potvin, Hazari, Klotz, Godwin, Lock, Cribbs, & Barclay. (2013). Disciplinary Differences in Engineering Students' Aspirations and Self-Perceptions. Presented at the ASEE Annual Conference, Atlanta, GA. Retrieved from http://www.asee.org/public/conferences/20/papers/7350/view

Pruneau, Khattabi, A., & Demers, M. (2010). Challenges and Possibilities in Climate Change Education. *Online Submission*. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED514727

Schuldt, J. P., & Pearson, A. R. (2016). The role of race and ethnicity in climate change polarization: evidence from a U.S. national survey experiment. *Climatic Change*, *136*(3–4), 495–505. https://doi.org/10.1007/s10584-016-1631-3

Sellmann, D. (2014). Environmental education on climate change in a botanical garden: adolescents' knowledge, attitudes and conceptions. *Environmental Education Research*, *20*(2), 286–287. https://doi.org/10.1080/13504622.2013.870130

Shealy, T., Valdes-Vasquez, R., Klotz, L., Potvin, G., Godwin, A., Cribbs, J., & Hazari, Z. (2016). Half of Students Interested in Civil Engineering Do Not Believe in Anthropogenic Climate Change. *Journal of Professional Issues in Engineering Education and Practice*, *0*(0), D4016003. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000323

Shealy, T., Valdes-Vasquez, R., Klotz, L., Potvin, G., Hazari, Z., Cribbs, J., & Godwin, A. (2015). Career Outcome Expectations Related to Sustainability among Students Intending to Major in Civil Engineering. *Journal of Professional Issues in Engineering Education and Practice*, *0*(0), 4015008. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000253

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2009). Seventh Grade Students' Conceptions of Global Warming and Climate Change. *Environmental Education Research*, *15*(5), 549–570.

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2010). Students' conceptions about the greenhouse effect, global warming, and climate change. *Climatic Change*, *104*(3–4), 481–507. https://doi.org/10.1007/s10584-009-9786-9

Shi, J., Visschers, V. H. M., Siegrist, M., & Arvai, J. (2016). Knowledge as a driver of public perceptions about climate change reassessed. *Nature Climate Change*, *6*(8), 759–762. https://doi.org/10.1038/nclimate2997

Skamp, K., Boyes, E., & Stanisstreet, M. (2013). Beliefs and Willingness to Act About Global Warming: Where to Focus Science Pedagogy? *Science Education*, *97*(2), 191–217. https://doi.org/10.1002/sce.21050

Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M. M., Allen, S. K., Boschung, J., … Midgley, P. M. (2013). Climate Change 2013 The Physical Science Basis. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Frontmatter_FINAL.pdf

*The Climate Change Educational Partnership: Climate Change, Engineered Systems, and Society: A Report of Three Workshops*. (2014). Washington, D.C.: National Academies Press. Retrieved from http://www.nap.edu/catalog/18957

United Nations. (2015). *Sustainable Development Goals*. United Nations Department of Public Information. Retrieved from https://sustainabledevelopment.un.org/?menu=1300

United States Global Change Research Program. (2009). *Climate Literacy: The Essential Principles of Climate Sciences*. NASA. Retrieved from https://pmm.nasa.gov/education/articles/climate-literacy-essential-principles-climate-sciences

Watson, M., Noyes, C., & Rodgers, M. (2013). Student Perceptions of Sustainability Education in Civil and Environmental Engineering at the Georgia Institute of Technology. *Journal of Professional Issues in Engineering Education and Practice*, *139*(3), 235–243. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000156

Wibeck, V. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. *Environmental Education Research*, *20*(3), 387–411. https://doi.org/10.1080/13504622.2013.812720

## Virginia Tech & Purdue University

# CLIMATE Survey

## Climate change literacy, engineering identity, career motivation, and student agency through engineering

Informational Regarding Participation

We are interested in your experiences through engineering that inform your understanding about climate change, your identity as an engineer, motivation for your future career, and agency as an engineer. By filling out this questionnaire, you will help us find ways to improve engineering education for future students. Please make your best estimate for each item and answer as many questions as possible. There are no right or wrong answers, just do your best. Some questions will not apply to your experiences and can be left blank (e.g. questions about a course you have not taken). Please note:

- You must be 18 years or older to participate.
- The survey will take approximately 20 minutes to complete.
- Participation is voluntary. You may withdraw at any time.
- Participation will NOT impact your grade in this course in any way.
- You will be asked for contact information (email) in case we want to follow-up on some of your survey responses. This information is voluntary and will not be shared with any third party.
- If you have any questions or concerns, please contact Tripp Shealy (tshealy@vt.edu)
- Participants may contact the Virginia Tech Office of Research Compliance if they have any questions regarding their rights as research participants.

