

INVESTIGATING THE PERCEPTION OF CONSTRUCTION SCIENCE STUDENTS
REGARDING THE URGENCY FOR SUSTAINABLE CONSTRUCTION:
A CASE STUDY IN TEXAS

A Thesis

by

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ABSTRACT

The Construction Industry impacts the environment worldwide and will affect the future of following generations. A complex network of stakeholders ranging from government agencies to investors, designers, contractors and suppliers deals with decision-making processes that impact each other's interests and the environment simultaneously.

Altogether, their actions can either alleviate or worsen climate change. It is therefore important to assess the level of awareness of students in programs related to the Construction Industry regarding sustainability, climate change and the power of the industry of which they will soon become part. Could absence of risk perception be the key factor causing personal detachment from these topics? This study anonymously surveyed 193 graduate and undergraduate students from the Department of Construction Science at Texas A&M University, one of the largest student bodies in this field in the United States. Several common misconceptions concerning the definition, causes and potential effects of climate change were identified among their responses. The project's criteria classified 26% of all respondents as 'informed' of climate change, revealing an overall need for enhancement in formal education towards sustainable construction and environmental sustainability in the program's structure.

DEDICATION

I would like to dedicate this achievement to my parents, Marvin F. Hirsch and Maria das Graças S. Leal, for their invaluable support to my goals of furthering my level of formal education and broadening the horizons of my professional career. They supported me throughout the entire process in a variety of ways and words cannot express how grateful I am for everything they have done for me to the present date.

I also would like to sincerely thank my sister, Diana N. Hirsch, whose active ‘lobby’ to influence my decision of studying in Texas in the U.S. was followed by countless support and generosity, helping me a lot in the process.

Lastly, I would also like to dedicate the completion of this work to my lovely Luisa Senne, for all her love and for the willingness of aligning her life goals to mine. She was as present and supportive in my life as she could possibly have been during the years I was at Texas A&M University.

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This project was supervised by a thesis committee consisting of Dr. Zofia Rybkowski – as the Committee Chair – and Dr. Manish Dixit of the Department of Construction Science, and Dr. Liliana Beltran, of the Department of Architecture.

The data collection for this study is largely attributed to the help of Mrs. Elizabeth (Liz) Smith and Mrs. Shelley Smith, in communicating with the department's students behalf of our research committee. It would have been very difficult to achieve the study's sample size without their involvement.

All other work conducted for the thesis was completed by the student independently.

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NOMENCLATURE

CC	Climate change
CI	Construction industry
COSC	Construction Science
ES	Environmental Science
GD	Graduate(s)
SU	Sustainability
TAMU	Texas A&M University
UG	Undergraduate(s)
US	United States

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1. INTRODUCTION

This study explored the mindset of a specific group of young individuals who will likely rise to assume influential positions in jobs related to the Construction Industry and whose decisions can critically impact the environment's long-term health.

Sustainability-related surveys on campuses typically target diverse populations regarding universities' procedures toward sustainability. This study specifically targeted Construction Science students to assess their level of awareness about the construction industry's power to influence climate change. Understanding how they view the relationship between climate change and action in the construction industry as a whole, if any, is one of the paths to guide the enhancement of formal education in this field.

The concept of climate change relates to fluctuations in the mean and/or the variability of the climate's characteristics that occur for a continued duration, usually for decades or more. Climate change is attributed to a combination of relentless anthropogenic activity impacting the composition of the atmosphere and the land use, and natural internal processes, including volcanic eruptions (IPCC 2014). Another definition of climate change, by the Framework Convention on Climate Change (UNFCCC), in its Article 1, describes the process as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". Hence, the UNFCCC proposes that human-related activities

impacting the atmospheric composition and climate variability deriving from natural causes can be distinguished.

Data collected from a variety of fields suggests that concern leads to risk management decisions. People fail to consider measures of precaution if they do not perceive imminent hazards or risks. Personal experiences directly determine the evaluation of reckless choices. Phenomena with a low likelihood of occurrence generate less concern than their probability usually justifies but generate more concern than they deserve in the uncommon events when they do occur. Exposure to severe and conspicuous effects of climate change is gradually becoming more frequent worldwide (Weber 2006).

Hawken et al. (2013) point out that not everyone comprehends the dimension or urgency of the simultaneous crises that affect the world in a variety of forms. Business and political leaders lament about the theoretically elevated cost of protecting the environment, the short and long-term benefits, and unavoidable costs of green procedures and diminishing returns of investment (ROI) in sustainable sources of energy. Therefore, the number of citizens who acknowledge the evolution of climate change remains in doubt and leads one to question the true motivations of entrepreneurs and influential leaders who continuously deny and question scientific evidence in the field. As Dryzeck (1997) expressed, environmental problems do not announce themselves as if they were within clearly labeled containers – declaring the presence of radiation, heavy metal pollution, depletion of the ozone layer, for example.

It is crucial to understand that environmental preservation can be achieved through consumer demand for green and environmentally friendly commercial processes and products. The path to sustainable consumption from this point of view derives from rational, environmentally conscious consumers who make decisions based on personal values (Ottman 1993). “Environmentally conscious consumers” are those who are willing to dedicate time and resources to express concern for the environment. In addition to rejecting products known to be poor in terms of energy efficiency, some consumers have positioned themselves to be against consumption (Lee et al. 2009). Because reusing minimizes the unnecessary disposal of products (Cherrier 2010), it rubs against all three processes that define consumption: acquisition, usage, and disposition (Holbrook 1987).

A significant gap persists between the pace in which the natural environment is decaying and the agonizingly lethargic rate at which individual consumers and companies are carrying out fundamental adjustments. However, independent of how slow the process of transformation or how difficult companies try to make it, this resistance will not stop the renewal of commercial tendencies. Businesses engage in processes of transformation influenced by social and biological forces that can no longer be avoided or diminished (Hawken 2010). The detachment from sustainable practices demonstrated by a large number of citizens and by the vast majority of corporations worldwide often generates uncertainty regarding the entire debate towards sustainable development. Such a scenario is comparable to the ‘crossing the chasm’ concept developed by Moore (2014), in the sense that climate change awareness has likely not

yet reached a consensus among the population sufficient to stimulate behavioral changes. Therefore, the population is simultaneously hesitant to adhere to sustainable attitudes and practices because one expects to see noteworthy changes among others to feel motivated to reconsider personal daily habits. This phenomenon causes consumers and firms to fall within the “late-majority” group, which will only adopt a specific line of thought “when most people have made the switch and it becomes really inconvenient to ignore it” (Moore 2014).

Countries that have experienced unpredictable hydrological hazards learned the importance of sustainable development after harsh natural events caused social hardship, health challenges, injury, and death. One might then ask: Do hurricanes alter Americans’ concerns about natural threats in the United States? Moreover, will Americans consider associating climate change with sustainability after experiencing two level 4 hurricanes in one year (e.g. 2017 Texas (Harvey), and Florida (Irma))?

1.1 Research Goals

The underlying goal of this project was to collect data that could serve as guidance for the Department of Construction Science at Texas A&M University to make inferences, evaluations and decisions regarding possible changes in the program’s core and elective courses. Such revisions to the graduate and undergraduate programs’ structure would focus in enhancing education toward sustainable construction and environmental sustainability.

1.2 Problem Statement

In light of mounting evidence regarding climate change and the role played by the construction industry, this research investigated the mindset of students from the Department of Construction Science (COSC) at Texas A&M University as a case study to determine if education should be enhanced in fields related to sustainable construction and environmental sustainability within programs related to construction science.

1.3 Assumptions

The main assumption tested by this survey's questions concerned whether students' overall level of awareness regarding climate change was "sufficient", according to the criteria established by the lead researcher – see section "6: Conclusion". One objective is to investigate if changes should be considered in the COSC program to address this matter. Secondary questions that were tested regarded analyses of answer trends among program levels at the Department of Construction Science to test if answers would present considerably different patterns among GD and UG level students, as suggested by prior published research studies. One of the questions investigated was whether male and female respondents presented distinct patterns of responses; this was to test the results obtained by Tuncer (2008) and Bord and O'Connor (1997). This research also investigated if exposure to previous education regarding environmental science influenced respondents' attitudes towards sustainability.

1.4 Limitations of Study

Although this study was conducted in a construction program with a total population of over one thousand students, the responses obtained in this survey cannot be considered to represent the entire range of construction science and/or management programs nationwide.

However, as the study reached a statistically significant sample size for this study (see chapter “4 – Results”), the results can be considered to reasonably reflect the general attitudes of Construction Science students at Texas A&M University.

2. LITERATURE REVIEW

Industrialized societies have typically viewed the environment as external to human nature over the past two centuries, mainly to be used and reaped, with the exception of selected areas for preservation as parks and forests. Environmental issues were mostly perceived to represent regional concerns. One underlying concept was that any relationship between people and the environment was represented as mankind's victory over nature (Dryzeck 1997). The belief that technology and human knowledge could defeat natural and environmental challenges seems to be comforting. Expected consequences of climate change include droughts, hurricanes, rising of temperatures and ocean levels, and their catastrophic effects that mostly strike poor populations. It is a commonly held assumption that solutions for complex issues resulting from climate change and related events will eventually show up (Hopwood et al. 2005). However, scientists, researchers and ecologists advocate in favor of the environment and consider that the harvest of natural resources in a sustainable manner is a wiser posture than simply betting on optimistic predictions. Many argue that if continuous growth in world population and its needs are not accomplished with more sustainable procedures, future generations will inherit a scenario of depleted natural resources that cannot be easily restored.

A number of factors can potentially influence the attitudes toward sustainability, including: (i) a nation's per capita income, average level of education and health; (ii) geographical location, in the form of regional availability of natural resources and

exposure to natural phenomena, and (iii) specific cultural habits, a subjective yet influential element that involves historical and religious use of natural resources, among other motivations. The belief that a higher percentage of educated citizenry leads to a more ecologically aware society is not true for many developed countries. As a matter of fact, some of the most developed nations in the world carry the largest ecological footprints (Rees and Wackernagel 1998).

Tuncer et al. (2008) observed that men demonstrate less concern about the environment than women. However, Bord and O'Connor (1997) argued that differences are a result of a variable vulnerability perception with regard to nature-related risks and are not specifically worries regarding ecological fragility. Their conclusion was that when potential risks to health and to one's well-being were attributed to nature-related problems, the levels of concern for women typically overcome those demonstrated by men.

Surveys performed on university campuses tend to cover a broad scope of matters within the topic of sustainability and are usually targeting the impressions of a diverse population regarding policies implemented on campus, with respect to sustainability. Tuncer (2008) studied college students in Turkey in which gender clearly was one of the factors influencing students' impressions of sustainable development. Girls presented a higher level of sensibility toward sustainable development when compared to boys. This conclusion was similar to the ones obtained by Loughland et al. (2003). Interestingly, Tuncer (2008) found that enrollment in an environmental course

did not play a role in influencing student attitudes with respect to sustainable development.

A relevant consideration is that overall support of sustainable actions does not indicate that survey participants comprehend the multiple facets of sustainability. Gaps in knowledge can be observed in surveys when it comes to a student's understanding of terms related to the field of sustainability. However, sustainability is most typically only associated with concerns about the environment. The economic and social domains of sustainable development are still marginal in the minds of many (WCED 1987). Researchers often use terms such as inclusion, diversity, democracy and participation to characterize education for sustainability. However, these only appear occasionally or not at all in keywords sections of papers (Kagawa 2007; Sterling 2004).

In their studies, Hoffman et al. (2008) concluded that our psychological and social mindsets bias our impressions with respect to green construction and present obstacles to complete adoption — and we frequently fail to identify why. Hence, design that favors the environment will continue to stall if the psychological aspects are not better explored. In 2007, the chair of the Building Owners and Managers Association (BOMA) International, Brenna Walraven, declared: “In no more than five years—and maybe in as little as 24 to 36 months—you will face a competitive disadvantage if your building is not green and operating efficiently” (Lockwood 2007). However, quite a few years passed before the numbers of ecologically designed building projects actually became significant. Regardless of accomplishments in the financial and technical aspects of green buildings, the United States' Green Building Council (USGBC) had only

certified about 1,000 buildings between LEED's inauguration in 1998 and the year of 2007 (Hoffman et al. 2008). The square footage of commercial construction that was registered to receive LEED certification rose from 3% in 2002 (Hoffman et al. 2008) to 6% in 2008. At that time, it accounted for a relatively limited portion of the 170,000 commercial buildings and 1.8 million homes that were erected on average per year over that time span in the US (Hoffman et al. 2008). Eventually, LEED became the world's most widely used green building rating system over the years, and in 2016 it had been applied to approximately 80,000 projects in 162 countries, including more than 32,500 certified commercial projects (Tufts 2016). Despite this, one wonders if the recent growth in LEED certification has more to do with genuine environmental concern or the drive to earn notability by market-savvy developers.

