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The Sustainability Knowledge, Attitude, and Behavior Differences between Green and Non-Green University Students

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This is to certify that the doctoral dissertation by

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Walden University
2020

Abstract

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MS, Walden University, 2009

BS, Hawaii State University, 2002

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Psychology

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Abstract

Research has shown that green schools and sustainability education (SE) can improve learning, health, attitudes, and behaviors. They can also model the necessary community, societal, and global changes needed for sustainable living. However, most students do not attend green schools or receive adequate SE. Limited peer-reviewed studies have also examined the sustainability knowledge, attitude, and behavior differences between green and non-green university student populations. The theoretical foundation of the study was based on the theories of planned behavior and social identity theory. In order to fill the research gap, 606 undergraduates and graduates from 265 U.S. accredited green and non-green colleges and universities were invited to complete an online sustainability survey in this quantitative study. The results of the three-way MANOVA showed that the main effects of knowledge, attitude, and behavior were significant for university type, SE, and gender. There were also significant interaction effects between university type and SE. Significant knowledge and attitude differences were also found between green and non-green student populations. SE also had a significant impact on behavior, whereas gender had a significant impact on knowledge. A multiple regression further revealed that sustainability attitudes were significantly predicted by sustainability knowledge, behavior, gender, and university type. The implications of these findings suggest that green schools and SE can impact knowledge, attitudes, and behavior which may lead to positive social change. Therefore, this study may be of interest to organizations, academic communities, researchers, curriculum developers, and policy leaders.

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Chapter 1: Introduction to the Study

Research shows that harmful environmental products and unsustainable practices are not only eroding our health, our future, and our world, they are also rapidly contributing to adverse climate change (Intergovernmental Panel on Climate Change [IPCC], 2007a, 2007b, 2007c, 2013, 2018a, 2018b; U.S. Environmental Protection Agency [EPA], 2020; World Bank, 2012, n.d.). While scientific experts recommend a +1.5°C (IPCC, 2018a, 2018b) to 2°C (World Bank, 2012, n.d.) climate change cap, with mitigations in place by 2030 (IPCC, 2018a, 2018b), many agree that these benchmark objectives alone are not enough (Begley, 2009a, 2009b; Goldenberg, 2013; IPCC, 2018a, 2018b; United Nations, n.d.-a, 1992, 2016). Earth is likely to reach +4°C within the next 70+ years unless clear, comprehensive, and expedient steps are taken to address climate change issues now (Begley, 2009a, 2009b; World Bank, 2012, n.d.).

Climate Change

Anthropogenic driven climate change is rapidly contributing to adverse global atmospheric, environmental, geological, social, and biological changes. As such, a wide variety of multi-disciplinary approaches will be needed to address these matters in time (IPCC, 2007a, 2007b, 2007c, 2013, 2018a, 2018b; National Aeronautics and Space Administration [NASA], n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e, n.d.-f; NOAA, n.d.; U.S. Global Change Research Program, 2013).

The U.S. and E.U. Responses to Climate Change

In response to the climate change issue, independent states have reported climate change objectives aimed at reducing greenhouse gases (GHGs) over the next 30 years

(National Conference of State Legislatures, n.d.). The E.U. has also agreed to reduce 40% of its GHGs by 2030 (European Commission, n.d.). Although proactive steps in the right direction, historical research has shown that insufficient actions have been taken to accomplish these types of objectives (Begley, 2009a, 2009b; Burns, Carter, Davies, & Worsfold, 2013; Carroll, 2010; Van Alstine, Afionis, & Doran, 2013).

The Ramifications of Climate Change

Since climate change is capable of causing significant biodiversity and extinction level events (Hooper et al., 2012), climate change is an issue of notable global importance. In response, scientists have recommended substantial GHG reductions over the next 20 to 30 years (IPCC, 2007a, 2007b, 2007c, 2013, 2018a, 2018b; NASA, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e, n.d.-f; NOAA, n.d.).

Some of the potential ramifications of climate change are ice cap melting, sea-level rise, storm frequency, and storm severity – all of which could lead to displacement, water/food shortages, disease, injury, and death (Centers for Disease Control and Prevention, n.d.; IPCC, 2007a, 2018b; Martin & Tilling, 2007; Sheffield & Landrigan, 2011; World Bank, n.d.). Research has also shown that significant climate change can contribute to health, mental health, and security issues, as well as energy and infrastructure destabilization (Binder, 2011; Centers for Disease Control and Prevention, n.d.; Martin & Tilling, 2007).

A Call to Action

The United Nations (1992) drafted a document titled *Agenda 21* that called on all governments and leaders to implement policies that would protect and preserve life-

sustaining resources for current and future generations to come. In particular, Sections 25.12–25.14 of *Agenda 21* recommended that environmental education (EE) and sustainable development education (SDE) be provided in schools (United Nations, 1992). Article 12 of the Paris Agreement similarly recommended that climate change education and training be provided to the public (United Nations, 2016). However, insufficient actions have been taken to unilaterally implement uniform sustainability education (SE) programs (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; Heming, 2017; National Center for Education Statistics, n.d.; Princeton Review, 2019, 2020; U.S. Department of Education, 2014, n.d.) and sustainable academic infrastructures in the United States (U.S. Green Building Council, n.d., 2013).

Climate Change Solutions

The literature reviewed identified SE/EE/SDE (United Nations, n.d.-a, 1992; United Nations Educational, Scientific, and Cultural Organization [UNESCO], n.d.-a, n.d.-b, n.d.-c; U.S. EPA, n.d.-g) and green schools as viable frontline solutions with which to address sustainability and climate change issues (Association for the Advancement of Sustainability in Higher Education [AASHE], n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; U.S. Green Building Council, n.d., 2013). However, research shows that only a limited number of green universities and SE programs exist in the United States (AASHE, n.d.; Buckley, 2019; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; National Center for Education Statistics, n.d.; Princeton Review, 2019, 2020; U.S. Department of Education, 2014, n.d.). For example, out of the 513/ 6,606 U.S. post-secondary Title IV schools (National Center for

Education Statistics, n.d.) identified, only some have received official green/LEED school designations and ratings (AASHE, n.d.; Princeton Review, 2019, 2020; U.S. Green Building Council (n.d.). Therefore, these were some of the primary areas of focus of this research.

This chapter provides a strong basis for this study and identifies the current gaps in the research. The variables, research questions, hypotheses, purpose, and nature of the study are presented herein, along with a brief introduction to the literature review. The theoretical and conceptual frameworks for the study are similarly presented, along with some key term definitions. I also provide a brief methodology overview, along with the study's assumptions, scope and delimitations, and potential for generalizability. The limitations, significance, and implications for practice and policy implications are further delineated in this chapter, along with some implications for positive social change.

Problem Statement

Although the U.S. Department of Education's (2014) climate change adaptation plan stated that it intends to (a) improve students' academic environments, (b) contribute to energy-efficiency practices, and (c) support environmental literacy, SE is still not adequately offered in the majority of U.S. schools, at all academic levels (AASHE, n.d.; Kenan, 2009; Rose, 2013; National Center for Education Statistics, n.d.; Yen-Chun, Shihping, Lopin, & Wen-Hsiung, 2010). Although many case-by-case examples of SE exist (AASHE, n.d.; U.S. Department of Education, n.d.), the United States has been cited for failing to adequately educate future generations about sustainability (Kenan, 2009; Mulkey, 2015; Nijhuis, 2011; Rose, 2013; Shephard, 2010; Shephard & Dulgar,

2015; Wright, 2009; Yen-Chun et al., 2010). Even though many universities have made noticeable sustainability improvements (Hart et al., 2016), research has shown that SE has still not been uniformly adopted or implemented in the majority of U.S. schools (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Rose, 2013; U.S. Department of Education, 2014, n.d.).

Although numerous studies have attempted to compare limited aspects of students' environmental or sustainability knowledge, attitudes, and behavior (Harraway, Broughton-Ansin, Deaker, Jowett, & Shephard, 2012; Heeren et al., 2016; Michalos, Creech, McDonald, & Kahlke, 2009; Mifsud, 2012; Sahin, Ertepinar, & Teksoz, 2012; Teksoz, Sahin, & Tekkaya-Oztekin, 2012; Uitto, Juuti, Lavonen, Byman, & Meisalo, 2011), no identifiable studies have attempted to measure the exact combination of variables proposed in this study. Therefore, these were the gaps that this research filled.

The Role of Sustainability Education in Creating Sustainable Communities

Even though an abundance of climate change research (IPCC, 2007a, 2007b, 2013, 2018a, 2018b) and solutions exist, climate change leadership appears to be lacking (Begley, 2009a, 2009b; Wood, 2007). The literature reviewed suggested that global changes need to be made in a meaningful, comprehensive, and timely way (Begley, 2009a, 2009b; Carroll, 2010). Many scientific, educational, and political authorities agree that green/LEED schools and SE are viable solutions with which to address climate change needs (Blewitt, 2010; Hegarty, 2008; UNESCO, n.d.-a, n.d.-b, n.d.-c; U.S. EPA, n.d.-g, 2020). Since both have proven track records with facilitating healthy behaviors in academic communities, both may also be useful in implementing positive social change

(Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Heuer, 2010; National Environmental Education Foundation, 2017; Sterling, 2010; U.S. EPA, n.d.-g).

Green Schools and Sustainability Education

Although varying levels of sustainability exist, green schools typically strive to teach some level of environmental literacy. They also usually tend to promote healthy lifestyles, attitudes, and behaviors (AASHE, n.d.; Marcus, 2012). As such, green schools offer one of the best platforms with which to teach and model SE (Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; Wiek, Bernstein, Laubichler, Caniglia, Minteer, & & Lang, 2013; Wiek, Xiong, Brundiers, & Van Der Leeuw, 2014; U.S. Green Building Council, n.d., 2013). In addition to providing safe, healthy, and nurturing academic environments (U.S. Green Building Council, n.d.), some green schools may also provide varying degrees of EE/SE (Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; U.S. Department of Education, n.d.).

Although green buildings can contribute to positive sustainability attitudes and behaviors, research suggests that ergonomics and green building infrastructures are not sufficient to influence and/or sustain positive sustainability behaviors over time. Research has alternatively shown that a combination of SE, leadership, and sustainable infrastructures can create/maintain total system-wide changes over time (D. Wu, DiGiacomo, Lenkic, Wong, & Kingstone, 2016).

The Benefits of Green Schools

The literature reviewed revealed that green schools are not only in the best position to provide SE, but can also help communities transition to more sustainable ways

of living and working (Fielding, Terry, Masser, & Hogg, 2008; Hegarty, 2008; Marcus, 2012; McNichol, Davis, & O'Brien, 2011; National Environmental Education Foundation, 2017; U.S. Green Building Council, n.d., 2013; U.S. Department of Education, 2014, n.d.). This is because green schools generally promote sustainability, health, SE, environmental stewardship, and positive social change (Bell & Dyment, 2008). For example, green schools not only have a positive impact on students' physiological (U.S. Green Building Council, n.d., 2013) and spiritual well-being (Bell & Dyment, 2008), but can also improve students' attitudes, behavior, sense of hope, and well-being (Kerret, Orkibi, & Ronen, 2014).

Research further shows that healthy environments and nature exposure can improve educational attitudes, promote environmental awareness, lower stress/aggression (Bell & Dyment, 2008). Therefore, a combination of healthy environment and healthy sustainable practices can have a great cumulative effect. In fact, many green schools have reported significant improvements in academic performance, health, attendance, and retention. Long-term potential financial benefits have also been associated with green buildings and schools (Kats, 2006).

Green School Studies

The green school studies are listed above as well as in Chapter 2. Research shows that limited peer-reviewed studies have been conducted using the combined variables of sustainability knowledge, attitude, and behavior. Most of this type of historical research has been conducted with lower-level academic groups (Michalos et al., 2009; Mifsud, 2012; Uitto et al., 2011; Wachholz, Artz, and Chene, 2014). Therefore, very minimal

U.S. peer-reviewed, university studies include the variable combinations of sustainability knowledge, attitude, behavior, SE, green universities, academic level, and gender (Al-Naqbi & Alshannag, 2018; Hay, Eagle, Saleem, Vandommele & Li, 2019; Michalos at al., 2009; Mifsud, 2012; Sahin et al., 2012; Sulitest, 2018, 2019; Teksoz et al., 2012; Wiek, 2013; Wiek, 2014). While similar sustainability research has been conducted (Michalos et al., 2009), few have attempted to measure the degree to which university type (green/non-green), SE, and gender impact U.S. college students' sustainability knowledge, attitudes, and behavior. No other identifiable study has also attempted to measure the degree to which university type (green/non-green), SE, academic level, gender, knowledge, and behavior predict sustainability attitudes. Therefore, these were some of the parameters that I addressed in this research.

Positive Social Change

One potential positive social change result of this research is that it could lead to a better understanding of the factors (SE, gender, and university type) that influence college students' sustainability knowledge, attitudes, and behavior. Another positive social change result of this research is that it could lead to a better understanding of the factors (SE, gender, university type, academic level, knowledge, and behavior) that shape sustainability attitudes. Since this research was grounded in theory, this study may build upon previous theoretical assumptions. Since this study was also based on sustainability knowledge/education (i.e., SE), it may be able to further curriculum development as well. Therefore, it is hoped that this type of research will not only shed light on students' sustainability knowledge, attitudes, and behavior, but also inspire more of the positive

social changes needed in society today (AASHE, n.d.; Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; United Nations, n.d.-a, 1992; UNESCO, n.d.-a, n.d.-b, n.d.-c).

A Multi-Disciplinary Approach to Creating Sustainable Communities

The literature reviewed showed that a multi-disciplinary approach would be needed to resolve global climate change and energy problems. Integral to this approach are ethics and SE – both of which are critical components of societal functioning and transformation. As such, Blewitt (2010) suggested that all would benefit from establishing ethical standards and public policies that address climate change mitigation needs. Although sustainability solutions are recommended for every sector, emphasis has been placed on academic institutions (United Nations, n.d.-a, 1992; UNESCO, n.d.-a, n.d.-b, n.d.-c; U.S. Green Building Council, n.d.), industries (Hunter & Salzman, 2007; Wood, 2007), regulation agencies (U.S. EPA, n.d.-e; Wood, 2007), and governments (Begley, 2009a, 2009b; Carroll, 2010; IPCC, 2007b; United Nations, 1992).

Purpose of the Study

One purpose of this study was to measure the impact of SE, gender, and university type (i.e., green/non-green) on U.S. college students' knowledge, attitudes, and behavior. Another purpose of this study was to measure the degree to which SE, gender, university type, academic level, knowledge, and behavior were able to predict sustainability attitudes. However, the literature reviewed revealed a shortage of sustainability studies which measured the combination of all the variables proposed in this study.

This study filled a research gap related to the impact of SE, gender, and university type (green/non-green) on students' knowledge, attitudes, and behavior. It also filled a research gap with regards to U.S. college participants, who were under-represented in sustainability research (Mifsud, 2012). This study also identified factors which were able to predict sustainability attitudes to varying degrees. This study further helped to build upon the theory of planned behavior (TPB; Ajzen & Fishbein, 1977) and social identity theory (SIT; Nieuwenboer & Kaptein, 2008) by supporting established theoretical assumptions and findings. Therefore, it is hoped that this study will contribute to the scholarly literature related to the future of SE at institutions of higher learning.

Research Questions and Variables

The first three research questions examined the mean differences in the dependent variables (DVs) based on the main effect tests from a three-way multivariate analysis of variance (MANOVA) analysis. I examined each independent variable (IV) and each DV, assuming a significant overall MANOVA. The IVs, or predictor variables, in the three-way MANOVA study were SE, university type (i.e., green/or non-green), and gender; the DVs were sustainability knowledge, attitudes, and behavior. The IVs in the multiple regression study were SE, university type (i.e., green/or non-green), gender, academic level, knowledge, and behavior. The DV in the multiple regression study was attitudes. I used SPSS 21 software to conduct MANOVA, multiple regression, demographic, and follow-up analyses.

Research Questions

RQ1: Are there significant mean sustainability knowledge main effect differences between gender, university type, and SE?

RQ2: Are there significant mean sustainability attitude main effect differences between gender, university type, and SE?

RQ3: Are there significant mean sustainability behavior main effect differences between gender, university type, and SE?