Thank you for your time and insight.

To protect your privacy, your name will NOT be mentioned in our study.

---

Tripp Shealy, Ph.D.
tshealy@vt.edu

This project is funded by the National Science Foundation, grant number NSF 1635534.

**SECTION 1: YOUR CAREER GOALS**

**1. Rank the top 3 disciplines you are MOST likely to enter upon graduation:** (Select one per column)

| | Extremely likely (1) | Somewhat (2) | Maybe (3) |
|---|---|---|---|
| Aerospace/Ocean/Astro Engineering | O | O | O |
| Agricultural/Biological/Biological Systems Engineering | O | O | O |
| Bioengineering/Biomedical Engineering | O | O | O |
| Civil Engineering (non-structural) | O | O | O |
| Chemical Engineering | O | O | O |
| Construction Engineering / Management | O | O | O |
| Computer Engineering | O | O | O |
| Electrical Engineering | O | O | O |
| Environmental/Ecological Engineering | O | O | O |
| Industrial/Systems Engineering | O | O | O |
| Materials Engineering | O | O | O |
| Mechanical/ Manufacturing Engineering | O | O | O |
| Mining Engineering | O | O | O |
| Nuclear Engineering | O | O | O |
| Software Engineering/Computer Science | O | O | O |
| Structural/Architectural Engineering | O | O | O |
| Other engineering | O | O | O |
| Business (non-engineering role) | O | O | O |
| Medical (non-engineering role) | O | O | O |
| Other (non-engineering) | O | O | O |

**2. How likely is it that you will enter one of the following sectors?**

| | Not at all likely - 0 | 1 | 2 | 3 | 4 –Extremely likely |
|---|---|---|---|---|---|
| Private/Corporate | O | O | O | O | O |
| Non-profit/NGO | O | O | O | O | O |
| Government/Public Policy | O | O | O | O | O |
| Education | O | O | O | O | O |
| Entrepreneurship/Start-Up | O | O | O | O | O |
| Healthcare | O | O | O | O | O |
| Military | O | O | O | O | O |
| Other | O | O | O | O | O |

**3. How likely is it that you will enter graduate school in the next five years? (mark all that apply)**

| | |
|---|---|
| O | MA/MS (non-engineering) |
| O | ME/MS (engineering) |
| O | PhD (engineering) |
| O | MBA |
| O | JD (Law) |
| O | MD |
| O | Other |

**4. How important are the following factors for your future career satisfaction?**

| | Not at all important - 0 | 1 | 2 | 3 | 4 -Very important |
|---|---|---|---|---|---|
| Making money | O | O | O | O | O |
| Becoming well known | O | O | O | O | O |
| Helping others | O | O | O | O | O |
| Supervising others | O | O | O | O | O |
| Having job security and opportunity | O | O | O | O | O |
| Working with people | O | O | O | O | O |
| Inventing /designing things | O | O | O | O | O |
| Developing new knowledge and skills | O | O | O | O | O |
| Having lots of personal and family time | O | O | O | O | O |
| Having an easy job | O | O | O | O | O |
| Being in an exciting environment | O | O | O | O | O |
| Solving societal problems | O | O | O | O | O |
| Making use of my talents and abilities | O | O | O | O | O |

| | | | | | |
|---|---|---|---|---|---|
| Doing hands-on work | O | O | O | O | O |
| Applying math and science | O | O | O | O | O |

**5. Which of these topics, if any, do you hope to directly address in your career? (*Mark all that apply)***

| | | | |
|---|---|---|---|
| O | Energy (supply or demand) | O | Water supply (e.g. shortages, pollution) |
| O | Disease | O | Food availability |
| O | Poverty and distribution of wealth and resources | O | Opportunities for future generations |
| O | Climate change | O | Opportunities for women and/or minorities |
| O | Terrorism and war | O | Environmental degradation |