For example, a significant portion of the studies have analyzed motivations towards sustainable development on corporate sustainable measures. A study conducted by Tollin and Vej (2012) explored typical commercial lines of thought. Through a comprehensive analysis of ten managers' mindsets, the authors aimed to understand the depth at which sustainability affected companies' marketing strategies. Similarly, a research project developed by Ditillo and Lisi (2016) analyzed the extent to which a firm's management procedures are directly influenced by adhering to sustainability-oriented changes in current and future operations. At corporate and industrial levels, a thorough evaluation of which factors determine important turning points or might produce significant impact in chain processes must take place before a business plunges

into cool looking ideas and attempts the implementation of innovative measures (Ditillo and Lisi 2016).

According to Black and Cherrier (2010), such a strong focus on large scale consumption entities appears to create a public perception that only corporate and industrial groups are culprits for climate change. However, as Black and Cherrier (2010) point out, almost no credit is given to the capacity of the combined efforts of billions of small volume consumers worldwide.

3. METHODOLOGY

To understand current attitudes of Texas A&M (College Station) Construction Science students toward sustainability, graduate (Masters and PhD) and undergraduate students were invited to complete a survey. Permission to administer the survey was first secured by Texas A&M University's Institutional Review Board (#1025-2018). The survey was offered in two versions—on-line and paper-based. The paper-based survey represented a printed version of the online survey, with identical questions and in the same order. The online version of the survey was offered in two phases; the first phase was administered from November 15th, 2018 to December 14th, 2018, and the second phase was administered from February 8th, 2019 to March 1st, 2019. The paper-based survey was administered in the building of the Department of Construction Science (Francis Hall), at Texas A&M University in College Station, Texas, and was offered to students taking four lecture courses between February 27th, 2019 and March 8th, 2019.

The online survey process consisted of contacting Construction Science students through their university e-mails and inviting them to voluntarily become part of the study by answering the online survey, making use of their own personal devices (i.e. laptops, tablets or mobile phones). The paper-based version of the survey was also voluntary. Students were assured anonymity and were required to provide their university e-mails for the sole purpose of limiting responses to one participation per respondent. Individual student level of knowledge about climate change and sustainability was measured via their responses to a total of fourteen questions, separated

into two sections, following an introduction section with demographic questions. The survey questions varied in type of response, quantity of alternatives and whether a response was mandatory.

The climate change section had seven questions, and focused on: students' awareness of potential effects of climate change; their predictions of how intensely and when such effects could impact themselves and future generations of their family; their perception of local and global impacts of climate change and their perception of necessity and, if so, urgency for action in the Construction Industry. The Sustainability section had six questions and focused on: knowledge about sustainability and identifying its three pillars (Economic, Social and Environmental); and impact of previous environmental sciences classes in their attitude toward sustainability and their opinion on whether formal education regarding environmental sustainability should be enhanced in the Department of Construction Science. The last question of the survey had an open-ended question in which students could input any comments they wished. The full version of the survey can be seen in **Appendix A** of this document.

The responses obtained in this study were stored in the online survey tool's database and were accessed only by the lead researcher. Data collected from paper-based versions of the survey were inputted into the online survey's database for the purposes of analyses, comparisons, and protection of theft and loss of the data collected. Responses to open-ended questions are available in **Appendix B** of this document. The questions that served as basis for the analysis of the original goals of this study and the inferences described in chapter "5 – Discussion" are displayed in this chapter.

4. RESULTS

4.1 Demographics

This study reached a sample size of 193 respondents out of a total of 1,044 graduate and undergraduate students enrolled in the Department of Construction Science while the survey was active, yielding a response rate of 18.48%. Participation of students from other fields was encouraged. However, their responses were not included among the data provided by the target population of this research (i.e. specifically students of the College of Architecture's Department of Construction Science).

A breakdown of the sample population is represented in Figures 1, 2, 3, 4, and 5. A noteworthy fact is the contrast in diversity among the student populations in the graduate and in the undergraduate programs of the Department of Construction Science. The undergraduate level program comprises a relatively homogeneous population, of which only 3.86% (39/1010) of students are international students, while the graduate program comprises a diversified population with students from a total of 10 countries. The sample population for this study reflects such trends: respondents indicating the US as their country of origin accounted for 92.81% of the undergraduate responses and for 7.69% of the graduate responses.

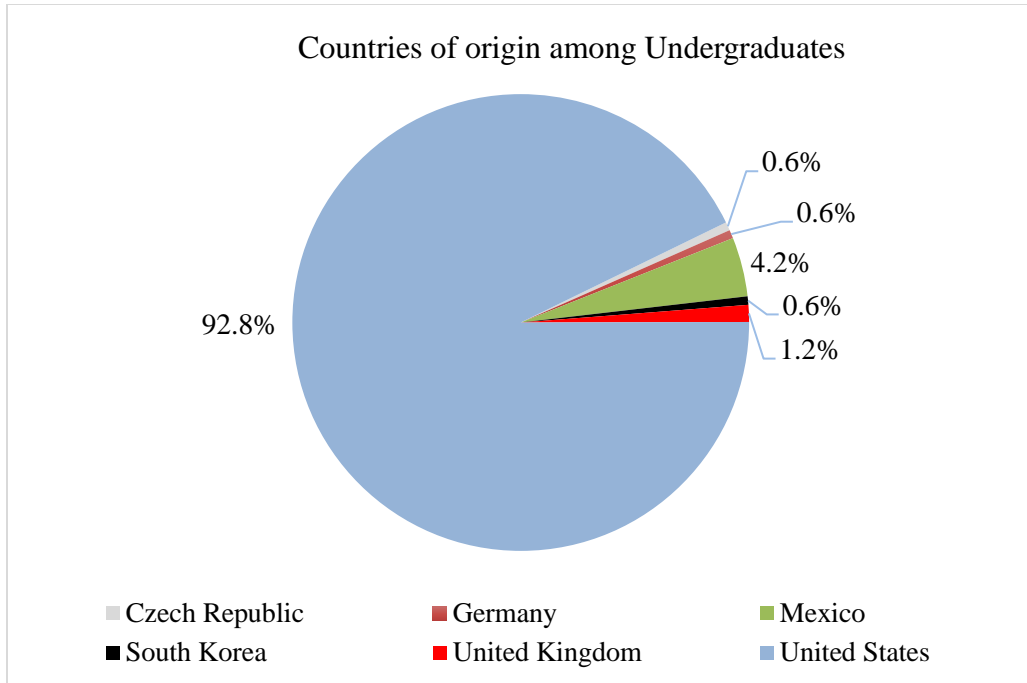


Figure 1 Countries of origin among undergraduate level respondents.

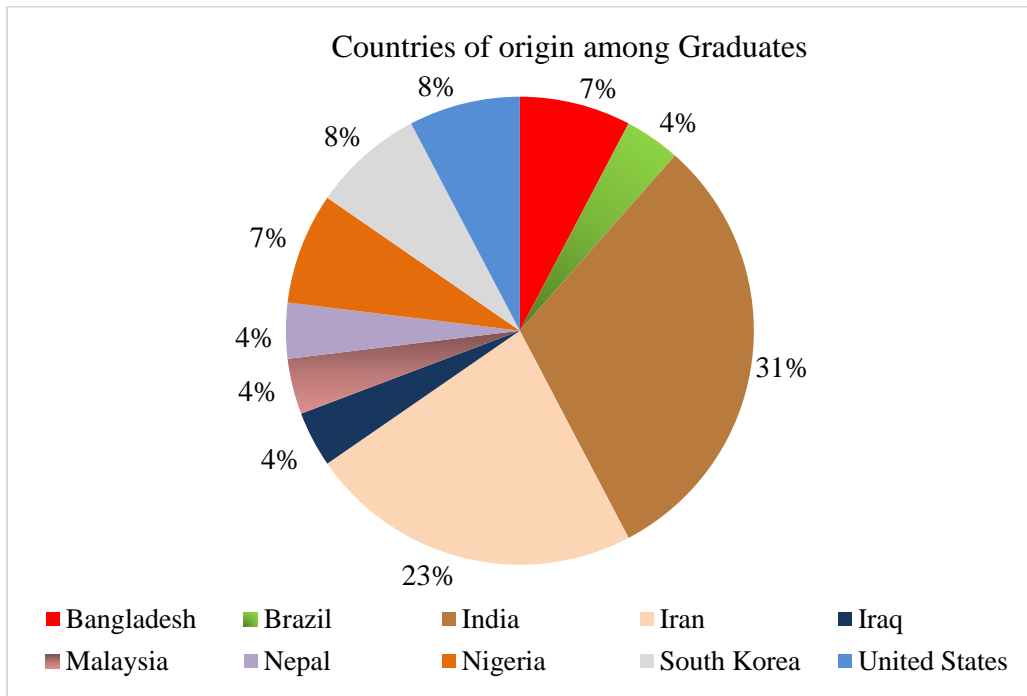


Figure 2 Countries of origin among graduate level respondents.

Participation was proportionally higher among graduate level students than it was at the undergraduate level. The graduate programs (GD – Masters and Ph.D.) account for a total of 34 students within the entire population, resulting in a 76.47% response rate to the survey among graduates (26 out of 34), versus a 16.53% response rate among undergraduates (UG – 167 out of 1010).

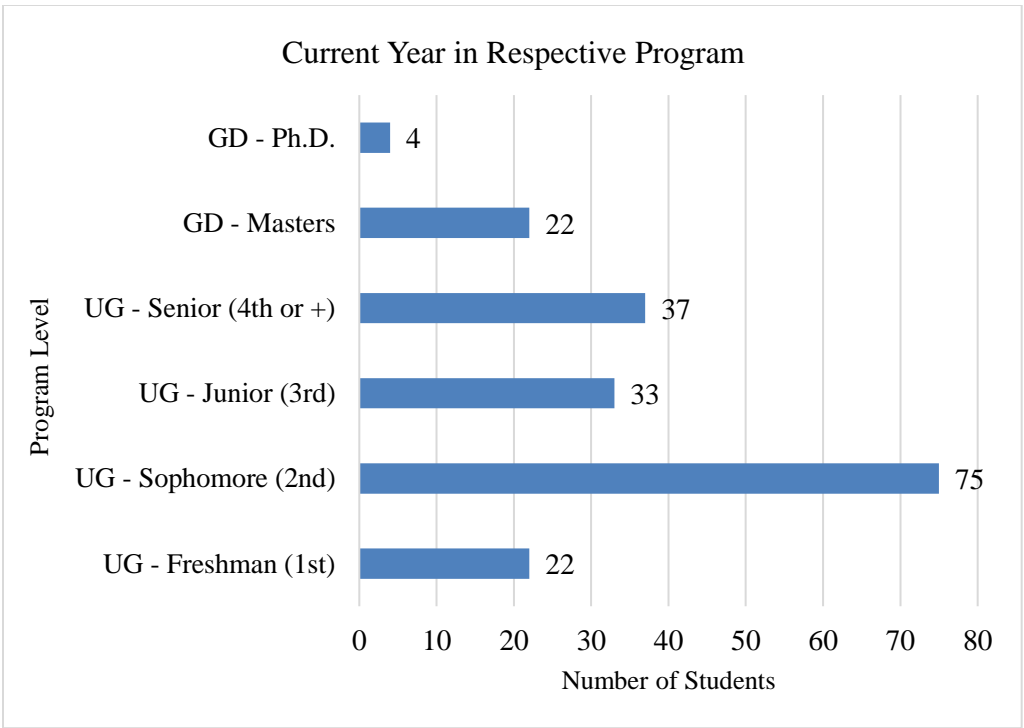


Figure 3 Year and program in which respondents were enrolled in during the surveying period.

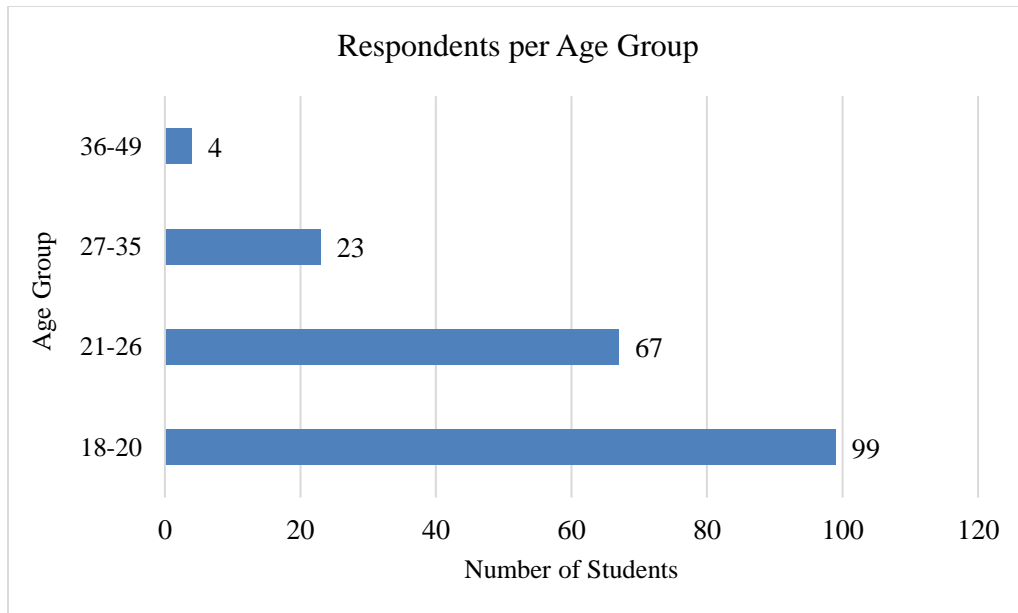


Figure 4 Age group distribution of respondents within the sample of respondents.