The fourth research question examined each of the 2 x 2 interactions, as well as the higher level 2 x 2 x 2 interaction, when considering combinations of the IVs for each DV, assuming a significant overall MANOVA.

RQ4: Are there significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE?

A fifth multiple regression research question examined the degree to which certain variables impacted the key variable of sustainability attitudes.

RQ5: To what degree do SE, university type, academic level, gender, knowledge, and behavior predict sustainability attitudes?

Hypotheses

$H_0$1: There are no significant mean sustainability knowledge main effect differences between gender, university type, and SE.

H_a1: There are significant mean sustainability knowledge main effect differences between gender, university type, and SE.

$H_0$2: There are no significant mean sustainability attitude main effect differences between gender, university type, and SE.

H_a2: There are significant mean sustainability attitude main effect differences between gender, university type, and SE.

$H_0$3: There are no significant mean sustainability behavior main effect differences between gender, university type, and SE.

H_a3: There are significant mean sustainability behavior main effect differences between gender, university type, and SE.

$H_0$4: There are no significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

H_a4: There are significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

$H_0$5: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior do not predict sustainability attitudes.

H_a5: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior predict sustainability attitudes.

Theoretical Framework for the Study

The theories that pertain to this study are TPB (Ajzen & Fishbein, 1977; Fielding, Terry et al., 2008) and SIT (Ashforth & Mael, 1989; Nieuwenboer & Kaptein, 2008). TPB explains how attitudes are impacted by observational learning and classical

conditioning (education), whereas SIT explains how people relate to group norms and cultures which shape individual/group identities, attitudes, and behavior (Ashforth & Mael, 1989; Nieuwenboer & Kaptein, 2008). Historically, pedagogical influences such as education (Holdsworth et al., 2020; Lertpratchya, Besley, Zwickle, Takahashi, & Whitley, 2017), observational learning, classical conditioning (Baron, Branscombe, & Byrne, 2009; Fielding, Terry et al., 2008), social identity, and group norms, have all been shown to impact individual and collective behaviors (Ashforth & Mael, 1989; Nieuwenboer & Kaptein, 2008). Therefore, both theories relate to this study insofar as they address factors which shape attitudes and behavior.

According to Smith et al. (2008), TPB is guided by attitudes, reasoning, intentions, and norms. However, it is also guided by a person's perceived ability to control their behavior, known as *perceived behavior control* (PBC). In contrast, SIT focuses on intergroup relations involving group processes and social perception. SIT also relates to group norms (attitudes and behaviors), social identity, and group membership (Ashforth & Mael, 1989; Dumont & Louw, 2009). SIT posits that social identity manifests when an individual identifies with dominant in-group collective attitudes, beliefs, practices, and behaviors (Chatzisarantis, Hagger, Wang, & Thogersen-Ntoumani, 2009).

How the Theories Relate to the Construct

This study was conducted with the Attitudes toward Sustainable Development Scale (Michalos et al., 2009), which aligns with both SIT and TPB theories. Although both theories relate to attitudes, behavior, and norms (Smith et al., 2008), SIT specifically

relates to group norms, social identity, group behavior, and group practices (Ashforth & Mael, 1989; Chatzisarantis et al., 2009; Dumont & Louw, 2009). I used the Attitudes toward Sustainable Development Scale (Michalos et al., 2009) to measure the impact that SE, gender, and university type (green/non-green) had on students' sustainability knowledge, attitudes, and behavior. This scale was also used to determine the degree to which SE, university type, academic level, gender, knowledge, and behavior could predict sustainability attitudes. Authorized permissions to use and slightly modify said scale appear in Appendix A.

Definitions

Sustainability refers to the act of creating and maintaining healthy communities and standards of living that promote and preserve life (United Nations, n.d.-a). Although the term *sustainability* has been defined in more than 300 ways (Scott, 2015), it has evolved from a broad-based term into a multi-disciplinary term. Today, the United Nations' (1992, n.d.-a) definition of *sustainability* broadly refers to the overall health, well-being, and viability of eco-bio-social systems over time. The U.S. Global Change Research Program (2013) similarly defined *sustainability* as the act of protecting life, natural resources, and reducing poverty. They further defined sustainable development (SD) as the right of generations to sustain themselves (U.S. Global Change Research Program, 2013).

In terms of sustainability education, the United Nations (1992, n.d.-a) recommended that SDE not be confused with EE. While EE addresses environmental preservation and responsible stewardship, SDE addresses socio-economic, political,

cultural, and environmental preservation parameters. Michalos et al. (2009) also recommended that ESD (i.e., used interchangeably with SDE) be evaluated and studied within the United Nations' 15 SD perspectives. These include environmental, economic, and social-cultural perspectives which encompass topics such as SD/EE/ESD, human rights, gender equity, natural resources, climate change, and health. Additional ESD criterion include, but are not limited to, disaster mitigation, security, government, and corporate responsibility (Michalos, 2009).

UNESCO (n.d.-a, n.d.-b, n.d.-c) similarly defines SDE as the study of climate change, health, security, sustainable lifestyles, and SD. However, SDE also reportedly includes topics such as consumption, health, climate change-related outcomes, poverty, gender, and peace (UNESCO, n.d.-a, n.d.-b, n.d.-c). As such, Palthe (2013) recommended that the term sustainability include references to SE, health, gender equality, socio-economic equality, social justice, and proper stewardship.

From the research reviewed, there seems to be some overlap between EE and SE. For example, the National Environmental Education Foundation (2017) referred to SE as EE. While both types of education provide varying levels of EE, SE expounds on the anthropogenic/environmental impacts as well as sustainable living education (National Environmental Education Foundation, 2017). Whereas SE expands on EE, SE specifically helps to infuse SD into all aspects of the societal infrastructure (UNESCO, n.d.-a, n.d.-b, n.d.-c). The U.S. Department of Education (n.d.) also referred to this type of recommended sustainability education as SE. McFarlane and Ogazon (2011) used similar terminology to refer to SE. They described it as education for sustainability

(EFS) and sustainability in education (SIE). Sterling (2010) further defined SE as a combination of SE, EE, SDE, knowledge, values, literacy, and awareness.

Assumptions

This non-experimental quantitative study has nine assumptions. The first assumption was that participants were 18+ years of age. The second assumption was that all participants had attended a U.S. accredited college or university within the past 5 years. The third assumption was that all students voluntarily participated in this study. The fourth assumption was that all participants completed the self-report survey accurately and honestly. The fifth assumption was that students understood the meaning of the terms: *sustainability, sustainability education,* and *green school*. The sixth assumption was that students knew what type of school (green/non-green) they had attended. This assumption was faulty and required investigation. The survey results indicated that most students did not know whether or not they had attended or were attending a green school. Therefore, research was conducted to determine each students' university type (green/non-green), which was based on AASHE's (n.d.) STAR rating system. The seventh assumption was that AASHE's (n.d.) independent green school findings, ratings, list, and reports were current and accurate at the time each participants' university type was assessed in 2017. The eighth assumption was that AASHE's system of determining green university status was/is fair and appropriate. The ninth assumption was that there were no identifiable differences between green/non-green university participants who responded or did not respond to the survey.

Scope and Delimitations

Limited previous research results suggested that SE, school type (green/LEED or non-green), gender, and academic level may influence sustainability knowledge, attitudes, and behavior. Since negligible historical research has been conducted to explore these effects (Michalos et al., 2009; Swaim, Maloni, Napshin, & Henley, 2014; Teksoz et al., 2012; Uitto et al., 2011), hypotheses were generated along these lines. Since previous research indicated that sustainability attitudes were the largest predictor of sustainability behaviors (Michalos et al., 2009; Uitto et al., 2011), I further explored the interaction effects between these variables. Although the general public was invited to participate in this research, participants were required to be age 18 or older and have attended a U.S. accredited college or university within the past 5 years. To recruit participants, I posted research invitations on academic, research, and social media platforms, such as SurveyMonkey.com, Qualtrics.com, the Barrett Honors Listserv, the Sona System, LinkedIn, Instagram, Twitter, and Facebook.

I also sent email invitation links to a small number of prospective Arizona State University's (ASU) sustainability faculty. However, all invitation links, whether on social media, academic and research platforms, email, or flyers, contained the same general information: (a) an invitation to the study, (b) a brief summary of the study, (c) notice of $2–$5 Amazon e-gift cards, and (d) access to the Survey Monkey survey link. Invitation links further directed prospective participants to the SurveyMonkey.com platform wherein online surveys were completed. Follow-up compensation information was made available to participants upon completion of the survey. Alternatively,

Qualtrics participants were recruited by Qualtrics. Qualtrics participants completed their surveys on said platform and requested their separate awards through that service. No paper surveys were collected since this was exclusively an online survey.

Generalizability

Generalizability is a factor in this study insofar as previous studies have primarily focused on younger populations (elementary – high school) within the United States and other countries. While said studies have likely contributed to some generalizability in the past, this study will help to improve generalizability by including under-represented U.S. college level participants.

Limitations

One limitation of this study was that most students had not received SE, which made the measurement of SE somewhat difficult. It is likely that students would have scored higher on the Knowledge, Attitudes, and Behaviors towards Sustainable Development Scale if they had received SE prior to taking the survey. A remedy to this limitation would be that students receive pre and post SE testing in order to accurately assess the impact of SE in the future. A second limitation was that participants who received SE had likely received a non-uniform variety. A remedy for this would be that all students receive a uniform variety of SE at each level of education. A third limitation was that the gender and academic level groups were disproportionate in size. This could be remedied with a larger male-targeted sample size and more even academic level groups in the future. A fourth limitation was that the scale questions did not adequately contain all the relevant and contemporary sustainability knowledge, attitude, and

behaviors possible. Therefore, updating the construct to include more relevant and contemporary knowledge, attitude, and behavior content would be beneficial.

A fifth limitation of this study was that the scale response options were in a forced-choice format and did not allow for a wider range of possible answers. A study conducted by Geldhof et al. (2015) showed that while forced-choice and Likert-type formats could be equally useful, Likert formats may help to improve the validity of certain criterion, depending on the study type. Therefore, the Likert format should be considered an option in future research. A sixth limitation was that the attitude questions did not exactly match the behavior questions. Therefore, aligning the attitude and behavior questions might improve the effectiveness of future TPB-grounded (Ajzen & Fishbein, 1977) studies.

A seventh limitation was that the scales did not meet the Cronbach's alpha overall level of reliability (0.68–0.75). However, independent criterion analyses revealed that many of the criterion items did meet and/or exceed the benchmark of acceptability. One way to overcome this limitation would be to improve the knowledge, attitude, and behavior questions. An eighth limitation was that this study was limited to a small number of U.S. university student participants. One way to overcome this limitation would be to conduct larger sustainability studies in the future. A ninth limitation of this study involved original scale references to Canadian participants (Michalos et al., 2009). This issue was remedied with the replacement of references to U.S. participants instead. Minimal scale modifications included five additional demographic questions related to gender, SE, university name, university type (green/non-green), and academic level.

Each of these limitations, either independently or collectively, may have limited generalizability in this study.

Significance

One purpose of this quantitative study was to measure the impact that SE, gender, and university type (green/non-green university) had on students' sustainability knowledge, attitudes, and behavior. Another purpose was to determine the degree to which SE, gender, university type, academic level, knowledge, and behavior impacted students' sustainability attitudes. Some potential contributions of this study include the possibility of knowledge advancement within the fields of SE, science, psychology, social science, business, and public policy. The results of this study may also contribute to a better understanding of SE, green schools, and sustainability knowledge, attitudes, and behavior.

Since this research was grounded in theory, the results of this study built upon the established psychological theories of TPB (Ajzen & Fishbein, 1977; Chatzisarantis et al., 2009; Fielding, Terry et al., 2008; Rivis, Sheeran, & Armitage, 2009) and SIT (Ashforth & Mael, 1989; Nieuwenboer & Kaptein, 2008). The results also provided a basis for SE in schools. Although both theories contribute to an understanding of group memberships and norms – SIT contributes to a better understanding of social identity formation, whereas TPB contributes to a better understanding of conditioning (i.e., training/education) determinants/contributors of behavior. Both theories help to explain the theoretical factors which shape and impact individual/collective knowledge, attitudes,

and behavior. Therefore, the results of this study provided theoretical support for the theories and helped to advance knowledge in the field.

Social Change

While governments (Carroll, 2010; European Commission, n.d.) and businesses (Holliday, 2010; World Bank, 2012, n.d.) should take steps to address sustainability changes (UNESCO, n.d.-a, n.d.-b, n.d.-c), academic communities can facilitate and model positive social change as well (National Environmental Education Foundation, 2017; U.S. Department of Education, 2014, n.d.). In fact, most of the literature reviewed indicated that SE should be provided in schools (Scott, 2015; United Nations, n.d.-a, 1992, 2016) in order to facilitate positive sustainability change (Linnenluecke & Griffiths, 2010).

Green/LEED schools and SE studies have shown that SE can improve learning, health, attitudes, and behaviors. They can also contribute to the necessary community, societal, and global changes needed for sustainable living (Fielding, Terry et al., 2008; Hegarty, 2008; Marcus, 2012; McNichol et al., 2011; U.S. Green Building Council, n.d., 2013). However, researchers have offered varied recommendations about how to best implement sustainability transformations in schools. For example, Saidin et al. (2015) recommended using infrastructure, SE, holistic methods, leadership, and shared values to transform communities. In contrast, Penger, Dimovski, and Peterlin (2015) recommended using shared leadership, modeling, values, innovation, culture, infrastructure, and community engagement as pathways to positive social change.

One potential positive social change implication within the scope of this study was the possibility of learning more about the effectiveness of the SE programs at various green/non-green U.S. colleges and universities. Another positive social change element was the possibility of learning more about the impact of SE, university type, and gender on students' knowledge, attitudes, and behavior. A third positive social change implication was the possibility of learning which factors (SE, university type, gender, academic level, knowledge, and behavior) were able to predict sustainability attitudes. Therefore, the results of this study may be of interest to academic leaders, curriculum developers, researchers, and students who are interested in sustainability studies and positive social change.

Summary

The literature reviewed indicated that sustainable lifestyles and sustainable organizational practices are the keys to a healthy life and planet (Carroll, 2010; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Wood, 2007). Research has also shown that SE/EE and green academic platforms are essential in helping future generations to transition to more sustainable ways of living (Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Green Schools Initiative, n.d.; National Environmental Education Foundation, 2017; Perry, 2013; Redman, 2013; Sahin et al., 2012; Sterling, 2010; U.S. EPA, n.d.-f, n.d.-g, n.d.-h). However, climate change, unsustainable living practices (Wood, 2007), pollution, and energy issues (Minqi, 2007; National Institute of Environmental Health Sciences, n.d.; U.S. Energy Information Administration [EIA], 2013, 2014, 2019c, 2019d, 2020; U.S. EPA, n.d.-a, 2020) are all

driving necessary sustainability changes. As a result, most governments and world leaders recognize the need for positive social sustainability changes (United Nations, n.d.-a, 1992; U.S. Global Change Research Program, 2013).

Many governing bodies and academic institutions have also agreed that a combination of green schools (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; U.S. Green Building Council, n.d., 2013) and SE (i.e., SD, SDE, EE) education (Michalos et al., 2009; UNESCO, n.d.-a, n.d.-b, n.d.-c; United Nations, n.d.-a, 1992; Varnon, 2012) can help to facilitate positive social change. Therefore, SE and green schools should be considered frontline sustainability solutions to climate change.

However, SE is not adequately offered in the majority of U.S. schools (Kenan, 2009; Rose, 2013; Yen-Chun et al., 2010). While a limited number of related studies have attempted to compare limited aspects of students' environmental or sustainability knowledge, attitudes, and behavior (Harraway et al., 2012; Michalos et al., 2009; Mifsud, 2012; Sahin et al., 2012; Teksoz et al., 2012; Uitto et al., 2011), none of these studies have attempted to measure all of the combined variables proposed in this study. One purpose of this study was to measure the impact of SE, gender, and university type (i.e., green/non-green) on college students' knowledge, attitudes, and behavior. Another purpose of this study was to measure the degree to which SE, gender, university type, academic level, knowledge, and behavior were able to predict sustainability attitudes. The theoretical foundation of this study rests on TPB and SIT.