## SECTION 2: YOUR COLLEGE EXPERIENCES

**6. While an undergraduate, have you done (or are you currently doing) any of the following?**

| | Never | Limited | Half a semester | One full semester | More than one full semester |
|---|---|---|---|---|---|
| Conducted engineering research with a faculty member | O | O | O | O | O |
| Conducted sustainability-related research with a faculty member | O | O | O | O | O |
| Participated in study abroad | O | O | O | O | O |
| Been involved with a disciplinary-specific society | O | O | O | O | O |
| Worked in developing countries | O | O | O | O | O |
| Worked for an engineering company as an intern/co-op | O | O | O | O | O |
| Worked on a student engineering design team | O | O | O | O | O |
| Lived in a residential or dorm-based engineering program/engineering living-learning community | O | O | O | O | O |
| Contributed as a member of an organization for women and/or minorities in engineering | O | O | O | O | O |
| Acted as a member of an outreach club (i.e. Habitat for Humanity, Engineers Without Borders) | O | O | O | O | O |
| Participated in an organization that focuses on environmental sustainability | O | O | O | O | O |
| Work-study or other type of job to help pay for your college education | O | O | O | O | O |

**7. Please indicate whether the following topics were covered in your courses. (*Mark all that apply)***

| | Discipline specific engineering | Engineering elective | Non engineering elective | Other Course(s) |
|---|---|---|---|---|
| Energy supply (e.g. fossil fuels, nuclear, solar, wind) | O | O | O | O |
| Energy demand (e.g. in buildings, transportation) | O | O | O | O |
| Climate change | O | O | O | O |
| Terrorism & war | O | O | O | O |
| Water supply (e.g. shortages, pollution, conflict) | O | O | O | O |
| Population growth | O | O | O | O |
| Food availability | O | O | O | O |
| Disease | O | O | O | O |
| Poverty and distribution of wealth and resources | O | O | O | O |
| Sustainable development | O | O | O | O |
| Life cycle analysis | O | O | O | O |
| Bio-mimicry | O | O | O | O |
| Environmental degradation | O | O | O | O |
| Providing opportunities for future generations | O | O | O | O |
| Female pioneers in engineering | O | O | O | O |
| Under-representation of females in engineering | O | O | O | O |
| Under-representation of racial minorities in engineering | O | O | O | O |
| Engineering careers, stages, or options | O | O | O | O |
| Benefits of becoming an engineer | O | O | O | O |
| Students' stories about engineering/science | O | O | O | O |
| Teachers' stories about their engineering/science experience | O | O | O | O |

**8. Please indicate how often the following occurred in your most recent engineering design course:**

| | Never | Rarely | Monthly | Weekly | Daily |
|---|---|---|---|---|---|
| The teacher lectured to the class | O | O | O | O | O |
| We spent time doing individual work in class | O | O | O | O | O |
| Concepts/ideas were introduced before formulas/equations | O | O | O | O | O |
| We spent time doing small group activities | O | O | O | O | O |
| We worked on labs or projects | O | O | O | O | O |
| Classmates taught each other | O | O | O | O | O |
| Whole-class discussions were held | O | O | O | O | O |
| The teacher did demonstrations | O | O | O | O | O |
| Topics were relevant to my career goals | O | O | O | O | O |
| You asked questions, answered questions, or made comments | O | O | O | O | O |
| Teacher called on students for responses (not voluntary) | O | O | O | O | O |
| Other students asked questions, answered questions, or made comments | O | O | O | O | O |

**SECTION 3: ABOUT YOU**

**9. Please indicate below the extent to which the following reasons apply to why you chose to major in engineering:**

| | Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|---|
| I like solving problems | O | O | O | O | O |
| Engineers make more money than most other professionals | O | O | O | O | O |
| Engineers help people | O | O | O | O | O |
| I am good at math and science | O | O | O | O | O |
| My parent(s) want me to be an engineer | O | O | O | O | O |
| An engineering degree will guarantee me a job when I graduate | O | O | O | O | O |
| I think engineering is fun | O | O | O | O | O |
| I like to figure out how things work | O | O | O | O | O |
| A faculty member, academic advisor, teaching assistant or other university affiliated person has encouraged and/or inspired me to study engineering | O | O | O | O | O |