Another demographic trend regarding the Department of Construction Science’s student population that presented a degree of similarity in the sample of respondents to the survey relates to the gender distribution. The percentage of female students enrolled in the graduate level programs in this department is approximately 32% (11 out of 34) and approximately 9% in the undergraduate program. From the sample’s data regarding the gender of respondents for this study, female students represent comparable groups among all responses: 44.44% (8 out of 18) of graduate level respondents and 14.38% (21 out of 146) of the undergraduate level respondents.

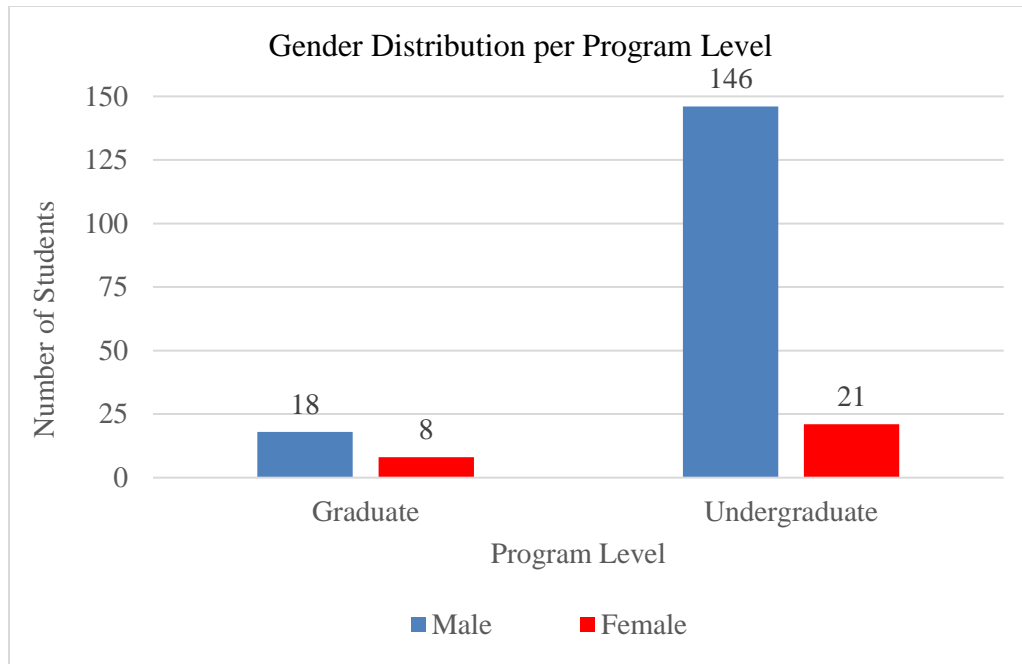


Figure 5 Gender and program level of students within the sample.

4.2 Climate Change

4.2.1 PERCEPTION OF INCIDENCE OF CLIMATE CHANGE EFFECTS

4.2.1.1 Personal and Intergenerational Exposure to climate change

The question displayed in figure 6 was developed with basis on a study developed by Akerlof et. al (2010). The Y-axis on Figure 6 enlists the five possible response alternatives to the question “Do you think climate change could affect...? You, Your children, Your grandchildren”, while the X axis indicates the number of times each option

was selected. With 91 selections, among a mean distribution of 3.34 and a standard deviation of 0.97, “a great deal” presented the highest number of selections among all options in Question 1 (Figure 7), regarding concern towards respondents’ generation of grandchildren. “A little” was the second most selected option in question 1, with 74 selections among a mean distribution of 2.97 and a standard deviation of 0.98, in which respondents attribute this option to potential climate change effects that they could personally face.

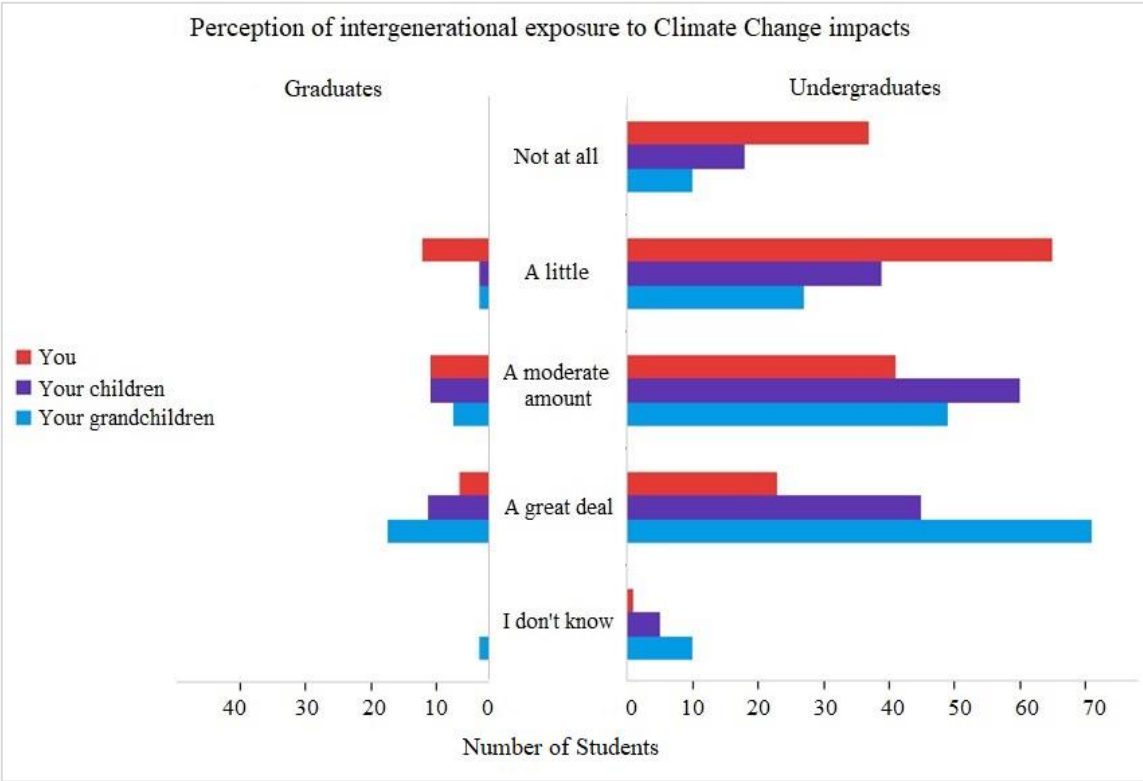


Figure 6 Respondents’ perception of personal and intergenerational exposure to CC impacts. (Question 1 of Appendix A)

4.2.1.2 Perception of local and global exposure to climate change

The question displayed in figure 7 was also developed with basis on a study developed by Akerlof et. al (2010). The previous five response alternatives were made available once again as possible answers to this question, as shown in the Y-axis of figure 7. However, this question refers to a perception of intensity of potential effects of CC and is entitled “If climate change is happening, how intensely do you think its effects would impact...? Your community, People in the US, People in other industrialized nations, People in developing countries, Future generations of people”. The X-axis in Figure 7 indicates the number of times each option was selected.

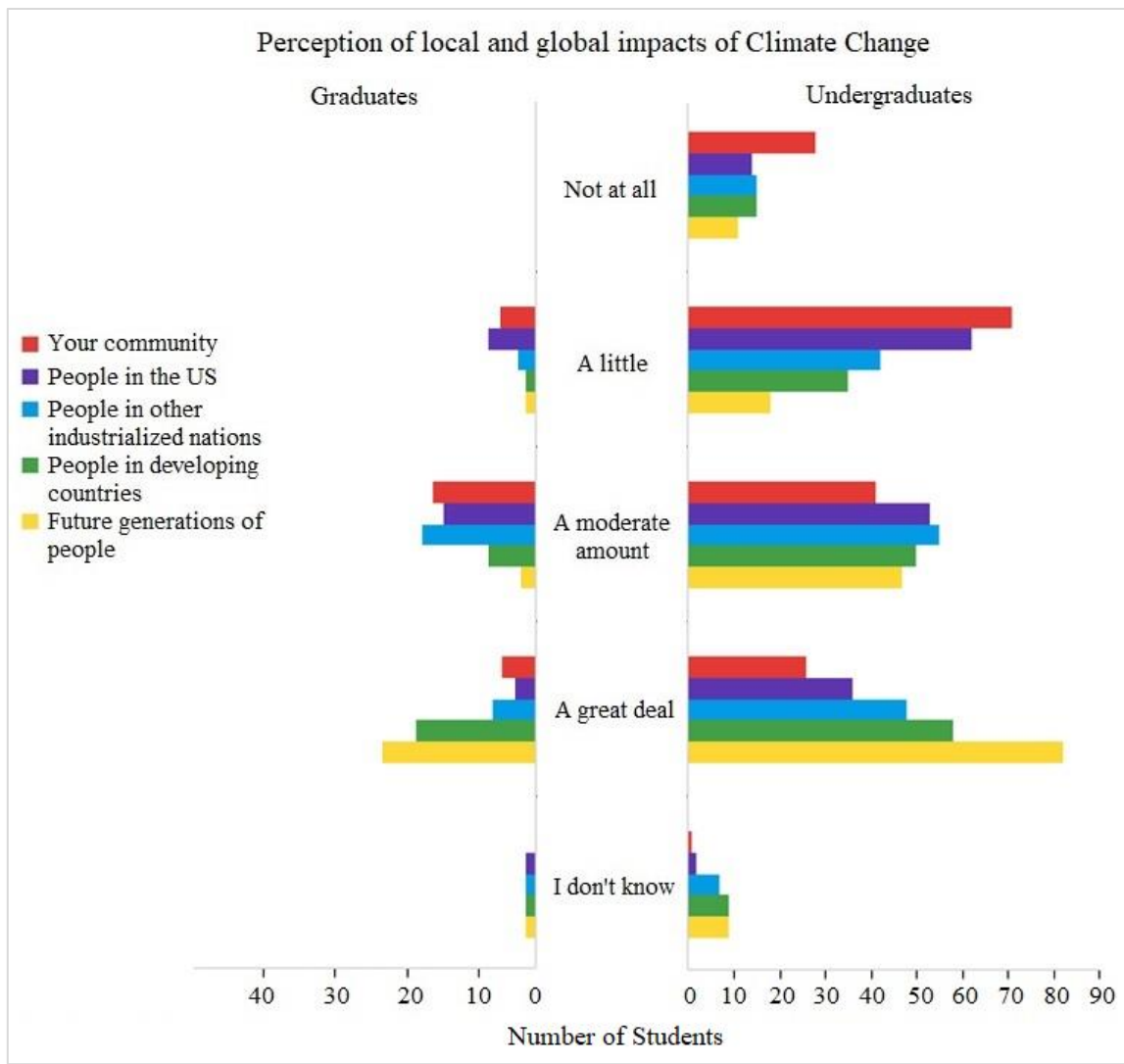


Figure 7 Respondents’ perception of local and global potential impacts of CC impacts.

(Question 2 of Appendix A)

Similarly, for the results observed in Question 1, a greater concern is expressed with respect to future generations of people. “A great deal” presented the highest number of selections among all options in question 2 of Appendix A and was selected 102 times, among a mean distribution of 3.42 and a standard deviation of 0.89. The option indicating

“A little” also was the second most selected option in question 2, with 76 selections, among a mean distribution of 2.51 and a standard deviation of 0.97, in which respondents refer to potential climate change effects upon the community they live in. Nevertheless, this option’s count was only 1 vote above the third most selected option, in which respondents indicated as “a great deal” their prediction of how intensely climate change could impact people in developing countries (mean = 3.15, standard deviation = 1.03).

Question 3 had an open-ended type of response and required respondents to describe, in their own words, what they believed climate change is. The answers provided by students to this question can be seen in Appendix B of this document.

4.2.2 AWARENESS OF CLIMATE CHANGE CAUSES AND EFFECTS

4.2.2.1 Classification of climate change causes

When asked “What do you think are the main causes of global climate change?”, more than half (103/193, 53.37%) of the respondents indicated they believe it is caused by humans only, while about one quarter of respondents attribute it to natural causes only (50/193, 25.91%). All respondents that denied climate change were undergraduate level students and represent 3.63% of the sample (7/193).