Chapter 2 provides a comprehensive literature review and research strategy that establishes the foundational and theoretical (Fielding, Terry et al., 2008; Nieuwenboer & Kaptein, 2008) basis for this study. It also provides a comprehensive, multi-disciplinary (NASA, n.d.-a; World Bank, 2012, n.d.), and scientific framework (U.S. EIA, 2017a, 2017b, 2019a, 2019b, 2020; U.S. EPA, n.d.-a, 2020) for understanding the need for SE and SE implementation in schools (Kenan, 2009; Mulkey, 2015; Nijhuis, 2011; Rose, 2013; Shephard, 2010; United Nations, n.d.-a, 1992, 2016, 2016; U.S. EPA, n.d.-g). I summarize studies that support and explain the significance and rationale for this study in the upcoming chapter.

Chapter 2: Literature Review

Introduction

The literature reviewed suggests that not enough is being done to meet global and national sustainability needs (Begley, 2009a, 2009b). While improvements and efforts have been made to address climate change issues over time, the climate change literature reviewed indicates that comprehensive national and international infrastructural changes are still needed (International Carbon Action Partnership [ICAP], n.d.; International Thermonuclear Experimental Reactor [ITER], n.d.; Regional Greenhouse Gas Initiative [RGGI], n.d.; United Nations, n.d.-a, 2016; U.S. EIA, 2019a, 2019b, 2020; U.S. EPA, n.d.-b, n.d.-c, n.d.-d, n.d.-e, n.d.-f, n.d.-g, n.d.-h; World Nuclear Association, n.d.).

In addition to global sustainability needs, most U.S. students are also in great need of comprehensive SE – at all levels (Kenan, 2009; Mulkey, 2015; Nijhuis, 2011; Rose, 2013; Shephard, 2010; Yen-Chun et al., 2010). Even though the U.S. Department of Education's (2014) Climate Change Adaptation Plan stated that they intend to improve students' academic environments and support environmental literacy, the literature reviewed suggested that SE is not adequately offered in the majority of U.S. schools (Kenan, 2009; Rose, 2013; Yen-Chun et al., 2010).

One purpose of this quantitative study was to compare the knowledge, attitude, and behavior differences between SE, gender, and university type (green/non-green) students. Another purpose of this study was to assess the degree to which SE, university type, academic level, gender, knowledge, and behavior could predict sustainability attitudes. The literature reviewed revealed a shortage of studies attempting to measure all

of the above-mentioned variables collectively. This study filled these gaps and also included U.S. college students who were under-represented in sustainability and SE research (Mifsud, 2012).

This study was furthermore able to build upon the psychological concepts of knowledge, attitudes, and behavior. It was also able to build on the psychological theories (TPB and SIT) that relate to SE by providing evidence that supports established theoretical assumptions and previous research findings. Therefore, it is hoped that this study will contribute to the scholarly literature related to the future of SE at institutions of higher learning.

Relevance of the Problem

Many scientific, academic, governmental, and environmental agencies agree that climate change is an anthropogenic phenomenon that needs to be addressed (NASA, n.d.-a; U.S EPA, 2020; IPCC, 2013, 2018a, 2018b). Although world population (United Nations, n.d.-b; Worldometers.info, n.d.) and industry growth (U.S. Census Bureau, n.d.; U.S. Department of Commerce, n.d.) have contributed to the current global carbon dioxide levels (Global Carbon Atlas, n.d.; U.S. EPA, n.d.-a, n.d.-i, 2020), agriculture (Gillis, 2013; Praneetham & Leekancha, 2015), livestock, pollution (Gerber et al., 2013), oil, and energy (U.S. EIA, 2011, 2013, 2014, 2020) have also contributed to rising rates (Gerber et al., 2013; National Institute of Environmental Health Sciences, n.d.; U.S. EPA, n.d.-a, n.d.-i, 2020).

The Relevance of Climate Change and its Contributors

Global carbon dioxide contributors. The Global Carbon Atlas (n.d.) identified the world's top 2017 fossil fuel carbon dioxide contributors as China (9,839 million tons [Mt]), the United States (5,270 Mt), India (2,467 Mt), and Russia (1,693 Mt). The world's total 2017 carbon dioxide emission level was listed at 36,153 Mt (Global Carbon Atlas, n.d.), with the most recent U.S. carbon dioxide level listed at 5,269 MMmt in 2018 (U.S. EIA, 2018). Although notable carbon dioxide pollution reductions have taken place (U.S. EPA, n.d.-b, 2018) in recent years, today's carbon dioxide levels are still similar to 1990 rates (U.S. EIA, 2019a, 2019b). The highest recent carbon dioxide level was seen in 2007, at 6,005 MMTs (U.S. EIA, 2019a, 2019b).

U.S. carbon dioxide contributors. The primary U.S. carbon dioxide contributors are reportedly petroleum, natural gas, gasoline, and coal (U.S. EIA, 2017a, 2017b). Transportation was also identified as the main U.S. carbon dioxide contributor in 2017, followed by industrial, residential, and commercial sources (U.S. EIA, 2017a, 2017b; U.S. EPA, 2020). The primary GHGs sources were reportedly carbon dioxide (82%), methane (10%), nitrous oxide (6%), and fluorinated (3%) gases (U.S. EPA, 2017).

Other sources of carbon dioxide pollution. Other lesser-known sources of carbon dioxide pollution include deforestation (NASA, n.d.-b), volcanic eruptions (NASA, n.d.-b; Wolfe, 2000), respiration (NASA, n.d.-b), solar flares (Science Daily, 2003), solar radiation, irradiance, sunspots (Beer, Vonmoos, & Muscheler, 2006; NASA, n.d.-b), aerosols (Srinivasan, 2008), and livestock (Herrero et al., 2015; Teachout, 2015).

Livestock carbon dioxide pollution. A significant under-reported source of pollution is global livestock. Global livestock GHG emissions reportedly range between 8% and 18% (depending on various assessment methods), with cattle contributing to up to 65–78% of the GHGs (Herrero et al., 2015). However, various pollution rates and assessment methods can be observed regionally over time. For example, the U.S. Department of Agriculture (USDA, 2010) reported a global livestock GHG rate of 30% (Boehm, Wilde, Ver Ploeg, Costello, & Cash, 2018), the United Nations Food and Agriculture Organization (n.d.-d) reported a 2018 global livestock GHG rate of 14.5%, and zu Ermgassen et al. (2018) reported a livestock GHG rate of 37%. Either way, it is suggested that global livestock is responsible for more pollution than the entire transportation sector combined (Teachout, 2015).

Livestock maintenance. Research shows that 270 million acres of U.S. land and 50% of the U.S. water supply is reportedly reserved for U.S. livestock (Teachout, 2015). Dieter et al. (2018) also reported that U.S. livestock drinks approximately 2 billion gallons of ground or freshwater every day. However, freshwater reportedly represents less than 1% of the total daily water used. Regardless, livestock is deeply embedded in the topic of sustainability since it relates to land and water use, human diets, lifestyles (fashion and furniture), and climate change (Gerber et al., 2013; Harwatt, 2018; Henderson et al., 2018; Herrero et al., 2015; Teachout, 2015; United Nations Food and Agriculture Organization [UNFAO], n.d.-a, n.d.-b, n.d.-c, n.d.-d).

Livestock demand and future pollution increase. Research shows that the 2010-2050 global demand for livestock products will likely increase (UNFAO, n.d.-a)

due to population growth (9.8 billion people by 2050; United Nations, n.d.-b). A similar report projected that livestock demand will increase by 73% for meat and 58% for dairy over the next 30 years (Gerber et al., 2013). Therefore, livestock is central to the topics of sustainability, pollution, and climate change (Gerber et al., 2013; Harwatt, 2018; Herrero et al., 2015; Teachout, 2015; UNFAO, n.d.-a, n.d.-b, n.d.-c, n.d.-d).

Deforestation and ecosystem depletion. Global agricultural and livestock research shows that approximately 80% of global agricultural land is used for livestock maintenance and production (Wirsenius, Azar, & Berndes, 2010). Additional research indicates that the predominant cause of Amazonian deforestation and depletion (Garcia, Filho, Mallmann, & Fonseca, 2017; Walker, Patel, & Kalif, 2013) is also livestock production. NASA satellite images confirm that significant portions of the Amazon rainforest and the surrounding area have been cleared to accommodate livestock (Bustamante et al., 2012). Since large land and water resources are being devoted to livestock, it is clear that livestock is central to the discussion of sustainability, pollution, and climate change.

The Relevance of Energy, Pollution, and Climate Change Projections

The International Energy Outlook Report projected that global petroleum-type fossil fuel use will represent 77% of the energy used in 2040, followed by natural gas, coal, renewables, and nuclear energy (U.S. EIA, 2017a, 2017b). While the U.S. EIA (2017a, 2017b) listed China as #1, the United States as #2, and India as #3, as the world's largest coal producers, China is projected to quadruple its coal production through 2040. China is also projected to remain the worlds' largest producer of coal for the foreseeable

future, whereas India is projected to supersede the United States as the world's second largest coal producer by 2040 (U.S. EIA, 2017a, 2017b).

Despite China's and United States' projected reductions in coal consumption by 2040, worldwide carbon dioxide levels are still projected to increase through 2040. India and other developing countries are also projected to increase their coal production/consumption and generate more carbon dioxide pollution, which will subsequently cancel out any negligible global carbon dioxide reduction benefits (U.S. EIA, 2017a, 2017b, 2019c, 2019d). As a result, more must be done at every level of society to address issues related to climate change and sustainability issues now (Begley, 2009a, 2009b; United Nations, n.d.-a, 1992, 2016; Wood, 2007).

The Relevance of Toxic Environments Impacting Health

Studies have shown that toxic elements and pollution not only cause adverse impacts on climates (IPCC, 2007a, 2013, 2018a, 2018b), environments, ecosystems (U.S. EPA, n.d.-a, n.d.-i, 2020), and animals (Walls et al., 2019; Win, 2018), they are also detrimental to human health and well-being (Centers for Disease Control and Prevention, n.d.; Lunenburg, 2011; Shaowei et al., 2013; Sheffield & Landrigan, 2011; Spira-Cohen, Chen, Kendall, Lall, & Thurston, 2011; Thapar, Cooper, Eyre, & Langley, 2013).

Research shows that pollution and toxic environments can contribute to a myriad of physical, cognitive, and psychological conditions, such as hypertension, cardiovascular (Shields et al., 2013), respiratory (Levesque, Surace, McDonald, & Block, 2011; Spira-Cohen et al., 2011) and neurological (Weinhold, 2011) disease. Toxic environments can also contribute to cognitive/behavioral deficits (Lunenburg, 2011; Thapar et al., 2013),

mood disorders (Rountree, 2009), Autism, ADHD (Thapar et al., 2013), ADD (Moulton & Wei, 2012), Alzheimer's (Moulton & Wei, 2012), Parkinson's (Levesque et al., 2011), central nervous system disorders (de Gennaro, Farella, Marzocca, Mazzone, & Tutino, 2013), toxic burden (Burnett, 2013), neurodegeneration, and cancer (Lunenburg, 2011).

Other illnesses related to toxic exposure and pollution include DNA and organ damage, anemia (Thrasher & Kilburn, 2001), mesothelioma, autoimmune disorders (Matsuzaki et al., 2012), fibromyalgia, chronic fatigue (Rountree, 2009), birth defects (Thrasher & Kilburn, 2001), sick building syndrome (Babatsikou, 2011; Institute of Medicine, 2000, 2006, 2011; Lunenburg, 2011; Redman, Hamilton, Malloch, & Kleymann, 2011), and death (Shields et al., 2013; Thrasher & Kilburn, 2001). Therefore, transitioning to healthier infrastructures (U.S. Green Building Council, n.d.), products, (EWG, n.d.), and lifestyles will be essential for human, environmental, and planetary survival (Begley, 2009a, 2009b; Carroll, 2010; IPCC, 2007a, 2013, 2018a, 2018b; NOAA, n.d.; U.S. EPA, 2020; Wood, 2007).

The Relevance of Sustainability

Sustainability is at the forefront of every mainstream scientific discussion and is forcing civilization to deeply question the long-term consequences of our individual/collective knowledge, attitudes, behaviors (Michalos et al., 2009), values, ethics (Hegarty, Thomas, Kriewaldt, Holdsworth, & Bekessy, 2011), and policies (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; IPCC, 2018a, 2018b, 2013; United Nations, n.d.-a, 1992).

Teaching social responsibility in schools. Research has shown that students can be taught social responsibility, which can translate into positive social change (Nicholson & DeMoss, 2009; Sanchez, Rodriguez Bolivar, & Lopez-Hernandez, 2013; Wolk, 2009). Since academic institutions are already shaping societal attitudes and behaviors (Hegarty, 2008), many researchers have suggested that educators have a public responsibility to teach, model, and promote the right ethical lifestyle and behaviors (Nicholson & DeMoss, 2009; Sanchez et al., 2013).

The Relevance of Green Schools

The literature reviewed indicated that green schools can improve communities in a myriad of ways. For example, they can improve student/employee retention, student performance, well-being, health, attitudes, and behavior (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; U.S. Department of Education, 2014, n.d.; U.S. Green Building Council, n.d., 2013). They can also prepare communities for the future (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c) by creating sustainable environments, infrastructures, and systems that serve as teaching models for society (Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; Carroll, 2010; Fielding, Terry et al., 2008; Hegarty, 2008).

The term green school is most often associated with safe, healthy, and energy-efficient academic environments. While all green schools are not created equal, many green schools attempt to model and/or teach sustainability on some level. Some green schools also infuse SE into their curriculum. Most are constructed to meet state laws, U.S. EPA (n.d.-e) guidelines, and LEED standards (U.S. Green Building Council, n.d.).

They also aim to use safer products, prohibit/limit toxic materials, implement sustainable practices, and conserve water and energy. Many additionally seek to improve indoor air quality, provide natural lighting, reduce noise pollution, and preserve natural habitats (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; U.S. Green Building Council, n.d.). Therefore, green/LEED construction/design can improve community public health and well-being. Green environments can also reduce environmental stress, lower asthma rates, improve academic performance, reduce absenteeism/attrition, improve behavior, and eliminate waste (Healthy Schools Network, 2016; Kats, 2006; U.S. Green Building Council, n.d.).

Green universities. AASHE (n.d.) leads in SE reform by providing SE feedback, infrastructure evaluations, and sustainability ratings to colleges and universities that request evaluations (AASHE, n.d.; Shephard, 2010). AASHE (n.d.) also provides additional research, operational, and academic support to universities working to become more sustainable (AASHE, n.d.; Wiek et al., 2013; Wiek et al., 2014).

LEED schools. The U.S. Green Building Council (n.d.) is the leading authority in sustainable LEED construction and design. Under this system, LEED (Leadership in Energy and Environmental Design) schools are rated (platinum, gold, silver, bronze, or certified) according to compliance with varying green building and environmental codes. In addition to providing an international certification system, the U.S. Green Building Council (n.d.) also establishes sustainable building guidelines while addressing environmental and community development issues.

Green schools and sustainability education. While many practical sustainability and climate change solutions exist, the most practical and obvious solutions are SE (Michalos et al., 2009; United Nations, n.d.-a, 1992; UNESCO, n.d.-a, n.d.-b, n.d.-c; Varnon, 2012) and green/LEED schools (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; U.S. Green Building Council, n.d.). While much of the literature reviewed identified SE (United Nations, n.d.-a., 1992, 2016) and green schools (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; U.S. Green Building Council, n.d.) as viable solutions to climate change, SE is reportedly not offered as a mandatory, or even optional course, within most U.S. schools (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Kenan, 2009; Rose, 2013; Yen-Chun et al., 2010).

The literature reviewed not only revealed a shortage of green/LEED colleges/universities within the U.S. (AASHE, n.d.; National Center for Education Statistics, n.d.; Princeton Review, 2019; Sierra Club, 2019), but also revealed a limited number of peer-reviewed, university level, sustainability studies (Weiss & Barth, 2019; Y. C. J. Wu & Shen, 2016). These were some of the gaps identified in this research. Negligible peer-reviewed, university level, sustainability studies, using the exact combination of variables in this study (SE, university type, academic level, gender, knowledge, attitudes, and behavior) were also found. This is a gap that this research filled.