**10. How confident are you in your ability to do the following:**

| | Not confident at all 0 | 1 | 2 | 3 | 4 Very confident |
|---|---|---|---|---|---|
| Apply knowledge of math, science, and engineering | O | O | O | O | O |
| Design an experiment then analyze and interpret the data | O | O | O | O | O |
| Design a system/process/component to meet desired needs | O | O | O | O | O |
| Contribute to an interdisciplinary team | O | O | O | O | O |
| Identify, formulate, and solve engineering problems | O | O | O | O | O |
| Understand professional and ethical responsibility | O | O | O | O | O |
| Communicate effectively | O | O | O | O | O |
| Understand the impacts of engineering solutions on society | O | O | O | O | O |
| Continue to learn after college | O | O | O | O | O |
| Be knowledgeable of current events and issues | O | O | O | O | O |
| Use techniques, skills, and tools necessary for engineering practice | O | O | O | O | O |

**11. In your opinion, to what extent are the following associated with the field of engineering?**

| | Not at all 0 | 1 | 2 | 3 | 4 Very much so |
|---|---|---|---|---|---|
| Creating economic growth | O | O | O | O | O |
| Preserving national security | O | O | O | O | O |
| Improving quality of life | O | O | O | O | O |
| Saving lives | O | O | O | O | O |
| Caring for communities | O | O | O | O | O |
| Protecting the environment | O | O | O | O | O |
| Including women as participants in the field | O | O | O | O | O |
| Including racial and ethnic minorities as participants in the field | O | O | O | O | O |
| Addressing societal concerns | O | O | O | O | O |
| Feeling a moral obligation to other people | O | O | O | O | O |

**12. To what extent do you agree or disagree with the following statements:**

| Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|
| I see myself as an engineer | O | O | O | O | O |
| My professors see me as an engineer | O | O | O | O | O |
| My peers see me as an engineer | O | O | O | O | O |
| My parents/relatives/friends see me as an engineer | O | O | O | O | O |
| I have had experiences in which I was recognized as an engineer | O | O | O | O | O |
| I am interested in learning more about engineering | O | O | O | O | O |
| I find fulfillment in doing engineering | O | O | O | O | O |
| I enjoy learning my chosen engineering discipline | O | O | O | O | O |
| I am interested in continuing to improve my engineering skills | O | O | O | O | O |
| I am confident I will become a skilled engineer | O | O | O | O | O |
| I understand concepts I have studied in engineering classes | O | O | O | O | O |
| I can do well on engineering exams | O | O | O | O | O |
| Others ask me for help in my classes | O | O | O | O | O |
| I understand concepts I have studied in engineering | O | O | O | O | O |
| I can overcome setbacks in my engineering courses | O | O | O | O | O |

**13. To what extent do you disagree or agree with the following:**

| Strongly Disagree 0 | 1 | 2 | 3 | 4 Strongly Agree |
|---|---|---|---|---|
| I notice the little things in life that others do not | O | O | O | O | O |
| I seek input from those with a different perspective from me | O | O | O | O | O |
| I believe understanding culture and context is a necessary part of engineering | O | O | O | O | O |
| I see engineering as a scientific process: developing a hypothesis and testing solutions | O | O | O | O | O |
| I believe there is always a better solution to an existing engineering problem | O | O | O | O | O |
| I can effortlessly understand points of view that differ from my own | O | O | O | O | O |
| I analyze relationships broadly to find a solution that will have the greatest impact | O | O | O | O | O |
| When problem solving, I focus on the relationship between issues | O | O | O | O | O |
| I like to use multiple tools and software to illustrate my ideas | O | O | O | O | O |
| I brainstorm multiple methods before I begin problem solving | O | O | O | O | O |
| Doing engineering design requires me to test many concepts | O | O | O | O | O |
| I seek feedback and suggestions for personal improvement | O | O | O | O | O |
| I hope to gain general knowledge across multiple fields | O | O | O | O | O |
| I frequently reflect on my mistakes to learn from them | O | O | O | O | O |
| I try to formulate and test a range of solutions when doing engineering | O | O | O | O | O |
| I enjoy building prototypes and testing them | O | O | O | O | O |