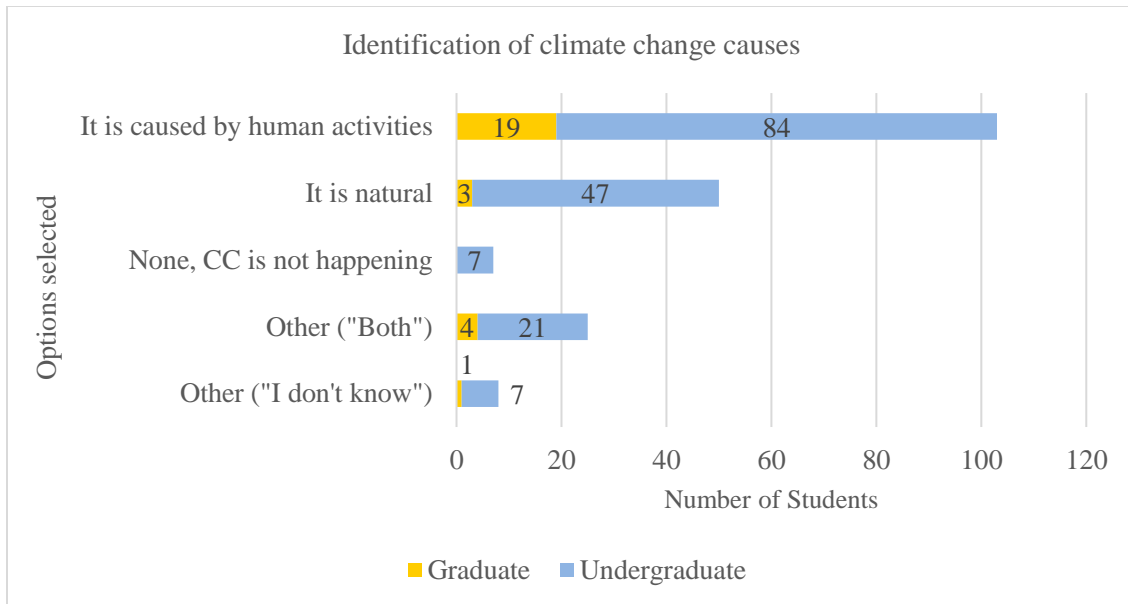


Figure 8 Respondents’ beliefs of the causes for climate change. (Question 4 of Appendix A)

Question 4 also included an open-ended option “Other” so participants could write in answers if desired. Some respondents (8/193, 4.14%) expressed indecision- or plainly stated “I don’t know”, since fulfilling the open-ended section of the “Other” option was mandatory to proceed to the next questions of the survey.

4.2.2.2 Identification of Potential Effects of climate change

A total of 8 options were available to the respondents when asked “Which of these could be considered potential effects of global climate change? Check all that apply”, and the distribution of their responses at the graduate and undergraduate level are shown in Figure 9.

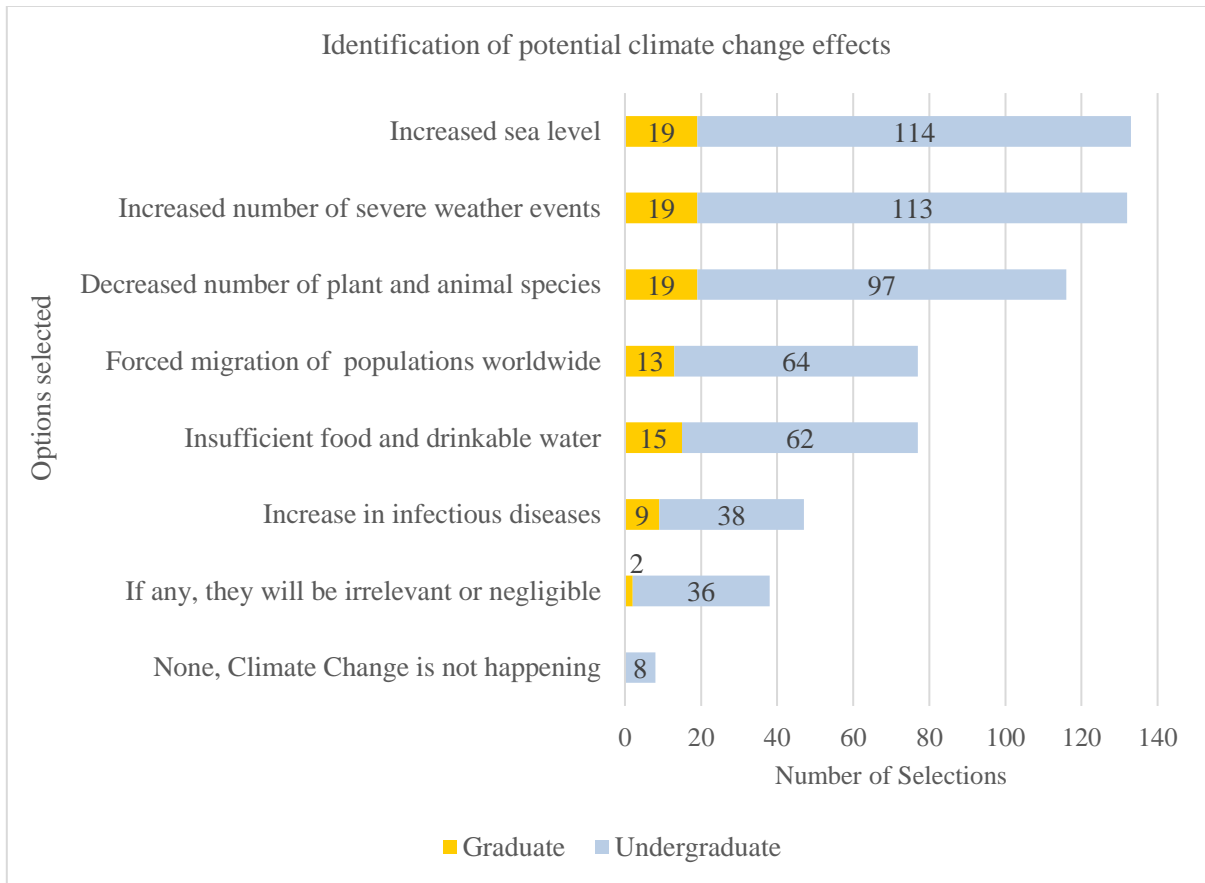


Figure 9 Respondents’ beliefs of the potential effects of climate change. (Question 5 of Appendix A)

From a total of 628 selections including all alternatives, the three most selected options by students at both program levels were nature-related only options: “Increased sea level” (133), “Increased number of severe weather events” (132) and “Decreased number of plant and animal species (116). Concern towards human health and well-being was observed in less than one third of the selections (32.01%, 201 selections). Seven (7) respondents selected the option “None, climate change is not happening” only as their response to this question; all were undergraduate level students.

4.2.3 SENSE OF INVOLVEMENT OF THE CONSTRUCTION INDUSTRY TO ADDRESS CLIMATE CHANGE AND URGENCY FOR ACTION

4.2.3.1 Evaluation of whether action is needed in the CI to address CC

Respondents were confronted with the question: “Do you think action is needed in the construction industry to address climate change?” and were prompted to select one out of four possible options.

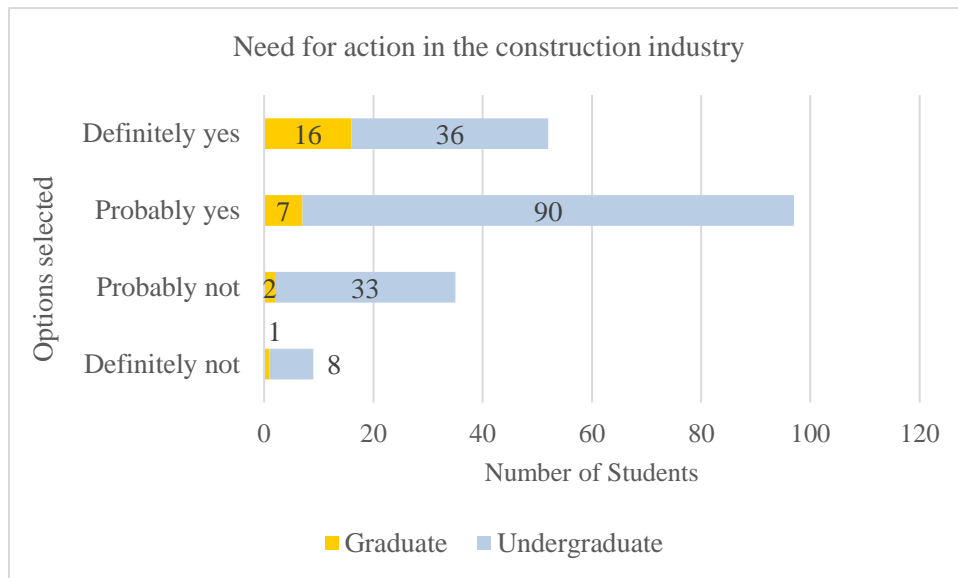


Figure 10 Perception of need for action in the construction industry to address climate change. (Question 6 of Appendix A)

More than 75% of all students expressed that action is certainly or probably needed in the industry (149/193, 75.25%). The distribution of responses between these options presented a different pattern than those observed in sections 4.2.1 and 4.2.2; in

this scenario, and the majority of each group did not select the same answer. While 61.53% of graduate students (16/26) are confident that action is needed in the construction industry to address climate change, the same opinion was shared by 21.56% (36/167) of the undergraduate students. The “probably yes” option was selected by 26.92% (7/26) of graduate students versus 53.89% (90/167) of undergraduate students.

Also contrasting the scenarios observed in sections 4.2.1 and 4.2.2, there was one graduate response among the certain denial category, selecting “Definitely not” as the response option, apart from other 8 undergraduate students. This group accounts for 4.66% of all responses (9/193).

4.2.3.2 Perception of urgency for action in the CI to address CC

Students’ understanding of the relationship between climate change and the construction industry was also evaluated via their perception of how urgent the action from this sector is, to mitigate potential impacts upon the natural environment.

As shown in Figure 11, the distribution pattern of graduate and undergraduate level responses to survey question 7 is uneven, with a mean of 5.25 and standard deviation of 2.93. Respondents who indicated 8 or more on a scale of 0-10 were classified by the research committee as highly concerned with this topic. More than half of the graduate students (53.84%, 14/26) indicated this level of concern, while this opinion was shared by 19.16% (32/167) of the undergraduate students.

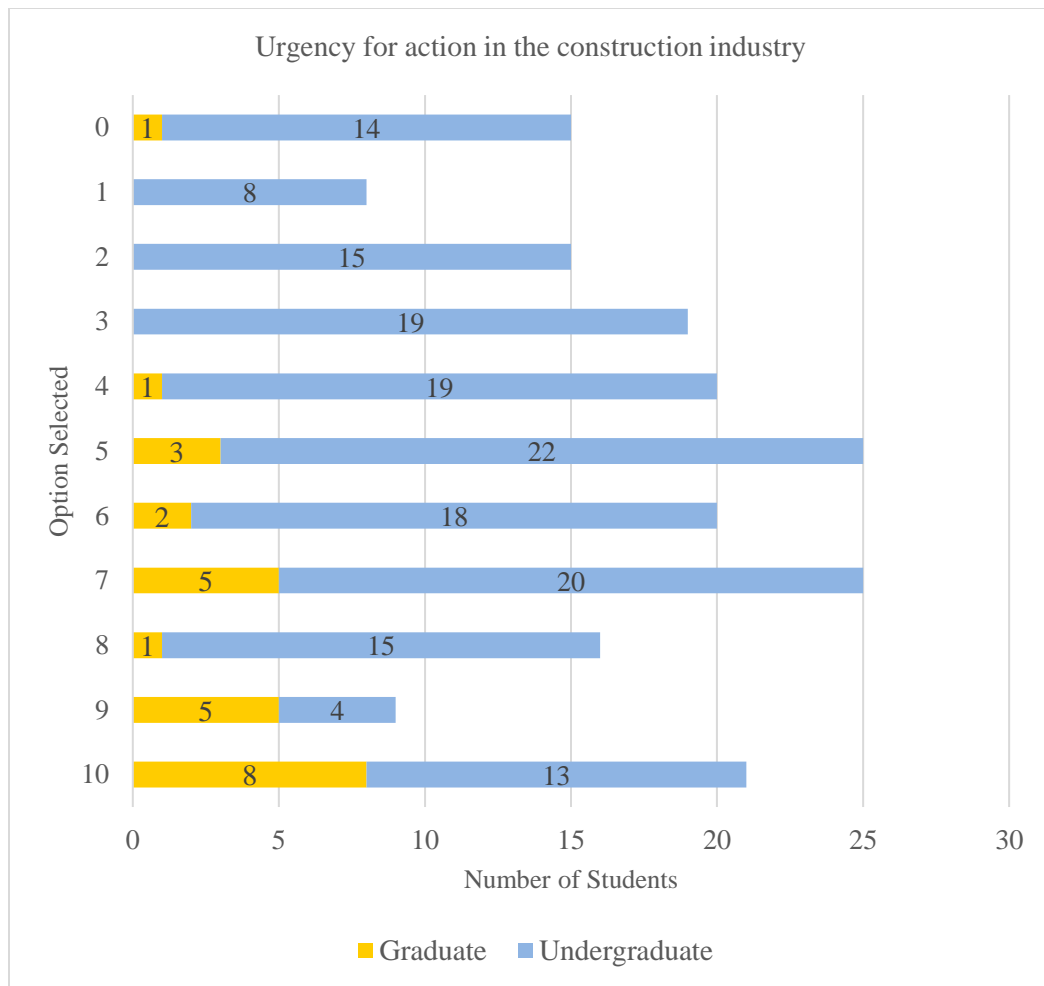


Figure 11 Urgency for action in the CI to address CC, in a scale of 0-10. (Question 7 of Appendix A)

Disparity is also noted in the responses of students that indicated answers from 0 to 3 and were classified by the research committee as presenting a low level of concern. This portion of students represents 33.53% (56/167) of undergraduate students and 3.85% (1/26) of graduate students. However, similar responses can be noted in the intermediary section, where responses ranged from 4 to 7, and can be viewed as

representing a moderate level of concern. A total of 42.31% (11/26) of graduate students indicated responses in this range, while 47.31% (79/167) of undergraduates indicated a comparable level of concern.