The Relevance of Sustainability Education

McFarlane and Ogazon (2011) believe that SE is integral to civilization's health, survival, and quality of life. They also maintain that the U.S. has a duty to lead SD efforts through clear objectives, SE, and healthy societal norms (McFarlane & Ogazon, 2011). Even though many educators, leaders, scientists, and researchers recognize the need for healthy schools, healthy communities, and SE (Apul & Philpott, 2011; Aurandt & Butler, 2011; Bourn & Shiel, 2009; Coman, 2008; Feng, 2012; Hegarty et al., 2011; Maxfield, 2011; Nicholson & DeMoss, 2009; Poff, 2010), many would agree that modern education is generally failing to build sustainable academic environments and provide adequate SE (Kenan, 2009; Rose, 2013; Shephard & Dulgar, 2015; Wright, 2009; Yen-Chun et al., 2010).

Since research has shown that supportive sustainable infrastructures and SE can encourage positive social change, it stands to reason that SE not only belongs in the public domain, but also in schools (Carroll, 2010; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Kates, Parris, & Leiserowitz, 2005; National Environmental Education Foundation, 2017; United Nations, n.d.-a, 1992; UNESCO, n.d.-a, n.d.-b, n.d.-c; U.S. Department of Education, n.d.). Therefore, SE is not only an academic necessity (United Nations, n.d.-a, 1992), but a health necessity as well (Hegarty, 2008; Lunenburg, 2011; Winter & Cotton, 2012). As such, academic institutions (particularly those in higher education) have a responsibility to not only provide SE, but to also explain the global relevance of this topic (Cassidy, 2015).

Grauerholz, Bubriski-McKenzie, and Jacques (2015) emphasized the importance of SE and SD education – particularly, socio-environmental factors that relate to global, community, socio-economic, and individual impacts. They recommended that students learn about hyper and sustainable consumerism in order to transform attitudes, motivations, and behaviors (Grauerholz et al., 2015). Goldman, Ayalon, Baum, and Haham (2015) similarly emphasized the need for EE and SE literacy in higher education.

Sabbaghi and Cavanagh (2015) also recommended that universities teach about sustainability ethics as it relates to education, spirituality/religion, social justice, and economies. Since societies, environments, and cultural identities are intertwined with economies, Sabbaghi and Cavanagh (2015) argued that societal leaders and members have a duty to make responsible choices about responsible ways of living. They also stated that universities also have a duty to provide the right SE curriculum and community supports (Sabbaghi & Cavanagh, 2015).

The National Environmental Education Foundation (2017) stated that SE could be the key to opening the doors to a brighter, healthier future. For example, SE can teach students about proper environmental stewardship as well as greening and sustainability activities (Stevenson, 2007). SE can also improve students' critical/creative thinking skills, promote positive lifestyle changes, and influence positive stewardship behavior. Green environments and SE/EE can also instill community values, standards, health, and adaptation skills (Guoliang, 2011; Thomas, 2009).

Researchers have offered a number of ways to approach SE administration. For example, Jonsdottir (2015) suggested that students could learn about SE solutions

through social justice, values, and empathy. He recommended transforming societal attitudes and behaviors through education, democracy, and justice. Konig (2015) also suggested that academic leaders and policymakers should work together to integrate science information with SE. Whereas Figueiro and Raufflet (2015) recommended using case studies, problem-based learning, and multi-disciplinary approaches, Hegarty et al. (2011) suggested that a single SE course would be most beneficial.

The literature reviewed showed that students can be taught SE skills in a variety of ways (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Redman, 2013). Some of these approaches include teaching/modeling sustainable behaviors, systems thinking, reasoning, and planning. Another supportive sustainability strategy involves community-building through stakeholder activities (Galloway, Shircore, Corbett-Jarvis, & Bradshaw, 2011; McIntosh, Filter, Bennett, Ryan, & Sugai, 2010; Redman, 2013).

Of all the SE delivery methods and SE pedagogical approaches reviewed, project-based learning (PPBL) was considered to be the most effective pedagogical approach for teaching SE (Wiek et al., 2014). The PPBL approach sets SE standards and competency expectations related to knowledge and skills that students must master during their SE training. This approach involves active learning, case studies, workshops, group projects, field trips, capstones, and community projects (Wiek et al., 2013; Wiek et al., 2014). Another useful method of incorporating SE into academic communities involves the Cebrian (2018) I3E model, which includes SE, community engagement, and empowerment through transformational learning.

Research has repeatedly shown that education is able to not only influence attitudes and behavior (Koger & Scott, 2007), but is also able to shape norms, habits, identity (Baron et al., 2009; Coman, 2008), cultures, and society (Hegarty, 2008; Lebo & Eames, 2015). If this is true, then SE belongs in the academic curriculum (Hegarty, 2008). Since academic institutions are involved in social infrastructure and collective identity building (Coman, 2008; Hegarty, 2008; Lebo & Eames, 2015), schools should likewise teach and model the appropriate SD/SE knowledge, attitudes, values, and behaviors necessary for adaptation (Jonsdottir, 2015; Sabbaghi & Cavanagh, 2015; Wiek et al., 2013; Wiek et al., 2014).

Despite all of the public SE/EE educational materials available (Hailstorks, 2013; IPCC, 2007a, 2013; National Environmental Education Foundation, 2017; Sustainable Schools Project, n.d.; U.S. EPA, n.d.-f), U.S. students are still reportedly not being adequately prepared for the future (Kenan, 2009; Mulkey, 2015; Rose, 2013; Shephard & Dulgar, 2015; Wright, 2009; Yen-Chun et al., 2010). Although leaders and educators have a shared duty to build socially responsible and sustainable communities (Carroll, 2010; Mulkey, 2015; Shephard, 2010), research shows that the recommended interventions are not happening on the scale or timetable required (Begley, 2009a, 2009b; Carroll, 2010; Van Alstine et al., 2013).

Aside from these shortcomings, research and education gaps continue to persist in this domain. For example, negligible studies have sought to measure the impact of SE, gender, and university type (green/non-green) on students' knowledge, attitudes, and behavior (Michalos et al., 2009; Uitto et al., 2011). In addition, no other identifiable

university study has measured the degree to which SE, gender, academic level, university type, knowledge, and behavior predict sustainability attitudes. These were the gaps that this research filled.

Pedagogical Approaches to Teaching Sustainability

Sterling (2010) maintains that SE should be used to help civilization to acquire SE knowledge, make better moral choices, and develop positive adaptive behaviors. However, one of the challenges with teaching SE effectively lies in the pedagogical realm (Redman, 2013; Sterling, 2010). Sterling (2010) asserted that the most common and ineffective approaches to teaching SE were the behaviorist and constructivist approaches. Sterling (2010) stated that neither were independently effective, yet subsequently recommended a blended model of both. A holistic, integrative, and transformative approach was recommended (Sterling, 2010). While many sustainability definitions and paradigms vary, most researchers agree that SE's primary focus should be on health (Palthe, 2013; Sterling, 2010), adaptation (Redman, 2013; Sterling, 2010; Swim et al., 2011), resilience (Hegarty, 2008; Zautra, Arewasikporn, & Davis, 2010), and whole systems change (Dubois & Dubois, 2012; Hegarty, 2008).

Strife (2010) noted the need for a SE/EE paradigm shift, contending that promotional and informational approaches would work best. Other researchers have recommended that EE/SE be infused into academic curriculums (Michalos et al., 2009) and disseminated within the post-modern and constructivist learning frameworks (Strife, 2010). Perry (2013) also advised educators to become more familiar with SE knowledge, assessments, curriculums, and pedagogical approaches.

Earl, VanWynsberghe, Walter, and Straka (2018) recommended adaptive education (i.e., EFS-type education) as the best pedagogical approach with which to teach SE. In short, this model recommends a community-based, multi-disciplinary approach, with contemporary/practical applications outside the classroom. Tarrant and Thiele (2016) also recommended SE, which is based on Deweyan philosophy. This pedagogical approach similarly includes adaptive intelligence/learning, skills-building, science, problem-solving, civic engagement, and positive individual/social change.

Evans, Whitehouse, and Gooch (2012) and Wals (2010) conceded that SE would likely have a more positive impact if presented in a comprehensive, contextual, and holistic way. However, Wals (2010) cautioned that values, preservation, democracy, and equality are often debatable within the SE context. In summary, the literature revealed that leaders and educators can best facilitate positive social/cultural change by establishing values, standards, and practices that support comprehensive SE/EE, health, (Hegarty, 2008; United Nations, n.d.-a, 1992, 2016; U.S. EPA, n.d.-d, n.d.-g; Wals, 2010), and sustainable environments (U.S. Green Building Council, n.d.).

Challenges with Implementing Sustainability Education

While many researchers advocate for increased SE in higher education, research has indicated some clear impediments to change (Shephard, 2010). First, there are some issues relating to the broad definition of SE. Next, there are issues surrounding the pedagogical approaches related to teaching SE. Third, there are barriers that may prohibit or limit universities from offering SE, such as conflicting leadership beliefs, funding issues, and a lack of moral incentives/obligations. Compounding factors may

include academic priorities, lack of administrative support, and/or lack of community involvement (Shephard, 2010). However, Scott (2015) identified community/school engagement as the biggest obstacle to SD change. As such, he recommended that qualified SD researchers and leaders become more involved in system-wide changes.

Assessing and changing student SE attitudes is another task that some researchers may find ominous. However, the largest barrier to teaching SE lies in the fact that many educators have likely not received adequate SE training or adopted a sustainable lifestyle themselves. Therefore, any prospective SE instructor should first acquire proper SE training and also adopt the appropriate SE attitudes and behaviors before attempting to teach SE (Shephard, 2010).

However, some academic leaders have stated that universities are not in a position to adequately teach about SE, morality, and character development (Shephard, 2010). Some also have suggested that academic institutions should not attempt to indoctrinate students with SE or influence attitudes and behaviors in this arena. Conflicting values, morals, and cultures are additional topics that might arise in this contextual realm. Some academic leaders/instructors have instead chosen to defer this topic to other sectors, maintaining that unspecified others should administer public SE instead (Shephard, 2010).

Moore (2005) listed several potential barriers that can impede the implementation of SE. These included unclear priorities, member disagreements, and ineffective administrative standards/regulations. Some additional impediments to SE implementation include leadership, funding, inadequate SE training, and ineffective SE

evaluation tools (Moore, 2005). Regardless of challenges, Moore (2005) recommended that SE be infused into every aspect of the curriculum.

Evans et al. (2012) evaluated two Australian schools' SE implementation experiences. Some of the barriers cited in these cases related to inadequate teacher SE knowledge, time, and funding. Other challenges included limited SE training, coupled with unsupportive administrative and/or peer support (Evans et al., 2012). Therefore, administrative cooperation is essential when trying to overcome SE implementation challenges. Evans et al. (2012) found that using a holistic, SE-infused environment, and system-wide approach was the most effective strategy when creating desired community changes. Some additional factors which helped schools to overcome barriers were innovation, community investment, financial support, and institutional/community support. Other solutions involved leadership, addressing resistance, and SE training (Evans et al., 2012).

A similar systems-change study took place at the University of British Columbia. In this case, some SE implementation challenges arose due to unclear sustainability definitions and policies rather than pedagogical approaches (Timmerman & Metcalfe, 2009). Resolving said issues and implementing a system-wide compliance system was essential for their SE program's success (Timmerman & Metcalfe, 2009). While SD and SE may be challenging to implement, Galloway et al. (2011) stated that every discipline should find ways to incorporate SE into their curriculum. Other researchers have recommended modeling (McIntosh et al., 2010) in conjunction with student-focused, practical learning approaches when teaching SE (Galloway et al., 2011).

Dannenberg, Hausman, Lawrence, and Powell (2012) stated that SE is the most effective first step towards positive social change. However, researchers have noted that some of the SE implementation challenges include costs as well as community and leadership support. Sustainability infrastructure, or lack thereof, can also prevent community growth. Therefore, sustainability support structures are essential for positive social change (Carroll, 2010; Dannenberg et al., 2012).

Although sustainability knowledge/SE can influence attitudes and behavior – attitudes and behavior are also shaped by awareness, values, beliefs, actions, priorities, and resources (Bossle, do Nascimento, Figueiro, Trevisan, & Muller, 2015). Therefore, sustainability changes may depend on stakeholders' desire for organizational change (Brannmark & Benn, 2012; Gibson, 2012; Petrick, 2010). Even though all sectors and organizations have been advised to transition to more sustainable ways of living and working, academic institutions have been given the added task of teaching SE. Brunold (2015) stated that one of the reasons that many organizations struggle with SE transitions is due to conflicting priorities (i.e., health vs. economic/organizational). Since SE transitioning is an area that many academic institutions struggle with, Brunold (2015) created a multi-disciplinary list of recommendations that can be found online.

Sustainability Education Recommendations

In order for sustainability changes to have the greatest lasting effect, numerous scientific experts, authorities, educators, and researchers agree that SE should be implemented in schools (AASHE, n.d.; Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; Carroll, 2010; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Heuer, 2010;

McNichol et al., 2011; National Environmental Education Foundation, 2017; Sterling, 2010; United Nations, n.d.-a, 1992, 2016; U.S. EPA, n.d.-g).

Many authoritative bodies and researchers have also clearly stated that SE should be made available to the general public and infused into cultures (Carroll, 2010; Evans et al., 2012; UNESCO, n.d.-a, n.d.-b, n.d.-c). McFarlane and Ogazon (2011) also recommended (cited in UNESCO, n.d.-a, n.d.-b, n.d.-c) that all schools infuse ESD (education for sustainable development – often used interchangeably with SE and SD) into every subject (cited in UNESCO, n.d.-a, n.d.-b, n.d.-c). Timmerman and Metcalfe (2009) further suggested that educational institutions are not only responsible for shaping civilization through values, ideas, and SE practices, but are also responsible for encouraging public policy change through research and education.

The U.S. Global Change Research Program's (2013) Congressional report also recommended that the United States invest in SE, human adaptation research, and climate change research. Although this report advises leaders about public policy issues and recommendations, this and other vital reports like it do not appear to be influencing change on the scale needed (Begley, 2009a, 2009b). Aside from needing more stringent greening and safety laws (Healthy Schools Network, 2016; Lunenburg, 2011), effective SE strategies and initiatives are still clearly needed (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016).

Global Sustainability Needs and Solutions

Government, academic, and scientific bodies have conducted various needs assessments in order to assess the global sustainability issue over time. Most of these

findings suggest that most global economies and infrastructures need rebuilding (Peters & Britez, 2009; World Bank, 2012, n.d.). Therefore, multi-disciplinary, global, and transformative SD changes will be needed in government (Carroll, 2010), education (United Nations, n.d.-a, 1992, 2016), transportation (World Bank, 2012, n.d.), agriculture (Boehm et al., 2018; Gillis, 2013), food (Gerber et al., 2013), livestock (Teachout, 2015), energy, and water domains (Krechovska & Prochazkova, 2014; U.S. EIA, 2014).

All industries will reportedly need increased monitoring and regulation (U.S. EPA, n.d.-e) in order to limit adverse impacts on life (U.S. EPA, n.d.-i, 2020). Last but not least, public and academic SE reforms will be needed in order to educate future and current generations about healthier ways of living (United Nations, n.d.-a, 1992, 2016).

Climate Change Solutions

Several climate change solutions have been proposed over time. Some of these solutions include the Kyoto Protocol (CNN, n.d.), the Paris Agreement (Climate Analytics, n.d.; Moore, 2018; National Public Radio, 2017; United Nations, 2015, 2016; U.S. EIA, 2017a), cap and trade programs (European Union, 2019; ICAP, n.d.; RGGI, n.d.; World Resource Institute, n.d.), sustainability ratings (AASHE, n.d.; Parguel, Benoit-Moreau, & Larceneux, 2011; Peters, Sisiopiku, & Kennedy, 2016; Princeton Review, 2019, 2020) nuclear energy (World Nuclear Association, n.d.), nuclear fusion (Fountain, 2017; International Thermonuclear Experimental Reactor [ITER], n.d.; Moynihan, 2015), and renewable energy (Begley, 2009a, 2009b; U.S, EIA, 2018; U.S. EPA, n.d.-h). While helpful, many more comprehensive ideas are still needed (Peters & Britez, 2009; World Bank, 2012, n.d.).