**14. To what extent do you disagree or agree with the following:**

| Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|
| I can make a change in my community with engineering | O | O | O | O | O |
| Engineering can improve our society | O | O | O | O | O |
| Engineering can improve quality of life | O | O | O | O | O |
| Engineering can be a resource for my community | O | O | O | O | O |
| I can make an impact in people's lives through engineering | O | O | O | O | O |
| Engineering can improve the quality of life in my community | O | O | O | O | O |
| Engineering knowledge is for the advancement of human welfare | O | O | O | O | O |
| Engineering will give me the tools and resources to make an impact on my community | O | O | O | O | O |

**15. To what extent do you disagree or agree with the following:**

| Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|
| We can pursue sustainability without lowering our standard of living | O | O | O | O | O |
| I have the knowledge to understand most sustainability issues | O | O | O | O | O |
| I feel a responsibility to deal with environmental problems | O | O | O | O | O |
| Pursuit of sustainability will threaten jobs for people like me | O | O | O | O | O |
| Sustainable options typically cost more | O | O | O | O | O |

| | | | | | |
|---|---|---|---|---|---|
| We should be taking stronger actions to address climate change | O | O | O | O | O |
| I can personally contribute to a sustainable future | O | O | O | O | O |
| Nothing I can do will make things better in other places on the planet | O | O | O | O | O |

**SECTION 4: CLIMATE SCIENCE**

**16. How much do you agree or disagree with the following statements about global warming and climate change:**

| | Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|---|
| I am sure that global warming is happening | O | O | O | O | O |
| Global warming is caused by humans | O | O | O | O | O |
| I do not believe global warming is occurring | O | O | O | O | O |
| I am not worried about global warming | O | O | O | O | O |
| Global warming is an important issue to me personally | O | O | O | O | O |
| My opinions about global warming are not changing | O | O | O | O | O |

**17. How much do you agree or disagree with the following statements about Earth's climate:**

| | Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|---|
| The Earth's climate has remained pretty much the same for millions of years | O | O | O | O | O |
| Global warming is happening because too many of the sun's rays get to the earth | O | O | O | O | O |
| Global climate change is accelerated by the melting of snow and ice covered surfaces | O | O | O | O | O |
| If human civilization had never developed on Earth, there would be no greenhouse effect | O | O | O | O | O |
| Climate and weather are basically the same thing | O | O | O | O | O |

**18. How much do you agree or disagree with the following statements about greenhouse effect, global warming, and climate:**

| | Strongly disagree 0 | 1 | 2 | 3 | 4 Strongly agree |
|---|---|---|---|---|---|
| The greenhouse effect and global climate change are the same thing | O | O | O | O | O |
| An increase in the greenhouse effect is causing global climate change | O | O | O | O | O |
| The greenhouse effect and global climate change are likely unrelated | O | O | O | O | O |
| Global climate change is causing an increase in the greenhouse effect | O | O | O | O | O |
| There is no definite proof that either the greenhouse effect or global climate change exist | O | O | O | O | O |

**19. Which of the following…(mark only one per row)**

| | Carbon dioxide CO2 | Water vapor H2O | Methane CH4 | Oxygen O2 | Ozone O3 |
|---|---|---|---|---|---|
| is the most abundant greenhouse gas? | O | O | O | O | O |
| amplifies the greenhouse gas effect most? | O | O | O | O | O |
| should we be most concerned about when thinking about global warming? | O | O | O | O | O |

**20. Please answer to the best of your knowledge:**

| | 0-10 | 11-30 | 31-50 | 51-70 | 71-90 | 91-100% |
|---|---|---|---|---|---|---|
| What percentage of climate scientists think that human-caused global warming is happening? | O | O | O | O | O | O |