4.3 Sustainability

4.3.1 KNOWLEDGE AND RELEVANCE OF SUSTAINABILITY

4.3.1.1 Awareness of the domains of sustainability

Question 9 was included in this study's survey in an attempt to determine if students associated sustainability only with environmental aspects. The specific question was "Do you think the concept of sustainability relates to...?" and the students were prompted to check all options that applied. The results displayed in Figure 12 display how many times each option was selected.

From a total of 440 selections that includes all of the options, "Environmental aspects" was the leading option and selected by 92.74% of respondents (179/193), either on its own or combined with one or more options. This option was selected as the only answer by 17.62% of all respondents (34/193), almost one quarter of all the graduate students (23.08%, 6/26) and roughly over one eighth of the all the undergraduate students (14.51%, 28/167).

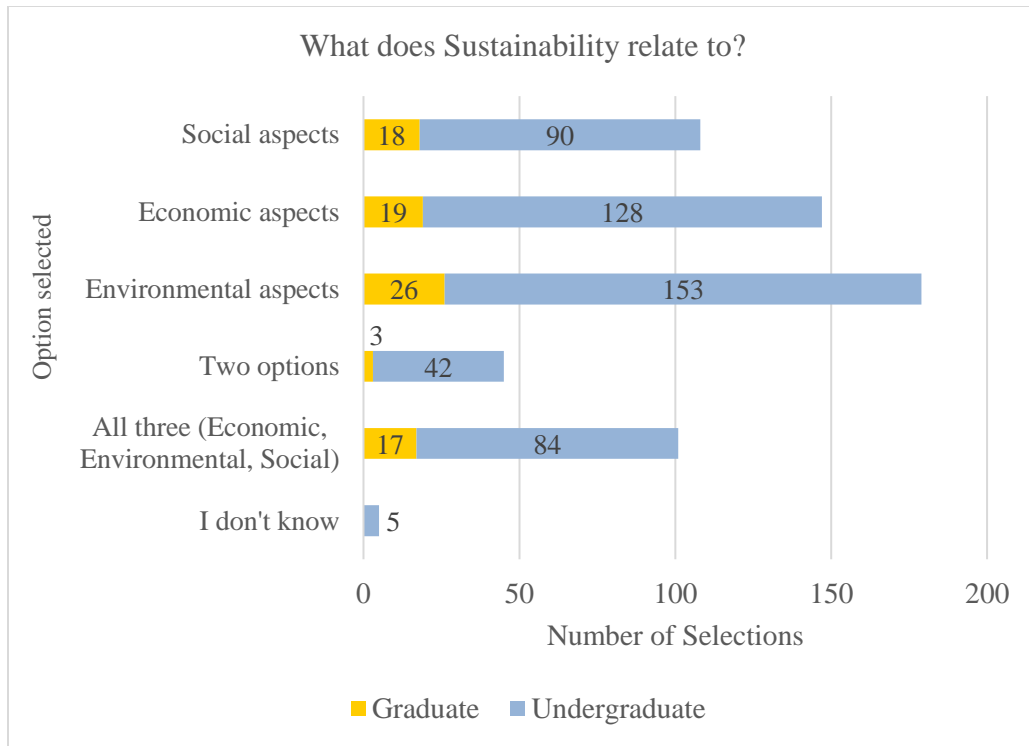


Figure 12 Respondents’ awareness of the range of concepts related to the topic of SU. (Question 9 of Appendix A)

A more complete response for this question was selected by 52.33% of all respondents (101/193), in which students selected three options (“Economic aspects”, “Social aspects” and “Environmental Aspects”) as their answer. This particular portion comprises 65.38% of the graduate students (17/26) and 43.52% of the undergraduate students (84/193).

4.3.1.2 Relevance of Environmental sustainability in daily life

In an attempt to evaluate students’ personal involvement with topic of sustainability and determine their openness to exposure to the topic within courses in the

Department of Construction Science, in Question 10 students were asked to indicate, on a scale of 1-5, the relevance of environmental sustainability in their daily lives. The results are shown in Figure 13. The pattern of responses presented a relatively normal distribution, with a mean of 3.39 and standard deviation of 1.04.

Three ranges of answers were also set for this question and classify the level of relevance of environmental sustainability to individuals as low (1-2), moderate (3) and high (4-5).

Almost half of the students in the entire sample indicated options 4 or 5 as their response (49.22%, 95/193); this share of respondents is represented to by 76.92% (20/26) of the total graduate students and 44.91% (75/167) of undergraduate students. When it comes to low level of relevance, 23.32% (45/193) of all the respondents indicated 1 or 2 as their response; such group is composed by 26.34% (44/167) of the undergraduate students and 3.85% (1/26) of the graduate students. Partial similarity is noticed at moderate relevance responses, representing 27.46% of all students. This portion of students is represented by 19.23% (5/26) of the graduate students and 28.74% (48/167) of the undergraduate students.

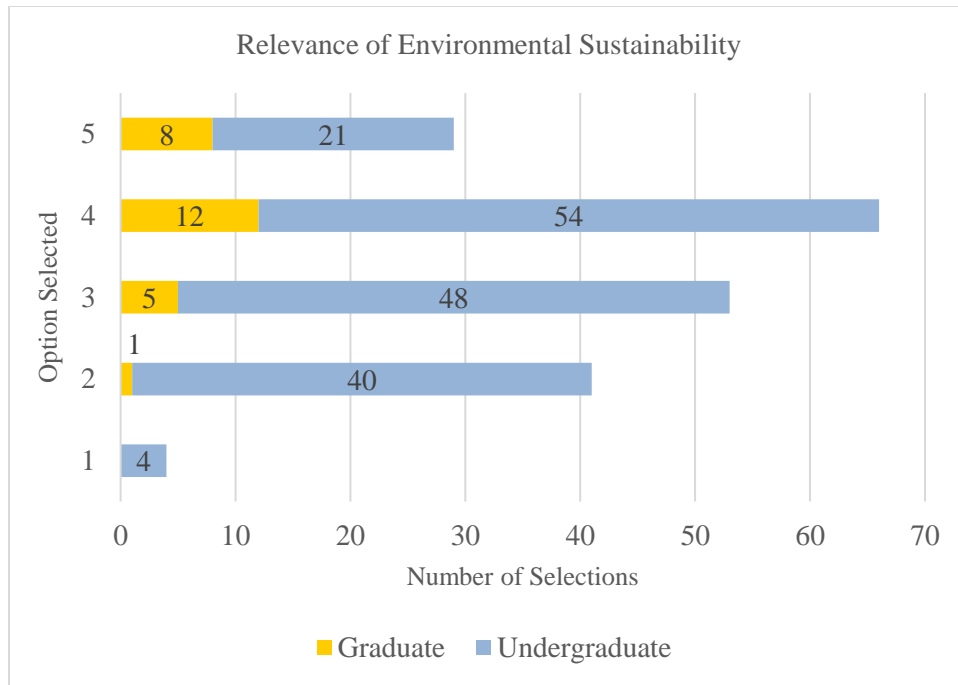


Figure 13 Respondents indicated the relevance of ES in their daily lives, in a scale of 1-5. (Question 10 of Appendix A)

4.3.2 INFLUENCE OF PREVIOUS FORMAL EDUCATION UPON CURRENT ATTITUDES

4.3.2.1 Previous formal education in Environmental Science courses

Questions 11 and 11B (Figures 14 and 15) were designed to test the conclusions presented in the studies developed by Tuncer (2008), to whom enrollment in formal Environmental Science courses did not necessarily play a relevant role in individuals' attitudes towards environmental sustainability.

Prior to participating in this survey, 53.89% (104/193) of the students had taken at least one formal course (minimum of 3 or more credit-hours) related to Environmental Science in either elementary school, high school or at college level. Out of these students, 26.92% (104/193) of them have been enrolled in at least two courses with similar focus. Their responses regarding the impact of their exposure to this topic upon their attitudes towards environmental sustainability can be seen in Figure 15.

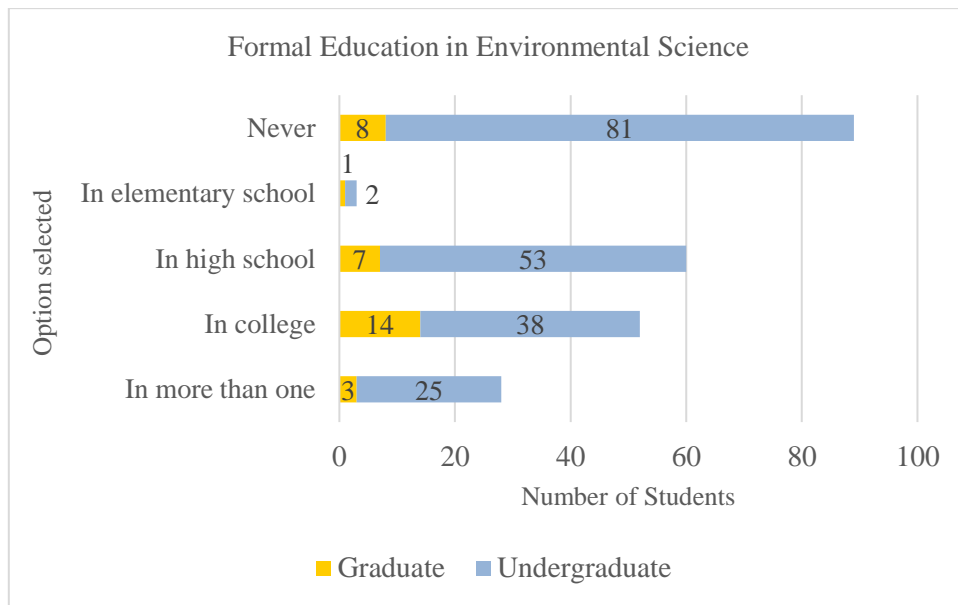


Figure 14 Respondents indicated whether they took any formal ES courses in the past. (Question 11 of Appendix A)

4.3.2.2 Impact of previous formal education in environmental science courses

The responses presented a normal distribution and 43.27% (45/104) of all the indicated “a moderate amount” as their answer to this question, with a mean of 2.96 and a standard deviation of 1.00.