The role of psychologists in climate change leadership. Since climate change is considered the result of maladaptive attitudes, behaviors, and non-specified motivations, many researchers have suggested that psychologists are best positioned, qualified, and ethically obligated to assist with climate change mitigation (Dubois & Dubois, 2012; Swim et al., 2011). By taking environmental, SE, culture, and legal rights into consideration (Swim et al., 2011), psychologists may be able to help civilization mitigate, adapt, and limit climate change impacts (Culley & Angelique, 2011; Dubois & Dubois, 2012; Jansson, 2011; Rotolo & Church, 2012).

Swim et al. (2011) also suggested that psychologists could contribute to positive social change by conducting multi-disciplinary research that measures anthropogenic impacts. Swim et al. (2011) further recommended that climate change should be studied within the contexts of psychology and the environmental systems model. While the American Psychological Association (APA) has recently become involved with SE and climate change related issues (Hailstorks, 2013), the field of environmental psychology has been conducting research in this field for many years (Swim et al., 2011).

The APA reportedly supports SE teaching and sustainability research and has endorsed a science, technology, engineering, and mathematics (STEM) project which supports SE within the field of psychology. Said activities are carried out through research, public policy recommendations, and multi-disciplinary platforms (Hailstorks, 2013). Other researchers also agree that psychologists should facilitate public SE discussions, conduct climate change research, facilitate attitude/behavior change, and

lead positive social change (Culley & Angelique, 2011; Dubois & Dubois, 2012; Jansson, 2011).

Schwering (2011) and Kenan (2009) stated that organizational leaders have a duty to address sustainability issues. In particular, industrial and organizational (IO) psychologists have a similar duty to facilitate positive organizational change through attitude, behavior, and culture change (Dubois & Dubois, 2012; Rotolo & Church, 2012). Some of the ways that IO psychologists can lead positive social change is by conducting needs assessments and helping leaders to implement whole-systems change (Dubois & Dubois, 2012).

Separate from the market's demands for sustainable products and services, corporate responsibility is another issue that psychologists can help community and organizational leaders to address (Dubois & Dubois, 2012; Krechovska & Prochazkova, 2014; Michalos et al., 2009). IO psychologists may also be able to facilitate positive social change in the realms of organizational performance (Chatzisarantis et al., 2009), culture (McFarlane & Ogazon, 2011), health, ethics, and well-being (Blewitt, 2010; Hegarty et al., 2011).

This chapter provides a comprehensive literature review which explains the significance, relevance, and rationale of the subject matter while also providing a solid foundation for research. The literature reviewed also provides a multi-disciplinary approach which includes related research findings. The theoretical frameworks, research questions, variables, hypotheses, and key terms, are further addressed in this chapter.

The methodologies, assumptions, and identified research gaps are further addressed, along with implications for social change and knowledge advancement in the discipline.

Literature Search Strategy

The following library databases were used for this research: PsycINFO, Academic Search Complete, Business Source Complete, CINAHL Plus with Full Text, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, Communication & Mass Media Complete, Computers & Applied Sciences Complete, Database of Abstracts of Reviews of Effects, Education Research Complete, ERIC, GreenFILE, Library, Information Science & Technology Abstracts, MAS Ultra – School Edition, MEDLINE with Full Text, Military & Government Collection, NHS Economic Evaluation Database, Political Science Complete, Primary Search, PsycARTICLES, PsycBOOKS, PsycCRITIQUES, PsycEXTRA, Regional Business News, Research Starters – Education, SocINDEX with Full Text, and Teacher Reference Center, EBSCOhost database, Entrepreneurial Studies Source Health and Psychosocial Instruments, Google, and EPA.gov.

The search terms researched were as follows: sustainability, sustainability education, environmental education, green schools, green school + psychology, LEED, climate change, 4-Phenylcyclohexene, IPCC, Environmental Protection Agency, OECD, United Nations, U.S. Budget, Department of Education, formaldehyde, VOCs, aldehyde, Center for Disease Control, Agenda 21, sick building syndrome, the theory of planned behavior + meta-analysis, theory of planned behavior + sustainability, environment + theory of planned behavior, theory of planned behavior + attitudes + environment, theory

of planned behavior + ethics, social identity theory, social identity + Henri Tajfel, behavior + sustainability + students, attitudes + sustainability + students, knowledge + sustainability + students, sustainability education + knowledge, sustainability + knowledge, sustainability knowledge, sustainability education + attitudes, sustainability education + behavior, climate change, climate change + psychology, attitudes towards sustainability, climate change + effects, effects of climate change, systems theory, carbon dioxide + school, asbestos + school, school + toxic environment, fossil fuels + schools + U.S, fossil fuels + schools + U.S., volatile organic compounds + schools + U.S., energy information association + China, U.S. energy, aldehyde + us schools, fracking, nuclear energy, sick building syndrome + U.S. schools, climate change + health effects, climate change + meta-analysis, climate change + health, formaldehyde + health, environmental safety + school, world population, knowledge, attitudes, and behavior, public + private universities, online + brick and mortar universities, virtual vs. brick and mortar + sustainability + schools, sustainable AND meta-analysis, sustainable AND meta-analysis AND education, health AND meta-analysis AND education, health AND meta-analysis, LEED AND meta-analysis, LEED AND meta-analysis AND sustainability, behavior AND meta-analysis AND sustainability, attitudes AND meta-analysis AND sustainability, sustainability attitudes AND meta-analysis, attitudes AND meta-analysis, attitudes towards sustainability AND meta-analysis, sustainability education AND meta-analysis, sustainability AND meta-analysis, school AND sustainability education, university AND sustainability education, Green AND \sustainability education, Green school AND sustainability education, LEED AND sustainability education, LEED

university, LEED university AND sustainability, LEED university AND sustainability education, sustainability attitudes, sustainability behavior, sustainability AND knowledge AND behavior, sustainability AND attitudes AND behavior, knowledge AND attitudes AND behavior, sustainability knowledge AND attitudes AND behavior, sustainability education, and attitudes AND behavior AND meta-analysis and corporate social responsibility, pollution, U.S. energy sources, global energy sources, greenhouse gases, renewable energy sources, and livestock AND sustainability, and livestock AND deforestation AND pollution.

The scope of the literature review spanned more than 40 years. However, the concentrated review of the literature centered on the past 1–10 years. Peer-reviewed journal articles, as well as reliable public policy, news, and science sources, were the primary focus of the research. Governmental and non-governmental scientific organizational reports were also reviewed. While many sustainability articles are in circulation, a meta-analysis revealed that only a limited number of higher education SE teaching (n = 23) and SE curriculum (n = 81) articles were published in EBSCO, Science Direct, ProQuest, and Emerald between the years 2005 and 2014 (Y. C. J. Wu & Shen, 2016). Weiss and Barth (2019) also reported finding limited higher education SE peer-reviewed journal articles (n = 223) containing the variable combinations of knowledge, attitude, behavior, SE, and university studies. Salas-Zapata, Rios-Osorio, and Cardona-Arias (2018) similarly found minimal (n = 10/159) quality studies referencing the variable combinations of sustainability knowledge, attitude, and practice (from Science-Direct, JStore, Pubmed, Scielo, and Google) between the years 1990 and 2016.

Theoretical Foundation

The TPB (Ajzen & Fishbein, 1977; Chatzisarantis et al., 2009; Fielding, Terry et al., 2008; Rivis et al., 2009) and SIT theories were selected to explain how education, values, and group norms can shape attitudes, behaviors, identities, culture, and society (Boon, 2011; Chatzisarantis et al., 2009; Coman, 2008; Dumont & Louw, 2009; Hegarty, 2008; Koger & Scott, 2007; Lebo & Eames, 2015; Nieuwenboer & Kaptein, 2008).

Both of these theories applied to this study insofar as TPB (Ajzen & Fishbein, 1977; Fielding, Terry et al., 2008) explains how attitudes are guided/shaped by observational learning and classical conditioning (Baron et al., 2009). In contrast, SIT (Ashforth & Mael, 1989; Nieuwenboer & Kaptein, 2008) explains how people identify with groups and group norms. Therefore, these theories help to explain the relationships between education (learning), socialization, values/ethics/morals, individual/social identity, culture, norms, attitudes, and behavior (Cheng & Chu, 2014; Cho, 2019; Fielding & Hornsey, 2016; Lee & Jan, 2018; Lertpratchya et al., 2017; Rex, Lobo, & Leckie, 2015).

The Theory of Planned Behavior and Related Studies

The key theorists involved in the development of the TPB were Icek Ajzen and Martin Fishbein (Ajzen & Fishbein, 1977). This theory originated from the theory of reasoned action, which was based on the relationship between attitudes and behavior. It was also derived from the expectancy-value model of attitude formation which focused on the relationship between attitudes and beliefs (Ajzen, 2010). In recent years, researchers have recommended that variables such as self-identity, past behavior (Smith

et al., 2008), perceived autonomy, and social identity be added to the TPB. Therefore, SIT theory is not only complementary – it is also partly related to the TPB theory since it relates to social identity (Chatzisarantis et al., 2009).

Some of the key TPB factors that shape attitudes and behavior are education, beliefs, attitudes, social factors, norms, perceived behavior control, and intentions (Ajzen & Fishbein, 1977; Baron et al., 2009; Holdsworth et al., 2020; Koger & Scott, 2007). However, research points to a wide range of other factors (including social identity) that can shape attitudes and behaviors as well (Ashforth & Mael, 1989; Cheng & Chu, 2014; Cho, 2019; Fielding, McDonald, & Louis, 2008; Holdsworth et al., 2020; Lee & Jan, 2018; Lertpratchya et al., 2017; Rex et al., 2015).

For example, Rivis et al. (2009) asserted that TPB is based largely on intentions, yet also represented by motivations. However, intentions are also represented by attitudes (which include perceived behavior control [PBC]), as well as subjective social norms. Related research shows that positive attitudes towards an activity, combined with positive subjective social norms, and PBC, may determine behavioral outcomes (Rivis et al., 2009). However, research shows that moral norms, perceived moral obligations, and their influences on behavior can also influence/indicate intentions. Research has also shown that anticipated effects can explain behavior even more than attitudes can.

Rivis et al. (2009) conducted a meta-analysis study to determine the relationships between intentions, anticipated effects, moral norms, and behaviors. One of the studies reviewed involved a Dutch eco-program study that measured the relationship between five pro-environmental behaviors and three personal norms (obligation, guilt, and

willingness). The results of this study showed a significant correlation, $r = 0.60$, $p < 0.05$, between behaviors and personal norms (Rivis et al., 2009).

A similar study ($n = 112$) conducted by Smith et al. (2008) examined the effect of attitudes and behaviors on consumer behavior. Their results revealed that attitudes, intentions, self-identity, norms, and past behavior were all reflective of participants' intentions. However, past behaviors were also often more reflective of habits versus reasoning. Self-identity was also found to be a strong predictor of intention in this study insofar as self-identity and past behavior were shown to predict shopping intentions. Therefore, Smith et al. (2008) concluded that TPB is the best theory that social scientists can/should use to predict human behavior. They further recommended that the self-identity variable be included in future TPB studies.

In another related study, Webb, Sniehotta, and Michie (2010) reviewed ten behavior change theories to determine which would be the most effective with addictive behavioral interventions. A TPB meta-analysis study ($n = 185$ studies) was conducted to determine the relationship between TPB and predicted addictive behavior. The results of this study showed that 27% of the variance was predicted by TPB. Webb et al. (2010) thus concluded that TPB is not the most effective theory with which to develop behavior interventions. However, they alternatively contend that TPB is appropriate to use when trying to determine how, and to what degree interventions might influence behavior.

Swaim et al. (2014) also applied TPB to their study when assessing university students' ($n = 178$) attitudes, intentions, and behavior towards environmental sustainability. These researchers found correlations between intentions and subjective

norms, behavior and intentions, and attitudes and intentions (Swaim et al., 2014). However, students' perceived behavior control (PBC) (related to intentions and behavior) was not found to be significant in this study (Swaim et al., 2014).

The Effectiveness of the TPB Constructs and Related Studies

Ajzen and Fishbein (1977) were the foundational developers of TPB. Ajzen and Fishbein's TPB model of behavior showed that many factors shape behavior. They include intelligence, education, knowledge, information, personality, and mood. With regards to the effectiveness of TPB constructs, Ajzen and Fishbein (1977) determined that attitude assessments are only able to adequately assess behaviors when the attitude content matches the related behavioral criteria. They also concluded that behavior change was the only variable that can appropriately measure attitude change (Ajzen & Fishbein, 1977). As a result, they recommended that attitudes be measured in relation to a specific behavior.

Other variables implicated in the TPB model are values, attitudes, experience, age, gender, ethnicity, culture, and religion (Boon, 2011). Together, all these factors shape intentions, beliefs (behavioral, normative, and perceived behavior control [PBC]), subjective norms, attitudes, and behavior. Boon (2011) conducted an Australian university study (n = 97) of first-year pre-service teachers' EFS related knowledge and beliefs. The results revealed a significant relationship between attitudes towards EFS and intentions to teach SE ($r = 0.51$, $p < 0.01$). There was also a significant relationship between the intention to teach EFS and perceived behavioral control ($r = 0.43$, $p < 0.01$) in this study (Boon, 2011).

Related research showed that values and beliefs were greater predictors of behavior – even more than attitudes (Schelly, Cross, Franzen, Hall, & Reeve, 2012). As a result of these findings, Schelly et al. (2012) emphasized the importance of nurturing positive sustainability values, beliefs, attitudes, and behaviors within organizational cultures.

Social Identity Theory and Related Studies

Dumont and Louw (2009) point to Henri Tajfel as the key theorist credited with developing SIT. This theory was founded upon inter-group relation concepts within the field of social psychology and relates to social identity, stereotyping, group membership, relations, conflicts, and social perception. Although people more often identify with normative in-groups rather than out-groups, SIT suggests that strong group associations can lead to the adoption of aligned goals, attitudes, beliefs, behaviors, norms, and identity (Dumont & Louw, 2009). Ultimately, SIT posits that individual alignment with in or out-groups leads to social identity formation (Ashforth & Mael, 1989; Chatzisarantis et al., 2009).

However, Chatzisarantis et al.'s (2009) noted an exception in their health study (n = 231). These researchers found that group norms were only influential as long as individuals identified with a particular in-group. They also found that perceived autonomy support may influence/predict intentions, attitudes, and behaviors (Chatzisarantis et al., 2009).

Parris, Hegtvedt, Watson, and Johnson (2014) conducted a university study (n = 301) which compared green/LEED and non-green/non-LEED housing students'

perceptions of environmental justice. The results of this study revealed significant correlations between environmental identity and procedural environmental justice. It also revealed relationships between distributive environmental injustice and ecological injustice. Significant correlations were also found in students' perceptions of procedural environmental justice, perceived university encouragement, and ecological injustice. An interaction effect between procedural environmental and ecological injustice was also observed in this study (Parris et al., 2014).

Literature Review Related to the Key Variables and Concepts

Michalos et al. (2009) conducted two Canadian studies (one weighted and one unweighted) that measured knowledge, attitudes, and behaviors towards SD across adult and student populations. These researchers used one survey with the adult population and another with students (grades 6-12). The adult knowledge scale (n = 384 unweighted; n = 384 weighted) produced a Cronbach's alpha score of: 0.74 unweighted, and 0.72 weighted, $p < 0.05$. The adult attitude scale (n = 471 unweighted; n = 461 weighted) produced a Cronbach's alpha score of: 0.89 unweighted, and 0.89 weighted, $p < .05$. The adult behavior scale (n = 291 unweighted; n = 271 weighted) produced a Cronbach's Alpha score of: 0.65 unweighted, and 0.64 weighted, $p < 0.05$. The student knowledge scale (n = 247) produced a Cronbach's alpha of: 0.79, $p < 0.05$, the attitude scale (n = 271) Cronbach's alpha was: 0.77, $p < 0.05$, and the behavior scale (n = 269) Cronbach's alpha was: 0.63, $p < 0.05$ (Michalos et al., 2009).