**SECTION 5. PEOPLE AND THE PLANET**

**21. Global warming will start to have serious impacts on…**

| | Now | 10yrs | 25yrs | 50yrs | Never |
|---|---|---|---|---|---|
| Me personally | O | O | O | O | O |
| My family | O | O | O | O | O |
| People in my community | O | O | O | O | O |
| People in the United States | O | O | O | O | O |
| People in other modern industrialized countries | O | O | O | O | O |
| People in developing countries | O | O | O | O | O |
| Plant and animal species | O | O | O | O | O |
| The world's poor | O | O | O | O | O |
| The natural environment | O | O | O | O | O |

**22. To what extent do you agree with the following:**

| | Strongly Disagree 0 | 1 | 2 | 3 | 4 Strongly Agree |
|---|---|---|---|---|---|
| We are approaching the limit of the number of people the Earth can support | O | O | O | O | O |
| When humans interfere with nature it often produces disastrous consequences | O | O | O | O | O |
| Humans are seriously abusing the environment | O | O | O | O | O |
| Plants and animals have as much right as humans to exist | O | O | O | O | O |
| Despite our special abilities, humans are still subject to the laws of nature | O | O | O | O | O |
| The Earth is like a spaceship with very limited room and resources | O | O | O | O | O |
| The balance of nature is very delicate and easily upset | O | O | O | O | O |
| If things continue on their present course, we will soon experience a major ecological catastrophe. | O | O | O | O | O |

**23. I believe that global warming is a(n)…**

| | Strongly Disagree 0 | 1 | 2 | 3 | 4 Strongly Agree |
|---|---|---|---|---|---|
| environmental issue | O | O | O | O | O |
| moral issue | O | O | O | O | O |
| religious issue | O | O | O | O | O |
| social justice (fairness issue) | O | O | O | O | O |
| political issue | O | O | O | O | O |
| scientific issue | O | O | O | O | O |
| engineering issue | O | O | O | O | O |
| health issue | O | O | O | O | O |
| economic issue | O | O | O | O | O |
| national security issue | O | O | O | O | O |
| agricultural (farming, food) issue | O | O | O | O | O |
| poverty issue | O | O | O | O | O |

**24. I believe that a cause of global climate change is…**

| | Strongly Disagree 0 | 1 | 2 | 3 | 4 Strongly Agree |
|---|---|---|---|---|---|
| Burning fossil fuels | O | O | O | O | O |
| Nuclear power generation | O | O | O | O | O |
| The ozone hole in the upper atmosphere | O | O | O | O | O |
| Livestock production | O | O | O | O | O |
| Dumping trash into our oceans | O | O | O | O | O |
| Waste rotting in our landfills | O | O | O | O | O |
| Agricultural use of chemical fertilizers | O | O | O | O | O |
| Deforestation | O | O | O | O | O |
| Volcanic Eruptions | O | O | O | O | O |
| Acid Rain | O | O | O | O | O |

**25. I believe a way to help reduce or slow down climate change is…**

| | Strongly Disagree 0 | 1 | 2 | 3 | 4 Strongly Agree |
|---|---|---|---|---|---|
| Building more nuclear power stations instead of coal power stations | O | O | O | O | O |
| Planting more trees in the world | O | O | O | O | O |
| Making more of our electricity from renewable energy resources | O | O | O | O | O |
| Recycling more | O | O | O | O | O |
| Not wasting electricity | O | O | O | O | O |
| Fertilizing the oceans to make algae grow | O | O | O | O | O |
| Reducing air pollution from toxic chemicals | O | O | O | O | O |
| Changing lifestyles to reduce consumption | O | O | O | O | O |
| Limiting the use of aerosol spray cans | O | O | O | O | O |
| Increasing public transportation | O | O | O | O | O |
| Eating less meat | O | O | O | O | O |

**26. How interested are you in working on the following solutions in your career?**

| | Not very interested | 0 | 1 | 2 | 3 | 4 | Very Interested |
|---|---|---|---|---|---|---|---|
| Redesigning conventional processes in order to minimize energy consumption | | O | O | O | O | O | |
| Developing technologies that improve energy efficiency | | O | O | O | O | O | |
| Creating ways to reduce carbon dioxide emissions | | O | O | O | O | O | |
| Spreading sustainability awareness in your community | | O | O | O | O | O | |
| Working on renewable energy technologies, such as solar and wind power | | O | O | O | O | O | |
| Improving infrastructure to make it more resilient to extreme weather | | O | O | O | O | O | |
| Working alongside local government to create legislation to mitigate climate change | | O | O | O | O | O | |
| Redesigning conventional processes in order to minimize waste production | | O | O | O | O | O | |