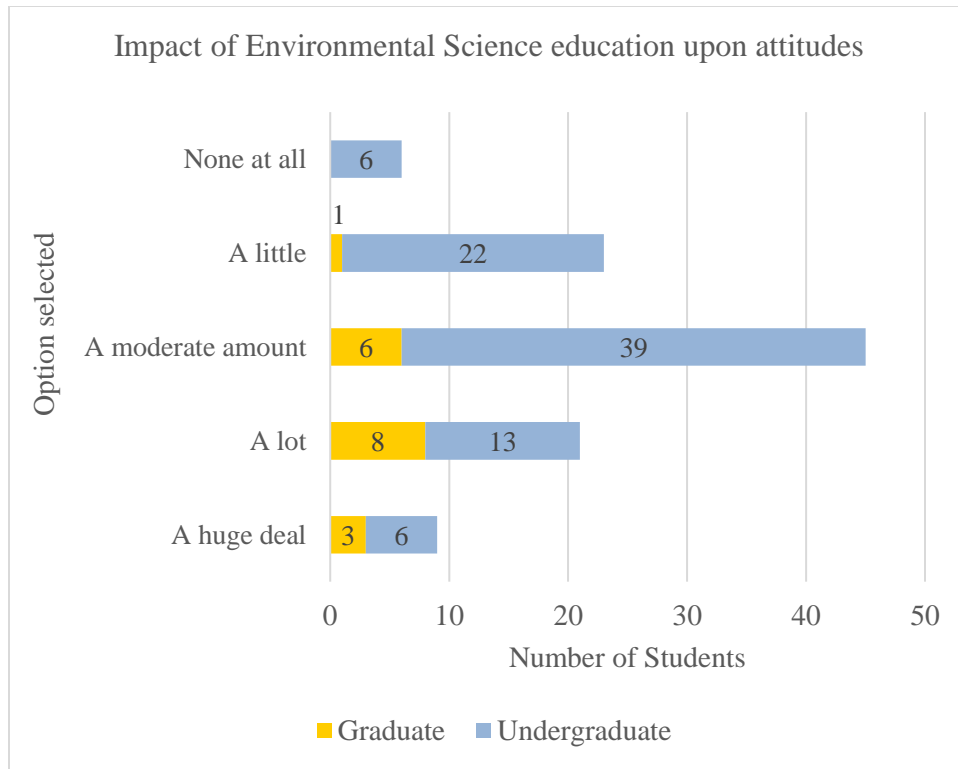


Figure 15 Impact of previous formal education upon respondents’ attitudes toward ES. (Question 11B of Appendix A)

The number of students that indicate “little” impact or “none at all” (27.88%, 29/104) from having taken formal courses in Environmental Science is slightly lower than the ones who indicated that such courses impacted them “a lot” or “a huge deal” (28.85%, 30/104). Visible differences in evaluation of impact upon personal attitude is observed among graduate student level responses to this question, in which 61.11% (11/18) of these students selected “a lot” or “a huge deal” as their response.

4.3.3 INTEREST FOR POTENTIAL COURSES IN ENVIRONMENTAL SUSTAINABILITY WITHIN THE PROGRAM

Students' opinion regarding the needs and requirements for courses related to environmental sustainability was also measured via Question 13 (Figure 16).

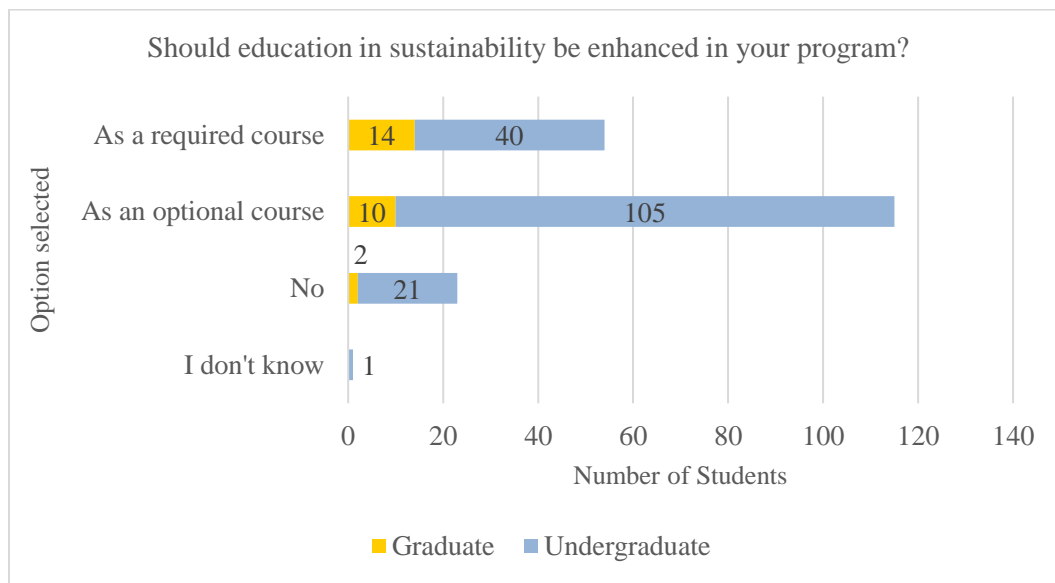


Figure 16 Respondents' opinion regarding an increase in ES education in the program. (Question 13 of Appendix A)

A total of 192 students expressed opinions when answering Question 13, while one undergraduate student indicated “I don’t know”. With a mean value of 1.56 and standard deviation of 0.76, a contrast was observed within the distribution of answers of graduate and undergraduate level students. The majority of graduate students (53.85%, 14/26) indicated that Environmental Science related courses should be required for

degree completion, while the largest portion (62.87%, 105/167) of undergraduate student level responses indicated it should be “an optional course”.

Table 1 Summary of the five main findings of the study.

Total participants: 193 Response rate: 18.48%	UNDERGRADUATE STUDENTS: 167		GRADUATE STUDENTS: 26	
	Females (21)	Males (146)	Females (8)	Males (18)
Well aware of climate change impacts (<i>selected 4 or more in 0-6 options</i>)	10 47.61%	59 40.41%	3 37.50%	11 61.11%
Senses urgency in Construction Industry to address climate change (<i>indicated 8 or more in a 0-10 scale</i>)	8 38.10%	24 14.37%	6 75.00%	8 44.44%
Denies and/or scorns climate change	1 4.76%	7 4.79%	0 0%	0 0%
Considers environmental sustainability relevant in daily life (<i>indicated 4 or more in a 1-5 scale</i>)	8 38.10%	67 45.89%	6 75.00%	14 77.78%
Believes environmental sustainability should be a required course	8 38.10%	32 21.92%	4 50.00%	10 55.56%

5 DISCUSSION

Proportionally, responses indicate that sustainability and climate change are substantially more relevant to graduate students than they are to the undergraduates in all the criteria assessed. Level of education and the cultural diversity factor likely played significant roles, since responses containing denials to climate change and skeptical comments as responses in open-ended questions were only observed among undergraduate level students. These specific respondents represent 4.15% (8/193) of the sample and indicated the U.S. as their country of origin – see Table 1, in chapter 4.

Although responses suggest that climate change is not unknown to students, several misconceptions regarding this topic were identified from evaluating the data collected. Data collected in this study reflects a similar tendency as the one observed by Akerlof et. al (2010) regarding American respondents. In their studies, Akerlof et. al (2010) suggested that Americans had a larger likelihood of viewing the potential impacts of global climate change an issue that will be faced by people living in other regions of the world, instead of posing challenges for themselves as well.

Overall, respondents appeared to consider that climate change would affect future generations rather than their own. The response patterns to the question in section 4.2.1.1 – “Perception of Personal and Intergenerational Exposure to Climate Change” are relatively similar, although graduates perceive the likelihood of their immediate next generation being impacted by climate change to be higher than do undergraduates. Likewise, the responses recorded in question 4.2.1.2 – “Perception of Local and Global

Exposure to climate change” suggest that undergraduate students tend to consider such impacts as external to the U.S., with low incidence in other industrialized nations. They also believed climate change would more likely affect future generations in less developed nations.

The fact that 60.67% (381/628) of students’ selections of potential impacts of climate change refer to matters somewhat external to humans is noteworthy (see section 4.2.1.2), since it supports the hypothesis that there is some personal detachment from the topic. Such a belief appears to be consistent at both program levels, as seen in Figure 9. A complete answer was provided by 13.98% (27/193) of all the respondents, and this group was composed by 5 graduate students (19.23% of the graduate sample) and 22 undergraduate students (13.17% of the undergraduate sample), in which respondents selected the 6 possible options that did not deny or minimize climate change.

Respondents seem to agree that environmental sustainability is an important matter in their daily lives, as less than 25% of all students indicated the topic represents a low level of relevance (see section 4.3.1.2). However, their perception of need for action in the worldwide billion-dollar industry they will soon become a part of, that consumes approximately 40% of the world’s resources annually, is incongruent with such claims. Consistency was noticed in female student answers but was clearly misaligned in males’ answers, as seen in Table 1 in the previous chapter. There is some truth to the idea that the General Contractors’ (GC) potential for influence is limited, since many of the strategic decisions are often made by the designers and the owner before the GC enters the process. The GC’s role is also limited because the best results from an environmental

standpoint are achieved during the design and procurement stages. Nevertheless, proper handling of construction waste, efficiency and lean processes in construction job sites offer the potential to reduce the impacts of any given building enterprise.

Contrasting responses at undergraduate and graduate levels were expected as one of the possible outcome scenarios of this study, in part due to politically conservative leanings of Texas and in part due to the rhetoric of climate change denial currently being made at the federal level in the US at the time of this project. However, it is difficult to determine at this point the major influences on personal beliefs and how these specific points of view affect the way they view these topics. It is also difficult to determine at which stage of formal education does exposure to environmental science have the greatest impact on an individual's mindset towards sustainability – from early ages through college.

6 CONCLUSION

Data collected from a survey administered to 167 undergraduate students and 26 graduate students in the Department of Construction Science at Texas A&M University suggest that awareness regarding sustainability and climate change is relatively low at both program levels, considering the vast scientific evidence related to this topic and known challenges mankind is likely to face over the next 30 to 50 years. Despite indicating greater awareness, the number of graduate students that were considered aware of climate change and sustainability was smaller than expected. Three key factors likely affect students' responses: cultural influences from the surroundings in which they were raised, distinct levels of education, and exposure to pollutants and extreme weather events during a respondent's lifespan. As US construction management students seldom seek degrees beyond the bachelors level, it is imperative for educators to consider how to make better use of their time while they are still in school.

This research assumed that a student's knowledge, level of concern and awareness regarding climate change and sustainability could be considered "informed" if the following criteria were met:

- 1) At least 4 out of 6 potential climate change effects were identified;
- 2) At least 6 on a scale of 0 to 10 regarding urgency for action in the construction industry was indicated;
- 3) At least 2 of the 3 pillars of sustainability (Economic, Social, Environmental) were selected.

A total of 50 students out of the 193 participants of the study met the criteria established, which represents 25.91% of the sample. Within these students, 22% (11/50) are graduate students and 78% (39/50) are undergraduate students. A breakdown of the results and the proportion of students per program level can be seen in Figures 17 and 18.

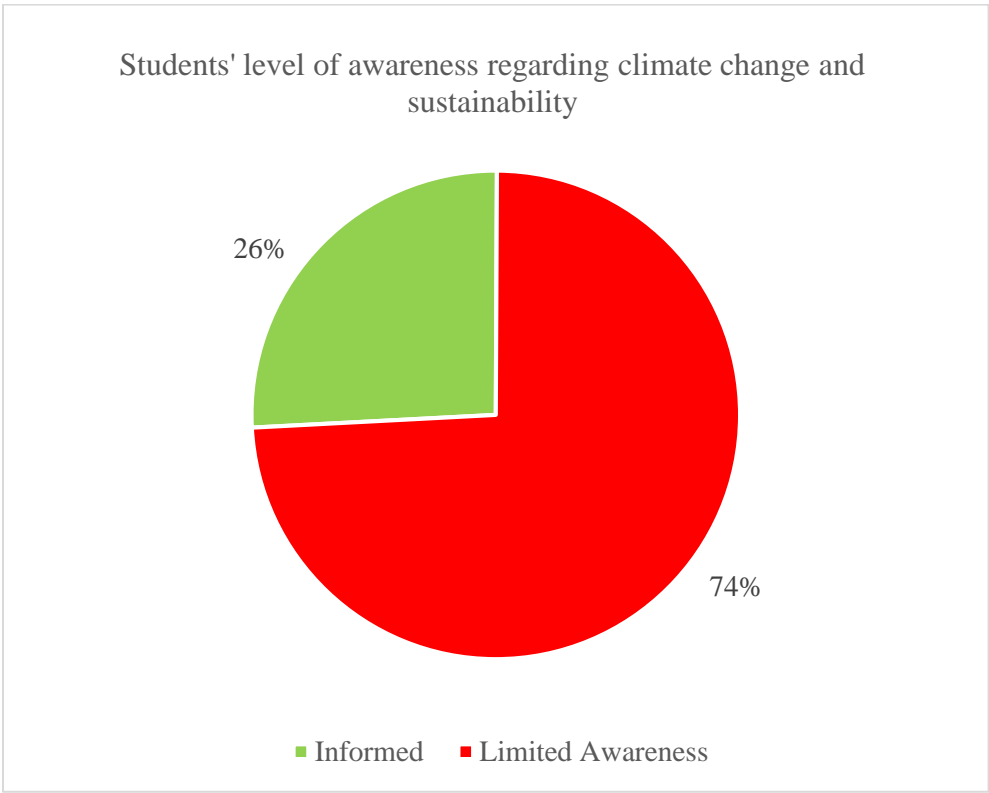


Figure 17 Results regarding students' level of awareness of climate change and sustainability.