Key Adult Findings

Michalos et al.'s (2009) unweighted adult regression results showed that attitudes, education level, and knowledge predicted adult behavior. Their weighted adult regression results also showed that attitude was a greater predictor of behavior than education level, although both were significant (Michalos et al., 2009). Behavior was predominantly predicted by attitudes in this study. One key finding in this study was that only 21% had self-reportedly received some amount of SE. Another key finding was that 78% believed that there was nothing that they could do to slow the rate of climate change. A third finding revealed that 76% believed that there was no benefit in getting involved with environmental issues. A fourth finding showed that 25% believed that government and corporations were in control of dictating outcomes.

A fifth key finding revealed that 65% of participants did not understand the relationship between SD and gender equality (Michalos et al., 2009). A good portion of the adult participants also seemed either unknowledgeable or confused about how poverty related to SD (Michalos et al., 2009). The adult behavior scale results indicated that participants were trying to reduce waste (83%), vote (89%), practice gender equality (89%), and avoid purchasing products from businesses lacking social responsibility (59%). All other adult behavior scores ranged from 21%–77% (Michalos et al., 2009).

Key Student Findings

The student behavior regression results showed that gender, attitudes, and knowledge significantly predicted student behavior (Michalos et al., 2009). While 70% of students had been collectively exposed to some climate change information, only 14%

had been exposed to the topic of SD. Regardless, 82% of all students in all grades believed that they should receive SE (Michalos et al., 2009). Key findings showed that 50% of 6th graders, 16% of 8th graders, and 25% of students in grades 9–12 believed that there was no sense in getting involved with environmental issues due to governments' and corporations' power to control outcomes (Michalos et al., 2009, p. 34). Another key finding was that 36% of 6th graders, 53% of 8th graders, and 64% of students in grades 9–12 believed that there was nothing that they could do to slow the rate of climate change.

Department Research Related to the Variables

The Sustainable Literacy Test (Sulitest, 2018, 2019) was born out of the Higher Education Sustainability Initiative and aligns with the United Nations' 2030 Agenda for Sustainability Development. This construct reportedly assesses sustainability knowledge concepts such as land/water use, climate action, sustainable communities, clean energy, quality education, industry/innovation, and infrastructure. Additional construct items include university sustainability practices, water/sanitation, gender equality, poverty reduction, and social justice (Sulitest, 2018, 2019). This construct contains 20 regional and 30 global multiple-choice questions, with added options for sustainability sensitivity/interest and demographic questions (Decamps, Barbat, Carteron, Hands, & Parkes, 2017).

The results of the original 2016 Sustainability Literacy Pilot Study (n = 42,683; 260 universities; 35 countries) revealed a worldwide average sustainability literacy average of 55% (Decamps et al., 2017). Additional studies revealed literacy averages

ranging from 40% to 50%, and 60% to 70%. However, the global sustainability literacy results (excluding regional questions) were in the 57th percentile range (Decamps et al., 2017).

Decamps et al. (2017) recommended exercising caution when interpreting the Sulitest results due to non-uniform item criterion (i.e., region-specific, country customizations, varying university standards) and multi-varied professional interpretations. Despite Sulitest's (2019) growing number (n = 120,641) of undergraduate, graduate, and post-graduate participants, only two peer-reviewed articles appear on the subject matter (Decamps et al., 2017; Zizka, McGunagle, & Clark, 2019). This could be because the original authors continue to update and publish their own results on their website. In addition, this survey is still new, under construction, has multi-variant adjustable features, and is not available to the public (Sulitest, 2018, 2019).

Zizka et al. (2019) referenced a meta-analysis Sulitest that assessed n = 16,575 STEM university students' levels of sustainability knowledge. Participants from 170 universities and 31 countries participated in the referenced pilot study. The results showed that higher education SE knowledge bases were generally lacking, with U.S. average scores ranging from 42% to 49%; worldwide scores ranged from 49% to 59%.

Zizka et al. (2019) also conducted a small comparative (pre and post-test) Sulitest with undergraduate study (n = 19) at an undisclosed U.S. university. The results of their study showed that students' scores (approximately 54%) were similar to national and international Sulitest averages. Since additional results indicated that SE was able to

improve sectional knowledge to varying degrees, Zizka et al. (2019) recommended future research that explores the relationship between SE and behavior.

Mifsud (2012) conducted a multi-national meta-analysis of 21 independent studies with n = 48,157 students (elementary – college) which assessed environmental attitudes, knowledge, and behavior. A number of these studies addressed environmental literacy (i.e., knowledge, attitudes, and skills), environmental sensitivity (i.e., awareness, concern, and attitudes), and environmental values (EV). The cumulative meta-analysis findings for all related studies were that students' environmental knowledge and attitudes were generally positive. A few of these studies also revealed that female environmental attitudes were more positive than males (Mifsud, 2012).

Only one study in this meta-analysis review addressed environmental behavior in relation to knowledge and attitudes (i.e., Grades 6–12; Mifsud, 2012). Although many lower-grade and adult populations have been surveyed with regards to environmental knowledge, attitude, and behavior, Mifsud (2012) reported that the late teen group was the least represented. One such study included Michigan State University participants who completed an environmental knowledge survey. The results of this study revealed the following knowledge results: pollution (44%), energy (56%), biodiversity (86%), and waste (88%; Mifsud, 2012).

Hay et al. (2019) conducted a sustainability knowledge, attitude, and behavior study with Australian university business students (n = 247). The purpose of their study was to test the effectiveness of SE within their curriculum. Some of the results of this study indicated that SE could not singularly or effectively eliminate climate change

skepticism or inactive behavior amongst students. The researchers cited the credibility of sustainability sources, along with conflicting societal/science information and social supports, as factors impacting student knowledge, attitudes, and behavior (Hay et al., 2019).

Whitley, Takahashi, Zwickle, Besley, and Lertpratchya (2018) conducted research at Michigan State University (n = 2828) to measure the relationships between values, openness to change, sustainability beliefs, behavior, and norms. The relationships between sustainability beliefs, norms, and behavior were also explored. Although biospheric values and norms were found to significantly predict behavior in this study, value-structured frameworks were considered more effective determinants of long-lasting behavior change (Whitley et al., 2018).

A study of 68 Finland schools sought to measure ninth graders' (n = 3,626) environmental interests, values, attitudes, and behaviors (Uitto et al., 2011). The results of this SD study showed that students' interest in environmental issues significantly influenced their attitudes towards responsibility and their behavior ($r = 0.45$, $p < 0.001$). Students' environmental interests were also significantly related to their bio-centric values ($r = 0.19$, $p < 0.001$). Female attitudes towards environmental responsibility were also shown to be more positive than males in this study (Uitto et al., 2011). Olsson and Gericke (2017) conducted similar sustainability research with Swedish students (n = 2413) from n = 25 schools (ages 12 – 19). The MANOVA results of this study showed an overall significant gender difference of 7% for the total sample population. However, age group was also found to be a factor in the results.

Harraway et al. (2012) conducted a similar New Zealand study of students' (n = 360; 200 females and 160 males) environmental attitudes and ecological worldviews. The New Ecological Paradigm Scale was used to measure the impact of SE on students' environmental attitudes and ecological worldviews. The results of this study indicated that females held stronger pro-ecological worldviews than males (Harraway et al., 2012).

Sahin et al. (2012) conducted a similar study of n = 958 Turkish students at a Middle East Technical University. The purpose of this study was to measure students' EV, attitudes towards sustainability, and sustainability behavior. The results indicated that students who had more positive eco-centric values/attitudes towards sustainability were more inclined to indirectly participate in positive sustainability behaviors. Therefore, sustainability knowledge influenced behavior in this study, with females demonstrating more positive EV and sustainability attitudes than males (Sahin et al., 2012).

Teksoz et al. (2012) conducted a similar university study (n = 1,345) to assess students' environmental knowledge, literacy, attitudes, and behavior in Turkey. The results of this study indicated that environmental knowledge was a predictor of environmental responsibility ($R = 0.26$, $p < 0.001$), attitudes towards the environment ($R = 0.48$, $p < 0.001$), and environmental concern ($R = 0.51$, $p < 0.001$). Environmental knowledge also reportedly had a positive impact on indirect environmental attitudes and behaviors (Teksoz et al., 2012).

A United Kingdom sustainability study suggested that higher academic level may be a factor that mediates and positively impacts sustainability attitudes and behavior

(Baiocchi, Minx, & Hubacek, 2010). Internal locus of control was also cited as a variable that could positively impact environmental behavior. However, Cleveland, Kalamas, and Laroche (2012) cautioned that sustainability attitudes and behaviors are not always consistent.

Wachholz et al. (2014) conducted climate change, sustainability knowledge, attitude, and SE satisfaction research at a New England university. Some key findings of this undergraduate study (n = 338) were that most of the students (n = 255) believed that climate change was real, n = 273 believed it was anthropogenic, and n = 217 believed it was a cause for worry. However, students in this study also demonstrated a disconnect between their beliefs/attitudes and behavior to the degree that only 18% were engaging in sustainable behaviors. Some participants (n = 185) also expressed uncertainty about humans' willingness to make the appropriate sustainability changes (Wachholz et al., 2014).

This study also revealed gender differences with regards to climate change concern. For example, females were either very or somewhat worried (80%) about climate change, whereas only 51% of males shared the same level of concern. Another key finding was that climate change concern was greater among the therapeutic majors and lowest among business majors (Wachholz et al., 2014). Most of the participants in this study (n = 209) expressed a desire for more climate change education.

Wodika and Schoof (2017) conducted a climate change literacy study of n = 264 students (112 females; 146 males) at a large mid-western university. The survey assessed students' level of trust in various community leaders. The key highlights of this study

were that 88% believed that climate change education was important, with 40% also believing that it was inadequate. Approximately 35% believed that sustainability efforts were worthwhile, whereas 11.5% were unconcerned with health and climate change. Some participants (15.5%) also questioned the relationship between climate change and health.

The results of this study showed a 45% correlation between sustainability knowledge and attitudes. However, degree type and education level had some additional bearing on the results. For example, agriculture, graduate students, and liberal arts students had the highest climate science/climate change knowledge and positive attitudes towards climate change, whereas undeclared students had the lowest climate change knowledge scores. Engineering students had the lowest sustainability attitude scores, followed by undeclared participants (Wodika & Schoof, 2017).

However, the results of this study also showed that most students had formulated their climate change opinions before college. Levels of community leadership trust were also assessed in this study. Students were found to reportedly place their highest levels of trust in scientists, federal/state authorities, teachers, and environmental activists. Students showed lower levels of trust in news agencies, religious organizations, TV, and politicians (Wodika & Schoof, 2017).

Strife (2010) reviewed more than $n = 170$ lower-level school studies which compared the differences between EE and EIC (environment as an integrated learning context) institutions and non-EE/EIC institutions. The results of this study indicated that both EE and EIC have positive impacts on student motivation, GPA, test scores, social

responsibility, and scholastic achievement rates (Strife, 2010). Comparable meta-analyses support these findings. For example, research has shown that nature exposure can improve cognitive/social skills, reduce mental health symptoms (e.g., stress, depression, ADHD, aggression; Strife, 2010), and increase well-being (Bell & Dyment, 2008; Dallimer et al., 2015; Kerret et al., 2014). Research has also shown that SE can improve critical thinking and problem-solving skills (Erdogan & Tuncer, 2009).

Yen-Chun et al. (2010) examined the SE exposure differences between the American Advanced Collegiate Schools of Business and the European Quality Improvement System. Their results outlined several key differences between both types of accrediting systems. For example, only 36/ 642 accredited schools (6%) reportedly offer SE courses. Accredited North American schools reportedly offer more ethics-type courses (versus SE courses), with added SE course completion expectations. Although Oceana and Europe reportedly offer more SE courses, accredited European schools reportedly offer 2.7 times ($p < 0.0001$) more SE courses and electives (Yen-Chun et al., 2010).

Summary

Climate change (IPCC, 2013; U.S. Global Change Research Program, 2013) and its adverse impacts (Burnett, 2013; Lunenburg, 2011; U.S. EPA, n.d.-i, 2020) are driving necessary adaptation and social change efforts (Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; United Nations, n.d.-a, 1992; U.S. Green Building Council, n.d.). As a result, sustainability and climate change are becoming important topics in government (Hegarty et al., 2011; Timmerman & Metcalfe, 2009; United Nations, n.d.-a; U.S. Global Change

Research Program, 2013), public policy (Carroll, 2010; United Nations, n.d.-a, 1992), communities (Carroll, 2010; McFarlane & Ogazon, 2011), organizations, businesses (Alcaraz & Thiruvattal, 2010; Holliday, 2010), and schools (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; United Nations, n.d.-a, 1992; UNESCO, n.d.-a, n.d.-b, n.d.-c).

The literature reviewed showed that there are many benefits associated with green/LEED schools, healthy environments (U.S. Green Building Council, n.d., 2013), and SE (AASHE, n.d.; National Environmental Education Foundation, 2017). For example, most green schools promote and improve health, sustainability, well-being, safety (Carroll, 2010; Strife, 2010; UNESCO, n.d.-a, n.d.-b, n.d.-c), social responsibility, and stewardship (Alcaraz & Thiruvattal, 2010; Hegarty, 2008; McFarlane & Ogazon, 2011; Parguel et al., 2011; Strife, 2010). Therefore, green schools and SE should be considered frontline steps to positive social change (AASHE, n.d.; Arizona State University, n.d.-a, n.d.-b, n.d.-c, 2014; U.S. Green Building Council, n.d.).

While research has shown that green school environments can have significant positive effects (Edwards, 2006; Kats, 2006; Strife, 2010), negligible research has been done to measure the impact of SE, gender, and university type on U.S. college students' knowledge, attitudes, and behavior. No other identifiable study has also sought to measure the degree to which all of the above-mentioned variables (including academic level) are able to predict sustainability attitudes. These were the gaps that this research filled.

Chapter 3 provides an explanation of the research design and rationale, variables, methodology (i.e., population, power analysis, sampling procedures, and participation), recruitment, participation, data collection procedures, and incentives. It also provides a review of the construct along with the instrumentation and operationalization of the construct. The research questions, hypotheses, methods, and research design are further delineated and discussed. The construct reliability and validity values are also presented, along with the ethical procedures, data analysis plan, validity threats, and remedies.

Chapter 3: Research Methods

Introduction

The purpose of this study was to measure the impact of SE, university type, and gender on students' sustainability knowledge, attitudes, and behavior. Another purpose of this study was to measure the degree to which SE, university type, academic level, gender, knowledge, and behavior predict sustainability attitudes. This quantitative comparative study included 606 student participants from green and non-green U.S. accredited colleges and universities.

Given the variables and previous research findings, it was expected that students from green/LEED universities would score higher on the Knowledge, Attitudes, and Behavior towards Sustainable Development Scale (Michalos et al., 2009). It was also expected that females would score higher than males on the attitude scale. It was further expected that students who had taken SE courses would score higher on the knowledge, attitudes, and behavior scales. It was lastly expected that students' academic level could impact students' sustainability knowledge, attitudes, and behavior scores.

In this chapter, I describe the research design and rationale, and delineate the methodology factors involved in this research. I also address the sample population, sampling procedures, instruments, operationalization of constructs, recruitment procedures, and participation. Data collection/storage procedures, operationalization of variables, data analysis plans, and threats to validity also are discussed.

Research Design and Rationale

Participants in this study completed a slightly modified version of the Knowledge Attitudes and Behaviors towards Sustainable Development Scale (Michalos et al., 2009). The original scale was created in order to satisfy a United Nations (1992) resolution to promote SDE, measure adult/community/student SD views, and assess the impact of SDE/ESD initiatives. Michalos et al. (2009) stated that their scale is not only reflective of the United Nations' definitions and interpretations of ESD, but is also in line with other leading experts' interpretations of ESD.

In this study, I used a quantitative comparative research design to measure the impact of SE, university type, and gender on students' sustainability knowledge, attitudes, and behavior. I also measured the variables impacting sustainability attitudes. IBM SPSS 21 was used to conduct MANOVA, ANOVA, MR, LR, and correlation analyses. SPSS 21 was also used to calculate frequency and descriptive statistics. Since this was an online study, there were no time constraints.