**27. Which of the following has contributed the most to your understanding of global climate change?**

| | Not at all - 0 | 1 | 2 | 3 | 4 –A lot |
|---|---|---|---|---|---|
| College courses (professors, textbooks) | O | O | O | O | O |
| Internet, books, newspapers, or magazines I have read on my own | O | O | O | O | O |
| Friends or family members (including parents) | O | O | O | O | O |
| Scientific/academic publications | O | O | O | O | O |
| Climate scientists | O | O | O | O | O |
| Mainstream media | O | O | O | O | O |

**SECTION 6: DEMOGRAPHIC QUESTIONS**

**28. What is your current major field of study? Please choose only one of the following:**

| | |
|---|---|
| O | Aerospace/Ocean/Astro Engineering |
| O | Agricultural/Biological/Biological Systems Engineering |
| O | Bioengineering/Biomedical Engineering |
| O | Civil Engineering (non-structural) |
| O | Chemical Engineering |
| O | Construction Engineering/Management |
| O | Computer Engineering |
| O | Electrical Engineering |
| O | Engineering Physics |
| O | Environmental/Ecological Engineering |
| O | Industrial/Systems Engineering |
| O | Materials Engineering |
| O | Mechanical/ Manufacturing Engineering |
| O | Mining Engineering |
| O | Nuclear Engineering |
| O | Software Engineering/Computer Science |
| O | Structural/Architectural Engineering |
| O | General engineering |

**29. Did you have a minor or concentration related to sustainability?** O Yes O No

**30. What year are you in college?** O 1st year O 2nd year O 3rd year O 4th year O 5th year O Other

`

**31. What have your in-major grades been up to now at this institution?**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| O | A | O | A- | O | B+ | O | B | O | B- |
| O | C+ | O | C | O | C- | O | D or lower | | |

**32. Generally speaking, do you usually think of yourself as a republican, a democrat, an independent, or something else?**
O Republican O Democrat O Independent O Other

**33. What is your religious affiliation?**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| O | Christian | O | Jewish | O | Atheist | O | Nothing |
| O | Muslim | O | Catholic | O | Agnostic | O | Prefer not to answer |
| O | Hindu | O | Latter Day Saints | O | Spiritual, but not committed to a particular faith | O | Other |
| O | Buddhist | | | | | | |

**34. Which of the following people have contributed to your selection of a career path? (*Mark all that apply)***

| | | | | | |
|---|---|---|---|---|---|
| O | Mother/female guardian | O | Father/male guardian | O | Siblings |
| O | Other relative | O | Sports coach | O | Contact with someone in that major/career |
| O | High school counselor /teacher | O | University counselor | O | University professor |

**35. What was the highest level of education for your parents/guardians?**

| | Less than high school diploma | High school diploma/GED | Some college or associate/trade degree | Bachelor's degree | Master's degree or higher | Don't know |
|---|---|---|---|---|---|---|
| Male parent/guardian | O | O | O | O | O | O |
| Female parent/guardian | O | O | O | O | O | O |

**36. What is your gender?** O Female O Male O Non-binary O Not listed O Prefer not to answer

**37. What is your sexual orientation?** O Straight/Heterosexual O Gay or Lesbian O Bisexual O Not listed O Prefer not to answer

**38. With which races/ethnicities do you identify? (*Mark all that apply)***

| | | | |
|---|---|---|---|
| O | African-American or Black | O | Caucasian or White |
| O | South Asian (e.g. Indian, Pakistani, Bangladeshi, Sri Lankan, etc.) | O | East Asian (e.g. Chinese, Korean, Japanese, etc.) |
| O | Other Asian | O | Native Hawaiian or Pacific Islander |
| O | American Indian or Alaskan Native | O | Other_____ |
| O | Hispanic/Latino | | |

**39. To help us estimate the size of the community you come from, please provide your home ZIP Code. _____**

**40. Would you be willing to receive an invitation to participate in a short follow-up survey next year?**
O Yes, my email address is _____ O No