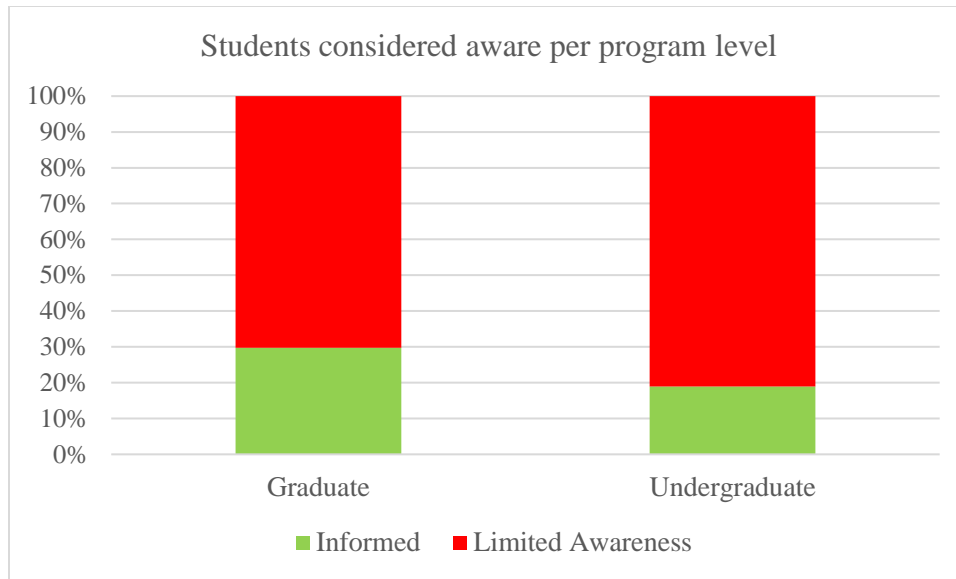


Figure 18 Awareness proportion per program level.

The sample of respondents represented the program’s demographic distribution at graduate and undergraduate levels with high fidelity, during the period in which the survey was active, and revealed that almost three quarters (74%) of the students in the sample have limited awareness of CC and SU.

The results displayed in Figures 17 and 18 present evidence that education regarding sustainable construction and environmental sustainability should be enhanced in both the graduate and undergraduate programs of the Department of Construction Science at Texas A&M University. Students demonstrated openness to such topics, as seen in Figure 16, and their answers to open-ended questions indicate that much clarification is needed when it comes to distinguishing climate change from global warming, greenhouse effect and weather fluctuations. Currently, the Department of Construction Science does offer a Sustainable Construction course; however, it is only available as an elective course at the graduate level.

6.1 Directions for Future Work

Potential expansions to this project could occur internally and externally to the Department of Construction Science at Texas A&M University.

The data collected in this stage could serve as an initial step to a larger project. If the COSC department considers adding sustainable construction or environmental sustainability related courses to its undergraduate program, another round of the survey could be administered to students in the future. Should changes to the program occur during the next 2-4 semesters, it would even be possible to apply the survey to students who participated in the initial round, to measure the effectiveness of the course(s) in informing their awareness of CC and SU (50.25% of the students that participated in this round [97/193] were enrolled in either the first or second years of the undergraduate program).

External expansions to the project are also possible. This could enlist the participation of other universities in the country, and even in other countries. Comparing responses between programs could be useful for educators to assess the level of students' awareness of a topic that is relevant at a global scale. Data collections could even reveal a need for enhancements in several architecture, engineering and construction related programs across the nation. However, collecting adequate data from other programs is a complex challenge that requires combined efforts and coordination.

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APPENDIX A:

SURVEY QUESTIONS USED IN THIS STUDY

Climate change

1) Do you think Climate change could affect...?

	Not at all	A little	A moderate amount	A great deal	Don't know
You	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your children	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your grandchildren	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2) If Climate change is happening, how intensely do you think its effects would impact...?

	Not at all	A little	A moderate amount	A great deal	Don't know
Your community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People in the US	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People in other industrialized nations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People in developing countries	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Future generations of people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3) In your own words, please briefly describe what do you believe Climate change is.

4) What do you think are the main causes of global Climate change?

None, Climate change is not happening

It is natural

It is caused by human activities

Other (please explain):

5) Which of these could be considered potential effects of global Climate change?

Check all that apply.

None, Climate change is not happening

If any, they will be irrelevant or negligible

Forced migration of populations worldwide

Decreased number of plant and animal species

Increased sea level

Increase in infectious diseases

Insufficient food and drinkable water

Increased number of intense / severe weather events

6) Do you think action is needed in the Construction Industry to address Climate

change?

Definitely yes

Probably yes

Probably not

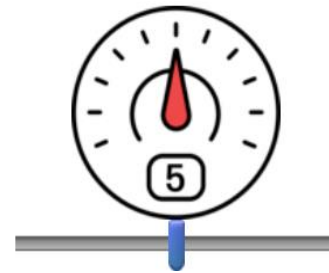
Definitely not

7) If any, how urgent is the need for action?

Slide bar to indicate your answer.

(0 = No action needed,

10 = Immediate action required)



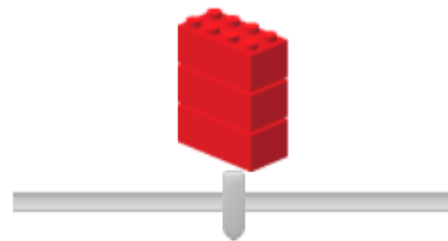
Sustainability

8) How would you rate your knowledge about the concept of sustainability?

Slide bar to indicate your answer.

(1 = Not at all knowledgeable,

5 = Very knowledgeable)



9) Do you think the concept of sustainability relates to...?

Check all that apply.

Social aspects

Economic aspects

Environmental aspects

I don't know

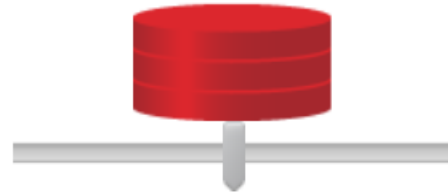
Other (please explain):

10) How important is Environmental Sustainability in your life?

Slide bar to indicate your answer.

(1 = Not at all relevant,

5 = Very relevant)



11) Have you ever taken a formal course in Environmental Science?

Check all that apply.

- Yes, in elementary school
- Yes, in high school
- Yes, in college
- No

[11B WAS SKIPPED TO THOSE WHO ANSWERED “NO” IN QUESTION 11]

11B) If you took a formal course, how much do you think the course influenced your attitude toward environmental sustainability?

- A huge deal
- A lot
- A moderate amount
- A little
- None at all

12) Have you ever taken a formal course (3 or more credit hours) in Sustainable Construction?

- Yes
- No

13) In your opinion, should formal education regarding Environmental Sustainability be emphasized in your construction science / management program?

- Yes, as an optional course
- Yes, as a required course
- No

Other (please explain):

14) Please add anything you would like to share.

APPENDIX B:
RESPONSES TO OPEN-ENDED QUESTIONS

3) In your own words, please briefly describe what do you believe Climate change is.

“The heating and cooling of our climate globally.”

“Change in weather”

“The environment changing around us uncontrollably.”

“The rising of oceans and the warming of the environment.”

“The abnormal rates of bad air causing the atmosphere to heat up”

“It is our atmosphere weakening due to greenhouse gasses”

“More extreme weather, both hot and cold.”

“Extreme changes in weather”

“A disease spread by the virus that is humanity”

“The earth goes through cycles of cooling and heating. That is climate change.”

“More hot, less cold.”

“A prolonged and gradual change in temperature and weather events.”

“Change in climate that has a negative impact on the earth. Areas are experiencing unprecedented temperatures.”

“Climate change is the natural changes in the environment. Humans do not affect it.”

“Global warming”

“Climates steadily increasing or decreasing”

“Natural occurrence”

“Dramatic change in weather from season to season”

“It's definitely something we should be aware of.”

“Extreme changing weather around the world, that affects places it normally doesn't a
“great deal.”

“Global warming”

“Change in climate”

“The climate is changing from how it was before.”

“I feel like Earth is either in cooling period or warming period.”

“Change in climate”

“the evolution of earths life”

“Drastic change in the environmental conditions and temperatures.”

“An overall change in climate patterns”

“A change in the weather condition of a place over a long period of time”

“Changes in the earth's climate cycles due to natural processes and human-related activities.”

“The changing of climate patterns from levels of CO2 and methane.”

“The rise of the average temperature across the globe”

“The NATURAL occurrence of climate events that the world has undergone for BILLIONS of years. The earth has seen very drastic changes in its time, and will see many more, nevertheless, it always survives and self corrects.”

“The change in climate”

“The changing of the weather and increasing temperatures.”

“Warming of the earth affecting weather patterns.”

“Changing the environment from what it is.”

“The increase of temps. / change in climate as a result of humans & natural causes”

“Changes in weather that can leave impacts to us forever”

“The climate's characteristics changing over time”

“Drastic changes in climate that could theoretically be harmful. Climate changes all the time; it always has.”

“A climatic shift of meteorological norms.”

“Climate Change is when the climate of the earth changes over time, it has occurred several times in earth's short history.”

“Change in weather patterns that are caused by multiple human and non-human factors.

“The change in temperature.”

“The natural, cyclical fluctuation of our globe's climate positively and negatively.”

“The warming of the planet caused by human activity.”

“The natural rise of temperature over time due to human interference / natural occurrences.”

“The earth responding to people who have mistreated it their entire existence”

“The natural cycle of the world's climate”

“The rising of heat in the world due to humans producing much more carbon dioxide than normal.”

“A change in climate normally.”

“The intense fluctuations of our world climate.”

“The rising temperature of the earth as a whole.”

“When the natural average weather of a region changes due to changes in temperature from various reasons like pollution and CO2 emissions, etc.”

“Warming of the earth.”

“Change in global temperatures”

“Climate change is the man-made change in the climate of the world which has many adverse effects to humans, and the natural world.”

“Changing the climate due to human activities”

“Change of average climate over the years”

“A shift in the current climate zones to different geographical locations along with an overall increase in global temperatures.”

“The shift in normal characteristics of the climate.”

“I believe the world is changing, but nothing to be blaming on humans. There's been many stages of the earth from ice ages to a world of fire. Eventually it will cycle back to one of these.”

“A change in global and regional weather patterns due to increased CO2 emissions.”

“Climate change is when the climate has changed drastically because of outside forces, meaning the climate naturally would not have changed.”

“Changing climate”

“That the global temperature index is changing and rising in temp.”

“Climate change is unpredictable.”

“It's about to be very wet where it shouldn't be.”

“A change in long term weather.”

“The gradual changing of the Earth's climate due to human waste.”

“The environment changing in temperature during different seasons than the ‘normal’ average.”

“Change in weather.”

“The theory that the earth is getting warmer by preventable man-induced actions that is negatively impacting the sustainability of the planet (in what ways, I couldn’t tell you) increase temperature fluctuation and natural disasters”

“I think climate change is mostly relating to weather.”

“Global warming, how we impact the earth affects climate change.”

“Where a climate changes drastically, weather its cold, hot, rainy, over pounded.”

“Changing of the climate”

“Climate changing is the warming of the earth because of carbon dioxide. This causes ice caps to melt and water levels to rise.”

“The change of climate”

“The phenomenon of climate change and changing patterns due to pollution and other environmental factors.”

“A change in the balance of nature which has adverse effect on living kingdom”

“Abnormal changes in climate that affect ecosystems.”

“Hotter summers, colder winters, the whole distraction of ecosystem, the raise of sea level and etc.”

“A natural heating cycle caused by natural processes.”

“A change in the Earth’s global climate.”

“I believe that the Earth experiences cycles of heating and cooling. If the earth is indeed getting warmer then we will have to adapt to the changing environment.”

“Global warming”

“Poorly verified over exaggerated liberal condemning and political agenda mechanism”

“The altering of the typical atmosphere and environment of our planet.”

“The drastic change in temperature, air quality and greenery around you. Weird behavior of climate i.e it gets cold unexpectedly.”

“Natural climate cycles”

“The earths icecaps melting and the ozone deteriorating.”

“The degree in which the world is changing in the sense of weather.”

“The climate is changing.”

“Climate change is a cyclical set of phases the earth goes through in response to additives being present in the atmosphere.”

“Climate change is a change in weather and surroundings in the environment.”

“To me, climate change is the earth's natural variation or shift of climates.”

“Temperature change, unusual weather conditions, etc. Caused by natural/artificial processes.”

“Increase in the concentration of CO₂ gas in the atmosphere”

“Accumulation of Greenhouse gases in the atmosphere. Wildly exaggerated by liberal agendas.”

“A myth.”

“I believe climate change is getting worse and needs to be addressed.”

“Climate Change is nature’s way of adapting to the external forces brought on to it caused by human beings.”

“How the climate/weather changes over time”

“The cumulative heating of earth's atmosphere that will disrupt the natural manner in which life on earth exists.”

“The gradual change in the weather conditions that can be caused by globalization, industrialization, population growth, et cetera that in turn effects the overall climate in the long-term basis.”