The Variables

The IVs, or predictor variables, in the three-way MANOVA study were SE, university type (i.e., green/LEED or non-green), and gender; the DVs were sustainability knowledge, attitudes, and behavior. The IVs in the multiple regression (MR) study were SE, university type (i.e., green/LEED or non-green), gender, academic level, knowledge, and behavior. The DV in the multiple regression study was attitudes.

Methodology

Population

A total of 606 college students from 265 U.S. accredited colleges and universities participated in this study. Half of the sample population (n = 303) were also current or recent Arizona State University students. Arizona State University is a top-rated green/LEED university and SE leader featured in the Princeton Review's (2019) list of Top 50 Green Colleges. They were also featured in the Princeton Review's (2020) list of the Best 385 Colleges in America and ranked 10th on the Sierra Club's (2019) list of America's greenest universities.

Participants may have included vulnerable or protected population groups such as elderly, pregnant females, and/or ethnic minorities. However, this type of data was not collected in this study. Demographic data, such as students' academic level, SE, gender, and university type (i.e., green/LEED or non-green), were the only items requested for comparative data analysis purposes.

Sampling and Sampling Procedures

The two primary factors impacting participation included students' availability and willingness to participate. Other participation factors involved inclusionary and exclusionary criteria such as age (participants were required to be adults over the age of 18), academic level (participants were required to be current college students or have been college students within the past five years), school type (participants must have attended U.S. accredited colleges or universities), and survey completion rates (participants must have spent a minimum of 3 minutes on the survey). Students were also

required to list the name of their university and answer all the online survey questions. This strategy allowed for a more targeted yet maximally inclusive range of participants.

The data collection period. I collected data over a 9-month period from December 2016 through August 2017. After 6 months of unproductive data collection efforts, a $5 Amazon e-gift card was introduced to incentivize prospective participants. Survey invitations were then placed on three social media platforms and two educational platforms.

Power analysis. A three-way MANOVA was used to measure the main differences and interaction effects between SE, university type, gender, and students' knowledge, attitudes, and behavior. A probability level of 0.05, a statistical power of 0.95, and a medium effect size of .25 (represented as f2 = 0.0625 in G*Power) were selected in order to adequately measure mean differences, establish significance (Faul, Erdfelder, Lang, & Buchner, 2007), and control for Type I errors (related to huge sample sizes and potentially nonrelevant findings) and Type II errors (related to inadequate sample sizes that are unable to detect effects; Sullivan & Feinn, 2012). A .25 medium effect size was also selected because it is considered the appropriate value of measurement for F-tests (G*Power 3.1.9.2.). As such, the a-priori test indicated that n = 129 were required for the MANOVA: Special effects and interactions test (G*Power 3.1.9.2.).

A MR was also used to determine the degree to which SE, university type, academic level, gender, knowledge, and behavior were able to predict sustainability attitudes. A probability level of 0.05, a statistical power of 0.95, and a recommended

medium effect size of 0.15 (Faul, Erdfelder, Buchner, & Lang, 2009) were used to ensure the validity of findings, identify significance, measure the mean differences between groups, and also control for Type I and II errors (Sullivan & Feinn, 2012). The G*Power 3.1.9.2. a priori test for linear multiple regression: Fixed model, R^2 increase, indicated that $n = 146$ participants were required for the MR study. Since the MANOVA and MR models fit this study and variables, they were able to build upon established theoretical assumptions and advance knowledge in this discipline. As such, the results of this study provided insight into factors that impact college students' sustainability knowledge, attitudes, and behavior.

Procedures for Recruitment, Participation, and Data Collection

Recruitment procedures. This study was open to the public and specifically recruited college students who met the inclusion and exclusion criteria over a 9-month period. Anonymous participants found the survey links on academic, research, and social platforms, as well as on flyers, and in a limited number of email invitations. A small number of web link survey invitations were emailed to Arizona State University sustainability faculty. However, due to the low faculty response rate, this participation group was strictly used to establish a survey completion baseline.

Informed consent. An adult informed consent form was the first document that participants encountered online prior to being able to access the online survey. Participants were invited to read the form and decide whether they met the criteria presented before agreeing to participate in this study. By completing the survey,

participants acknowledged meeting the participation requirements, and also gave consent to willingly participate in this study.

Data collection. University students completed the Knowledge, Attitudes, and Behaviors towards Sustainable Development Scale (Michalos et al., 2009) on either the Survey Monkey or Qualtrics data collection platforms. Survey invitations and links were also placed on the following IRB-approved platforms: the Barrett Honors Listserv, Sona System, LinkedIn, Instagram, Twitter, and Facebook. All invitation types (social media, online, flyer, and email) contained the same general information: an invitation to the study, a brief summary of the study, notice of $2–$5 Amazon e-gift cards, and access to the Survey Monkey link. All public and academic invitations contained a survey link that directed participants to the Survey Monkey website. However, Qualtrics participants were recruited by Qualtrics and accessed the survey on that platform. All surveys were collected on both of these internet platforms with no time constraints other than a data collection deadline.

The research data collection agency, Qualtrics, was retained for the purpose of balancing the green and non-green participant pools and obtaining greater gender symmetry. Qualtrics is a secure research data collection company that partners with a wide variety of market research panel partners to create pools of survey takers. They are a global data collection company that assists with finding and matching survey participants with survey topics of their choice (Qualtrics, n.d.). For these reasons, Qualtrics was retained to increase the participant pool and ensure that the G*Power population requirements were met. Survey Monkey was the other data collection

research company that was used to collect public survey data. Survey Monkey is a secure Microsoft-owned research platform that allows users to create surveys, as well as collect, analyze, and store results on their website.

Survey Monkey and Qualtrics compensation. Hundreds of eligible Survey Monkey participants were compensated with $5 Amazon e-gift cards. However, once the population quota was met, the Amazon e-gift compensation rate was reduced to $2 until the data collection period ended in August 2017. All eligible participants who completed this survey and requested compensation were promptly awarded within 7 days of survey completion.

In order to have qualified for the Amazon e-gift card, participants had to have agreed to the consent form, met the age criteria (18+ years of age), met the education criteria (participants were to have been college students attending a U.S. accredited college or university within the past 5 years), and completed the survey in no less than 3 minutes. After completing said survey, participants were to have emailed a request for compensation. All that was required for compensation was an active email address, a declaration of completion, declaration of the participant's university name, and the survey completion date. A small number of Survey Monkey survey awards were retained due to incomplete surveys, minimal complete times (0–2 minutes), non-accredited school status, and/or rapid succession claims coming from the same email or IP address. Qualtrics participants were compensated with a variety of Qualtrics incentives, such as airline miles, gift cards, cash, redeemable points, and/or sweepstakes entries (Qualtrics, n.d.). It was unknown which of these incentives were paid out to any of the Qualtrics

participants since each reward was privately selected by each participant within the Qualtrics platform.

Survey exit and debriefing. Participants were able to exit the survey at any time by closing their internet browser. Further follow-up and survey debriefing procedures were not required or necessary in this study. Upon survey completion, participants were provided with instructions about how to claim the e-gift card.

Instrumentation and Operationalization of Constructs

The Knowledge, Attitudes and Behaviors towards Sustainable Development Scale was developed by Michalos et al. (2009). This scale was appropriate for this study insofar as it contained the matched variables and item criterion needed for this study. Permission to use the instrument was granted by the construct developers and documented permissions appear in Appendix A.

Reliability and Validity

The Knowledge, Attitudes, and Behaviors towards Sustainable Development Scale was originally administered to Canadian adult and student populations (Grades 6–12) (Michalos et al., 2009). The construct originally measured three sustainability domains: knowledge (17 items – later changed to 15 items when two items were removed), attitudes (15 items), and behavior (15 items). The adult (n = 384 unweighted; n = 384 weighted) knowledge scale produced a Cronbach's alpha score of 0.74 unweighted, and 0.72 weighted. The adult (n = 471 unweighted; n = 461 weighted) attitude scale produced a Cronbach's alpha score of: 0.89 unweighted, and 0.89 weighted. The adult (n = 291 unweighted; n = 271 weighted) behavior scale produced a Cronbach's

alpha scores of 0.65 unweighted, and 0.64 weighted. The student (n = 247) knowledge scale produced a Cronbach's alpha score of 0.79, and the student attitude scale (n = 271) produced a Cronbach's alpha score of 0.77. The student behavior scale (n = 269) produced a Cronbach's alpha score of 0.63 (Michalos et al., 2009).

Michalos et al. (2009) used Cronbach's alpha to test the psychometric properties of each scale criterion. The findings suggested that each of these measurements generated reliability results which offered some statistical support for their scale. Michalos et al.'s scale is reflective of the United Nations' definition of ESD, as well as the 15 SD perspectives. Since it was created with the assistance of top United Nations and Decade for Education for Sustainability Development (DESD) members and Canadian SE experts, it could be considered to have good face validity. No other references to validity were mentioned by the original authors of this construct (Michalos et al., 2009).

Operationalization of the Variables

The IVs, or predictor variables, in the three-way MANOVA were SE, university type (i.e., green/LEED or non-green), and gender; the DVs were sustainability knowledge, attitudes, and behavior. The IVs in the multiple regression study were SE, university type (i.e., green/LEED or non-green), gender, academic level, knowledge, and behavior. The DV in the multiple regression study was attitudes. Each of the self-reported survey items relate to the topic of sustainability and SD as well as the United Nations' 15 sustainability objectives. In this case, knowledge refers to each participant's sustainability knowledge. Attitude refers to positive attitudes towards sustainability, and

behavior relates to engagement in positive sustainability behaviors (Michalos et al., 2009).

One example of a SD knowledge question was item K17: "Education for sustainable development emphasizes respect for human rights" (Michalos et al., 2009, p. 22). While only 15 items appear on the knowledge scale, the original numbering and sequence was maintained despite the removal of two previously identified questions. One example of an attitude towards sustainable development question was item A1: "Every girl or boy should receive education that teaches the knowledge, perspectives, values, issues and skills for sustainable living in a community" (Michalos et al., 2009, p. 23). An example of a behavior scale question was item B13: "I have changed my personal lifestyle to reduce waste" (Michalos et al., 2009, p. 25). Sustainability knowledge, attitude, and behavior scores represented the answers that each participant or group got right. Therefore, a total score of 45 points (15 points per scale) was the highest score possible (Michalos et al., 2009).

Data Analysis Plan

SPSS 21 software was used to compare the sustainability differences between green/LEED and non-green university student populations. Data cleaning was also performed to preserve the integrity of the study. As a result, more than 100 surveys were excluded from the study due to (a) incompleteness, (b) participants' affiliation with a non-accredited school, (c) unverifiable college name, and/or (d) too short of complete times (less than 3 minutes). MANOVA and MR statistical tests were used to test the

hypotheses and the results were interpreted using confidence intervals and probability values.

Research Questions and Hypotheses

The first three research questions examined the mean differences in the DVs based on the main effect tests from a three-way multivariate analysis of variance (MANOVA) analysis. Each IV and each DV was examined assuming a significant overall MANOVA. The IVs, or predictor variables, in the MANOVA study were SE, university type (i.e., green/LEED or non-green), and gender; the DVs were sustainability knowledge, attitudes, and behavior. The IVs in the Multiple Regression study were SE, university type (i.e., green/LEED or non-green), gender, academic level, knowledge, and behavior. The DV in the Multiple Regression study was attitudes.

Research Questions

RQ1: Are there significant mean sustainability knowledge main effect differences between gender, university type, and SE?

RQ2: Are there significant mean sustainability attitude main effect differences between gender, university type, and SE?

RQ3: Are there significant mean sustainability behavior main effect differences between gender, university type, and SE?

The fourth research question examined each of the 2 x 2 interactions, as well as the higher level 2 x 2 x 2 interaction, when considering combinations of the IVs for each DV, assuming a significant overall MANOVA.

RQ4: Are there significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE?

A fifth multiple regression research question examined the degree to which certain variables impacted the key variable of sustainability attitudes.

RQ5: To what degree do SE, university type, academic level, gender, knowledge, and behavior predict sustainability attitudes?

Hypotheses

$H_0$1: There are no significant mean sustainability knowledge main effect differences between gender, university type, and SE.

H_a1: There are significant mean sustainability knowledge main effect differences between gender, university type, and SE.

$H_0$2: There are no significant mean sustainability attitude main effect differences between gender, university type, and SE.

H_a2: There are significant mean sustainability attitude main effect differences between gender, university type, and SE.

$H_0$3: There are no significant mean sustainability behavior main effect differences between gender, university type, and SE.

H_a3: There are significant mean sustainability behavior main effect differences between gender, university type, and SE.

$H_0$4: There are no significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

H_a4: There are significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

H_05: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior do not predict sustainability attitudes.

H_a5: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior predict sustainability attitudes.

Threats to Validity

No known threats to external validity existed. This was a survey with little established validity because it is a relatively new construct. However, this construct likely has good face validity given the SE experts who contributed to its development. Some internal validity threats may exist, but the original authors remedied some threats to validity by removing two confusing questions from their study (Michalos et al., 2009). Other potential threats to validity were also removed for the purpose of this study. For example, three Canadian-specific survey questions were modified (K8, K12, and A11) to address U.S. participants instead. Said changes were made with the original authors' approval and appear in Appendix A. Four additional demographic questions were also added to the survey and relate to students' SE exposure, university type, gender, and academic level. This instrument was minimally modified in order to improve the validity of the survey, as well as to test the psychometric properties of the scale.

Ethical Procedures

Institutional permissions were obtained from Walden University's IRB # 11-08-16-0103236, the Sona System, Arizona State University, and the Barrett Honors Listserv. All research participants received IRB approved research invitations and survey links either through academic research platforms (including the Barrett Honors Listserv and The Sona System), research websites (including Survey Monkey and Qualtrics), or social media websites (including Facebook, LinkedIn, Instagram, and Twitter). A small number of flyer invitations were either emailed or delivered as hard copies.

Informed consent was made available as the front matter on both the SurveyMonkey.com and Qualtrics.com platforms. These were the only two survey collection platforms used. The highest level of privacy and confidentiality were maintained throughout this study. Participants' names, associated surveys, and identifying information were largely anonymous and unknown to the researcher. The only way that the researcher could have been aware of some participants' identities was if a participant willfully identified themselves in a compensation email request. However, even with this minimal information, direct connection to any survey would be impossible. No participant names, addresses, name-identifying email addresses, or name-linked surveys were requested or stored anywhere. Most participants also opted to use an anonymous email address when requesting compensation.

Each participant was treated humanely and did not suffer any harm as a result of this study. Participants had the right to decline or quit participating in this study at any time. There was also no deception in this study. All survey information, qualifying

criteria, exit information, confidentiality concerns, and compensation information were addressed within the Informed Consent form. Compensation instructions were also provided upon exiting the survey. Some participants withdrew early from the study and/or did not complete their surveys. As a result, this data was omitted from the study during the data cleaning process. Other ethical concerns related to a small amount of fraudulent reward claim attempts. This was evidenced by very short complete rates of 0–2 minutes) and attempts to collect multiple Amazon e-gift cards from the same IP or email address. Follow-up email verifications were performed in some of these instances. Some participants were asked to explain why multiple claims came from their email address, declare the college that they attended, and/or state the date and time of survey completion. Approximately 100 surveys were discarded in order to preserve the integrity of this study. Incomplete, unqualified, and/or fraudulent claims were omitted from the study. All survey results were kept anonymous and confidential. All anonymous participant data, survey information, and results will be stored on the Qualtrics and Survey Monkey platforms, as well as the researcher's computer for a period of five years. Only the researcher and committee members will have access to the data.

Summary

This study compared the sustainability knowledge, attitudes, and behavior differences between U.S. green/LEED and non-green university student populations. It was expected that students who attended a green/LEED university would score higher on the sustainability knowledge, attitudes, and behavior scales. It was also expected that participants who were exposed to SE would score higher than those who had not received

SE. It was further expected that non-green university affiliation, coupled with minimal SE, would result in lower sustainability knowledge, attitude, and behavior scores. Based on prior research findings, it was additionally expected that females would demonstrate higher positive attitudes towards sustainability than males.