”The rising average temperature”

“Climate change is the heating of the earth's temperature. Causing average temperatures to raise and melt ice.”

“Climate change is the change is average temperature of the atmosphere and how it affects the ecosystem.”

“The earth getting warmer , and more extreme weather”

“It's a change in weather patterns.”

“Climate change is a natural progression of the Earth aging. We went through the Ice Age, Prehistoric Age, etc. Thus, we are bond to have change in our climate.”

“The earth naturally cycles through cold and hot periods, so we must adapt as earth cycles.”

“It's a threat”

“The natural process of Earth's climate evolving”

“I think it is the gradual change of the Earth's climate over the course of several years.”

“A change in the behavior of the earth as a result of human interaction impacting human resources.”

“A severe increase or decrease in temperature compared to past years”

“Change in the climate caused directly by humans”

“A weather change.”

“An increase or decrease in the normal temperature range of the earth”

“Climate change is the definition for a change in climate.”

“Rising average global temp. over time”

“I believe climate change is largely the induction of greenhouse gasses that damage carefully calibrated earth systems such as the atmosphere, hydrosphere and biosphere.”

“Change in the weather condition of a place over a long period of time”

“Heat being trapped in atmosphere, melting ice, causing sea level to rise.

“The very, very slow warming of the earth.

“Large change in climate by pollution.

“The heating of the Earth due to human activities/industrialization such as car emissions, power plants and much more”

“The natural cycle of temperature change which the earth goes through ever few million years”

“The irreversible change to the earth’s climate patterns caused by the overconsumption of hydrocarbons”

“I’m not sure.”

“Different seasons changing - not as dramatic as people make it out to be.”

“A change in climate”

“The change in natural behaviors including weather, plants, and animals.”

“Change in climate due to Human activity”

“The earth's yearly climates are slowly getting hotter or colder each year.”

“Shifts in seasons, amounts of rainfall, wind and overall temp.”

“Something bad.”

“A universal change in climate, not specifically hot or cold.”

“Of course climate of earth will always be changing, but the bad practices of most industries make the Earth's climate worse off.”

“Climate evolving over periods of time.”

“The unhealthy changing weather patterns, greenhouse effect”

“The natural and affected change of the earth's climate over time.”

“coming problem”

“Human actions such as pollution causing long term, severe changes in the climate.”

“Depletion of the ozone causing warmer temperatures”

“The warming of Earth”

“Change in the surroundings”

“The gradual change in climate over time.”

“Introduction of harmful pollutants that deteriorates the atmosphere.”

“The possible effects of mass chemicals being produced by humans.”

“Warming of the atmosphere due to human activities, increased amount of carbon emissions and other harmful pollutants”

“Greenhouse gases, pollution”

“The change in temp”

“Not true”

“Earth getting warm”

“Climate change is temperatures outside of the normal averages for the past couple decades. I spend a lot of time outdoors and have definitely noticed warmer fall and winters. But the planet has had warmer and cold temperatures dating back to creation. So I am not sure if this is a normal swing, or a manmade swing.”

“Climate change is a culmination of human activities which have polluted the environment and are resulting in changes to the earth’s atmosphere and environment. These changes have serious and lasting effects on not only humans but all the creatures on earth. The threat of rising tides endangers coastal cities (of which large portions of humans live) and increases in ocean temperatures has led to the growth of harmful bacteria, increased the severity of natural weather incidents such as hurricanes, and had negative effects on the sustainability of Arctic and Antarctic ice.”

“The change in the Planet's temperature that results in increases of temp. out of normal ranges.”

“A human made change to the world we live in.”

“Long-term change in global climate”

“The overall environment changing due to weather”

“Climate change is a change in the regular patterns of weather.”

“The gradual shift in average temperatures and precipitation.”

“A conspiracy”

“Human activities releasing harmful chemicals into the atmosphere”

“The phenomenon of climate change is one of the most dangerous phenomena in the life of the planet, it negatively affects the lives of more than six billion people living above the surface of the earth, in addition to the negative impact on various aspects of life is different, so it has become an important environmental issues recently; And their direct impact on the different vital sectors, whether agricultural, water or health, the international organizations and bodies concerned with the environment to enact laws and legislation to ensure the preservation of the environment and everything related to them, in addition to raising awareness of the risks of global climate change.”

“Overall rising atmospheric temperature.”

“The warming of Earth's atmosphere due to CO₂ emissions.”

“A change in regional climate patterns.”

“The weather going to extremes”

“Weather and climates changing due to man made decisions”

“The change in weather caused by human activity and what we are doing.”

“Climate change is the natural rate that the climate changes over the years”

“The natural balance of nature and earth shifting into chaos causing disastrous effects on life on Earth.”

“Change in the climate throughout years (temperature)”

“Global warming”

“A cycle of Earth”

4) What do you think are the main causes of global Climate change?

None, Climate change is not happening

It is natural

It is caused by human activities

Other (please explain):

Open-ended responses provided to the alternative labeled “Other” in Question 4 above:

“Caused by human activities and sometimes natural too.”

“Human activities causing changes in the natural balance and nature trying to find the balance.”

“It does not exist”

“It is natural, but amplified by human activity”

“Not as bad as many have been taught to believe”

“It is both natural and affected by human interaction.”

“A mixture of natural and human activities”

“While I believe humans do have an impact on the quality of the natural environment, I do not think humans are the main factor influencing climate change. Within the last half century, the climate change debate has evolved from "the next ice age", to "global warming", to now just "climate change". These inconsistencies are part of what leads me to believe climate scientists have other hidden agendas behind the climate change debate.”

“I think climate change is natural but has been expedited by human activities over the past two centuries.”

“I believe that it’s a natural phenomenon but that humans have made it occur slightly faster but not enough to worry about it as much as the media has made it out to be.

“It is natural, however humans do have some impact on the ozone layer.”

“I really have no clue”

“I believe it is a natural process that has been accelerated by human activities.”

“I believe Human activity has a growing part, but it is a natural process.”

“It is a sum of both; however, human activities are forcing natural processes to occur extremely faster than they would, and both nature and ourselves are not prepared for the consequences.”

“A mixture of it being natural and it being caused by humans”

“The government controlling jet streams”

“Changes in greenhouse effect / it can be occurred because of solar radiation.”

“I have to study more about it. Some individuals think that it is going to happen because of human activities (even researchers and they have their own reasons). However, some others think that this changing is not going to happen. Thus, I have to study more to decide which side I get.”

“Natural and caused by human activities.”

“It is natural and also caused by human activities.”

“Both”

“It is caused by humans and nature.”

“Natural, but human activities act as a catalyst for Climate Change.”

“None, it's natural”

“It is both natural and caused by human activities.

“The climate has been naturally changing for billions of years (ice ages). Humans aren't helping, but we aren't the cause.”

“Both natural and caused by humans”

“Both natural + human activities”

“98% natural, 2% humans oriented”

“Both.”

“Combination of natural and human activities.”

“Both.”

“Both natural and caused by human activities.”

14) Please add anything you would like to share.

“N/A”

“I think students should be required to learn sustainable construction. It was an uphill fight to decipher V4 requirements, but I do not want to learn hippie construction ideology.”

“The Climate is going to continue to change because we are on a spinning ball in space. Something greater than humans would have to happen for that change to be drastic. I think it's important for all future people that join the construction industry to know the cons of construction to our environment. The more we know about the topic, the more change that will happen to benefit our environment/society.”

“It's the responsibility of professionals and everyone on earth to help sustain this planet for us and posterity and an education in that regard is invaluable”

“People foolishly think that only some areas of the world will be affected by CC. Nature and science have proven us that everything is connected. So, unless students worldwide (including US) receive comprehensive education on this topic and become

environmentally conscious adults, our fate is doomed to wars, loss of biodiversity and extreme hardship due to weather. Every action counts!”

“In the box where it asks what the effects might include when referencing Climate change, it is only describing the addition of heat. There should be more options, like the addition to colder weather becoming an effect on the environment as well. Perhaps we are at the start of an Ice-Age, who knows, nevertheless, the options for dropping temperatures was not present in the options.”

“N/a”

“These ideas are important, and it is a field that I would love to work in. However, most of my knowledge is self-gained, not much from school.”

“With the construction industry emphasizing LEED and Sustainability, an optional course would be a good start integrating at the college level.”

“The course would be wonderful if optional as an elective. However, I firmly believe the Department ought to look more into combining Structures I & II, and redesigning a few other courses first.”

“Make it happen”

“N/A”

“I definitely think this is an important topic that will be extremely relevant in industry. I don't think we have enough class space to make a course on this topic required, but I definitely would have taken one as an elective if it was offered.”

“N/A”

“I have almost zero actual knowledge on this issue. I'm aware of the arguments circulated through partisan politics and (increasingly) partisan media, but the FACTS of the issue are not circulated. Therefore I cannot really claim any position for this issue, whether in support or in dissent.”

“The government should take action regarding the sustainability! As long as the government benefits from unsustainable policies, achieving full sustainability is not gonna be achieved! To me the people should be educated to take actions!”

“Climate change is occurring but at an alarmingly slow rate. Until technology has advanced to the point that it is affordable enough to implicate on a global scale we don't need to worry.”

“There should be an optional class that does LEED certification.”

“Maybe should just be in the architecture department”

“I really like the changes/improvements that I am seeing to the Construction Science program. Please keep up the good work and thank you!”

“Many people think Climate Change is a political issue/opinion. It is scary to think how many people really think Climate Change isn't real.”

“Apart from making people aware about sustainability in their professions, people should be taught about the small changes in their daily life which can lead to sustainability”

“I think getting a LEED certification from a sustainability class would be very productive.”

“This was a well put together and straight forward survey. Thank you, have a blessed day.”

“I see the construction industries main negative impact when looking at sustainability, is it's excessive construction waste or lazy handling of construction waste. Obviously, there is no money to be made in a general contractor sustain-ably handling construction waste so there is a lack of motivation to improve.”

“Sustainability is of importance to me because of increased efficiencies and reduced cost for things like energy. Global warming is not the end all be all that some individuals think it is. However, I do feel like it is important to take care of the earth we live on.”

“None.”

“Although not much of the Industry cares about sustainable construction. Our program is building the next generation and we will be the ones my make it apart of the industry”

“I think structures should not be taught based on the fact that the instructors tell students they shouldn't know this because it's an engineering matter. I do think courses relevant to sustainability that is taught in Europe, Southeast Asia, and Australia should be

implemented. Right now there are summits and conferences in the UAE addressing these issues (The Big 5 - Dubai 2018). If we are to evolve with the industry and global trends then we should be teaching to that level. We really need to take a look at what the rest of the world is doing if we are going to make an impact in the US. Building a better world weighs more than padding your pockets.”

“Adding hands-on building projects/classes would be an opportunity to teach students about construction waste and how to deal with it, as well as sustainability in construction.”

“Volcanoes are the main cause not humans”

“A course like this may be able to help students understand what they can do and the impact they have.”

“We need to take bigger steps towards achieving greater Sustainability and limiting Climate Change”

“There is a lot of resistance within construction groups against climate change. I've seen the induction of DEF fluid complained ad nauseam, to the extent that inferior forklifts were used to circumvent using DEF. This is a clear indication that a bitter bias is rooted in many establishments that is best addressed before an echo-chamber of misinformation is instilled. Therefore, I do believe environmental sustainability should be a required class in construction science. Optional classes will simply educate those already receptive but not convince, which is entirely necessary for many, others that will eventually have an accumulative degree of influence within the construction field.”

“Our planet is a gift to us all, it is the joint responsibility of everyone (sustainability advocates and all) on this planet to sustain it. We need to educate everyone I think climate change is going to be something we don't try to fix until it is too late I don't believe "climate change" should be made into some big deal. The weather changes all the time.”

“Last year, I took sustainability course with Dr. Rybkowski. It was totally a mind blower course. I strongly recommend any student in COSC dept to take this course, since it reveals aspect of the construction industry need a great deal of improvement which eventually affects the whole globe in terms of having more sustainable living place for future generations.”

“If the globe could work together to be more environmentally friendly we would be better off.”

“This is a good research, keep it up.”

“Get rid of Soil and structural analysis 2.”

“N/A”

“Forcing students in this program to take an Environmental Sustainability course would not go over well. But providing willing students the opportunity to learn about this topic will help to improve overall awareness in the industry and may help to spread its ever increasingly important message.”

“I think I know what it takes to have a sustainable building.”

“We shouldn't intentionally harm the environment, but we also shouldn't ‘Green New Deal’.”

“We should act quickly before it is too late to save our lovely blue planet which it is our only home! Rather than spending billions of dollars trying to send few people to mars which is not guaranteed they will even survive. human can be smarter and invest this billions in saving our plants. Take an example of that. A size of France island of plastic trash is floating in the ocean and no one country is willing to clean our vital source of life and energy.”

“Ice age > History repeats itself”