The IVs, or predictor variables, in the MANOVA study were SE, university type (i.e., green/LEED or non-green), and gender; the DVs were sustainability knowledge, attitudes, and behavior. The IVs in the Multiple Regression study were SE, university type (i.e., green/LEED or non-green), gender, academic level, knowledge, and behavior. The DV in the Multiple Regression study was attitudes. The research questions, hypotheses, methods, and research design were discussed in this chapter. The power analysis, methodology, procedures, construct reliability, and validity issues were also presented in this chapter, along with the data analysis plan, research rationale, threats to validity, and ethical procedures.

The upcoming chapter provides a comprehensive overview of the data collection procedures, descriptive statistics, research questions, hypotheses, analyses, and interpretations of the findings. Some of the other parameters addressed within this chapter are the scale reliability results, validity checks, and summary statistics. The results of the MANOVA and multiple regression findings are interpreted within the scope of the research questions and hypotheses.

Chapter 4: The Results

Introduction

The purpose of this quantitative three-way MANOVA study was to compare the knowledge, attitude, and behavior differences between SE, gender, and university type (i.e., green/non-green). The purpose of the MR study was to further assess the degree to which SE, university type (i.e., green/LEED or non-green), gender, academic level, knowledge, and behavior impact sustainability attitudes.

Research Questions

RQ1: Are there significant mean sustainability knowledge main effect differences between gender, university type, and SE?

RQ2: Are there significant mean sustainability attitude main effect differences between gender, university type, and SE?

RQ3: Are there significant mean sustainability behavior main effect differences between gender, university type, and SE?

The fourth research question examined each of the 2 x 2 interactions, as well as the higher level 2 x 2 x 2 interaction, when considering combinations of the IVs for each DV, assuming a significant overall MANOVA.

RQ4: Are there significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE?

A fifth multiple regression research question examined the degree to which certain variables impacted the key variable of sustainability attitudes.

RQ5: To what degree do SE, university type, academic level, gender, knowledge, and behavior predict sustainability attitudes?

Hypotheses

$H_0$1: There are no significant mean sustainability knowledge main effect differences between gender, university type, and SE.

H_a1: There are significant mean sustainability knowledge main effect differences between gender, university type, and SE.

$H_0$2: There are no significant mean sustainability attitude main effect differences between gender, university type, and SE.

H_a2: There are significant mean sustainability attitude main effect differences between gender, university type, and SE.

$H_0$3: There are no significant mean sustainability behavior main effect differences between gender, university type, and SE.

H_a3: There are significant mean sustainability behavior main effect differences between gender, university type, and SE.

$H_0$4: There are no significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

H_a4: There are significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE.

$H_0$5: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior do not predict sustainability attitudes.

H_a5: Sustainability education, university type, academic level, gender, sustainability knowledge, and sustainability behavior predict sustainability attitudes.

In this chapter, I review the purpose of the study, outline the research questions and hypotheses, and provide recruitment data as well as a summary of the data collection procedures. This chapter further presents descriptive demographic statistics related to the sample population. MANOVA and multiple regression results are also delineated, along with interpretations and summaries for each.

Data Collection

Response Times

Most participants completed this survey in approximately eight minutes. There were no imposed time limits on this survey beyond the minimum 3-minute standard requirement. Figure 1 shows a wide range of survey completion times.

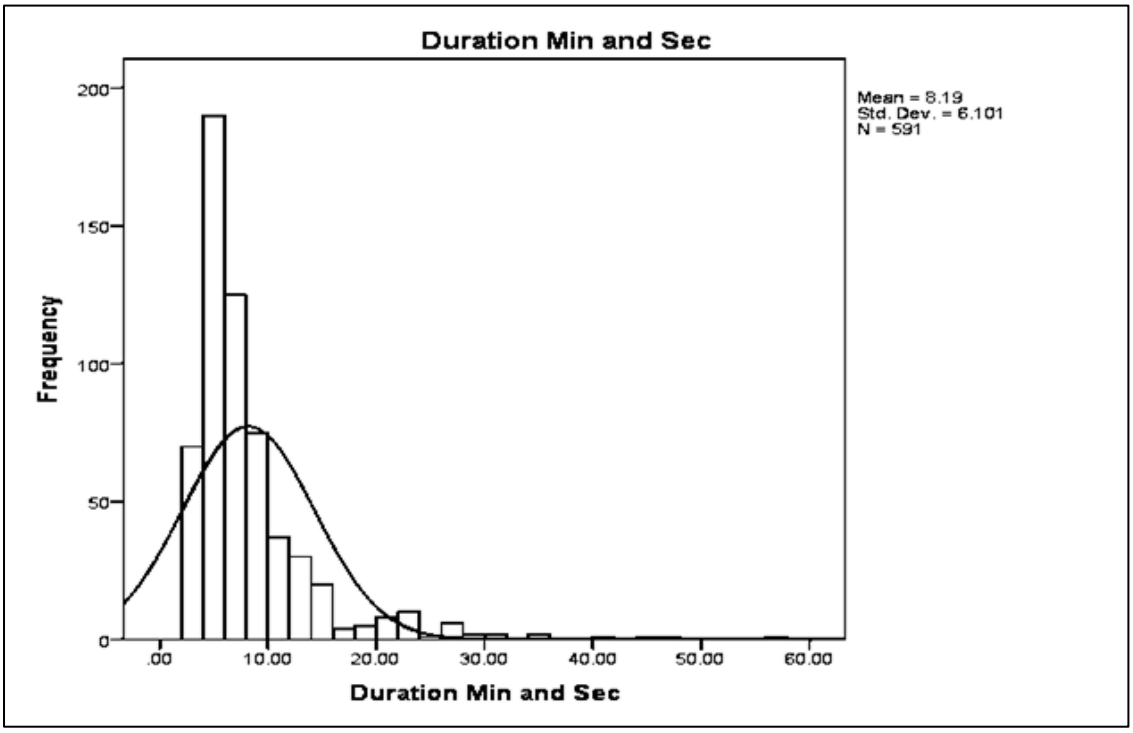

Figure 1. Survey completion times.

The 3-minute minimum complete time was established by one or more Arizona State University sustainability teachers/subject matter experts who demonstrated that this survey could be completed correctly in this short amount of time. However, participants were given the option to take as long as necessary to complete the survey. Since participants were given the option of taking a break and returning to complete the survey at a later date or time, a small number of participants took more than 1 hour to complete the survey. Surveys with excessively long completion times (more than 1 hour) or excessively short completion times (fewer than 3 minutes) were excluded from the average complete times reported.

Descriptive Statistics

Green and Non-Green University Classifications

For the most stringent classification purposes, green and non-green status designations were determined by the STARS green rating system which was developed by AASHE (n.d.). When students were asked to identify which type of university (i.e., green vs. non-green) they attended, 70% (n = 426) of participants stated that they did not know which type of university they were attending or had attended. Approximately 23% of students believed that they were attending (or had previously attended) a green/LEED university, whereas 7% believed that they were attending (or had previously attended) a non-green university.

As a result of this finding, exhaustive academic research was conducted to ascertain the exact type of school (i.e., green/LEED or non-green university) that each student participant had attended (AASHE, n.d.). Upon review of all the colleges and universities that participants had reportedly attended, it was determined that 71% (n = 430) of the participants had attended STARS rated green/LEED universities (AASHE, n.d.). The remaining 29% of participants (n = 176) were currently attending or had attended non-green universities. Non-green status was evidenced by some schools' lack of appearance on the STARS rating list (AASHE, n.d.).

Participants

Online surveys were completed by 717 U.S. participants who had attended 265 U.S. accredited green or non-green colleges/universities within the past 5 years. However, due to inclusionary and exclusionary requirements, only 606 (n = 430 green; n

= 176 non-green) of the surveys qualified for inclusion in this study. Of those, 303 participants had attended or were attending ASU. Undergraduate students (n = 408) represented 67% of the sample, whereas graduate level students (n = 198) represented 33% of the sample population.

There was a disproportionate number of female students (n = 404; 67%) compared to male students (n = 202; 33%) in this study. While the uneven gender groups were unintended, the literature reviewed showed that females possess stronger positive attitudes towards sustainability than males (Harraway et al., 2012). Therefore, it was not surprising that more females than males volunteered to participate in this study. Table 1 delineates the demographic frequencies.

Table 1

Frequency Table for Nominal Variables

Variable	*n*	*%*
STARS ratings		
Green university	430	71
Non-green university	176	29
Missing	0	0
SE education		
No	424	70
Yes	182	30
Missing	0	0
Student level of education		
College freshman	45	7
College sophomore	109	18
College junior	101	17
College senior	153	25
First-year graduate student	44	7
Second-year graduate student	47	8
Third-year graduate student	35	6
Fourth-year doctorate level	33	5
20+ doctorate-plus level	39	6
Missing	0	0
Gender		
Female	404	67
Male	202	33
Missing	0	0
Education Level		
Graduate level	198	32
Undergraduate level	408	67
Missing	0	0

Note. Due to rounding, percentages may not equal 100%.

Notable Frequencies and Percentages

Seniors (n = 153, 25%), females (n = 404, 67%), and undergraduates (n = 408, 67%) made up the largest percentages of the sample. In addition, green university affiliation was the most frequently observed college type in this study (n = 430, 71%). A key notable finding was that n = 424 students (70%) in this study had not received SE.

Summary Statistics

Table 2 below delineates the average scores for each of the knowledge, attitude, and behavior scales.

Table 2

Summary Statistics Table for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Skewness	Kurtosis
Knowledge	12.93	2.12	606	0.09	-1.13	0.93
Attitudes	13.01	2.20	606	0.09	-1.51	2.20
Behavior	10.46	2.84	606	0.12	-0.31	-0.59

Note. Results are rounded to the nearest tenth.

The skewness and kurtosis are also presented in Table 2. A result of -2 skewness indicated that each identified variable was asymmetrical about its mean. However, each item's kurtosis is also not greater than or equal to 3, which indicates that each variable's distribution is reflective of a normal distribution (Laerd Statistics, 2015; Westfall & Henning, 2013).

Research Question Evaluations

A three-way MANOVA was used to assess the sustainability knowledge, attitude, and behavior differences between gender, university type (green/non-green), and SE population groups.

Evaluating the MANOVA assumptions. The MANOVA assumptions include tests of multivariate normality, absence of multicollinearity, and evaluation of homogeneity of covariance. The first three assumptions were met. There was an existence of a continuous DV. The IVs were categorical, having two or more independent groups, and there was also independence of observations. There were also some linear relationships between the DVs (knowledge, attitudes, and behavior) for each of the IVs (university type, SE, and gender), although to varying degrees.

Absence of multicollinearity. A Spearman's Rho was performed to examine the correlation between the DVs: knowledge, attitudes, and behavior. The results demonstrated a correlation between the knowledge and attitude scales ($r = 0.70$, $p < 0.001$, two-tailed), the behavior and knowledge scales ($r = 0.22$, $p < 0.001$, two-tailed), and the behavior and attitudes scales ($r = 0.30$, $p < 0.001$, two-tailed). Although there were some correlations between the DVs, the results of the variable combinations had correlations less than 0.9 in absolute value, which indicated that the results were unlikely to be significantly influenced by multicollinearity.

Multivariate outliers. Mahalanobis distances were calculated on the residuals and compared to a χ^2 distribution (Laerd Statistics, 2015; Newton & Rudestam, 2012). There were also several outliers that exceeded the critical value cut off point. As a result,

a follow-up three-way MANOVA was performed to compare the differences with and without outliers. Since removal of the residual outliers did not significantly impact the majority of the findings, the outliers were kept in the overall study. The results of each significant finding (with and without outliers) are presented in the Results section.

Multivariate normality. Multivariate normality was assessed with Mahalanobis distances, which were calculated for the residuals and plotted against the quantiles of a Chi-square distribution (Laerd Statistics, 2015). Normality was observed and assumed since the points form a relatively straight line. Figure 2 below shows the Mahalanobis distance of the residuals.

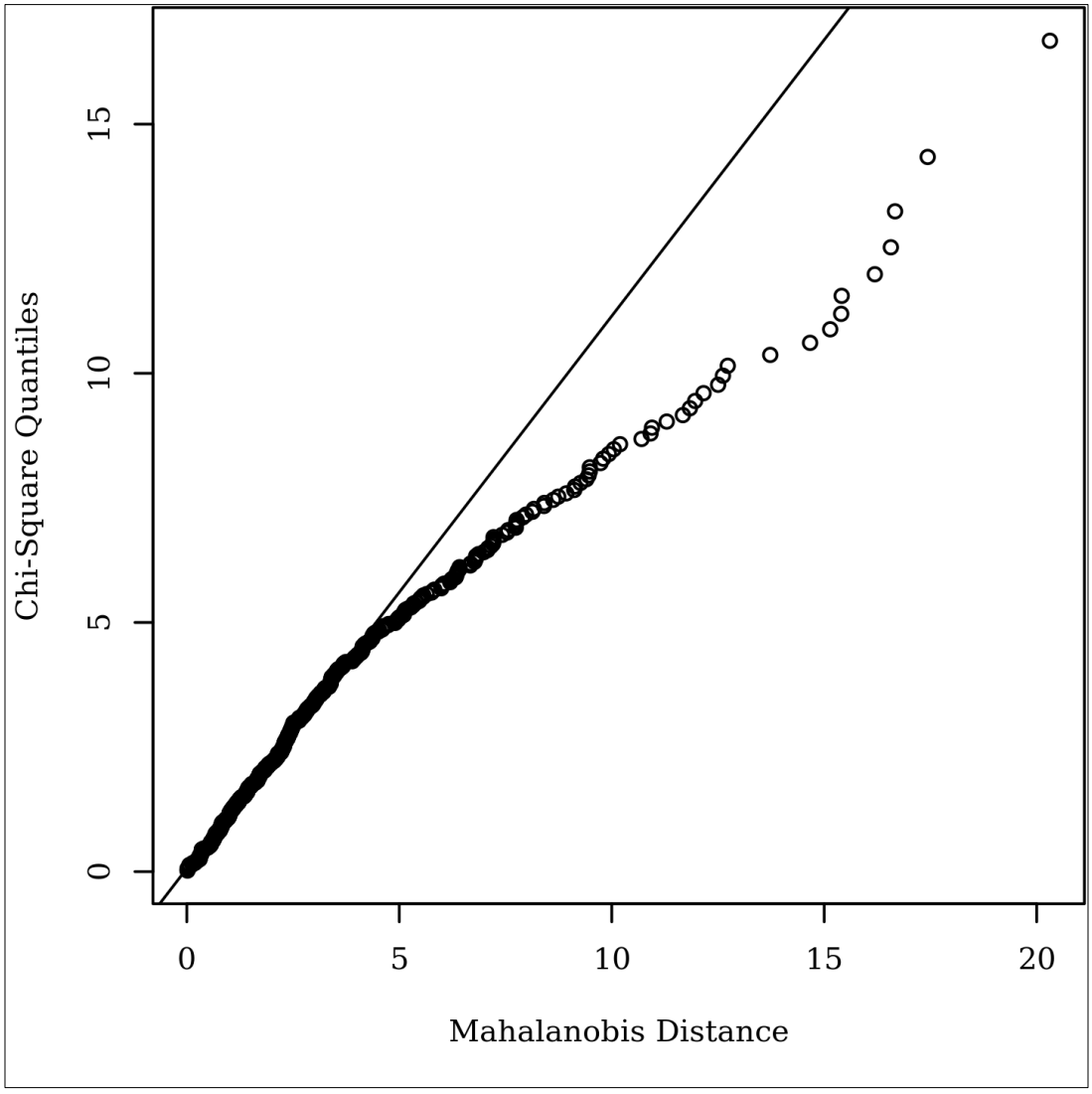

Figure 2. Multivariate normality assessed with a Mahalanobis distance chart.

The Shapiro-Wilk tests were also used to determine normality. Some of the results were significant, and therefore, the assumption of normality was not met. However, the MANOVA is robust enough to overcome this violation, even in the event of small or unequal sample sizes (Laerd Statistics, 2015; Pituch & Stevens, 2016).

Assumption of equal variances and covariances. Box's *M* was used to assess the equality of covariance matrices in the population and homogeneity of variance. The

results were significant, $\chi^2(42) = 122.809$, $p < 0.001$, which indicates that the assumption of homogeneity of covariance matrices was violated. However, Box's *M* is not always accurate in its interpretation of covariance, especially with larger sample sizes (Laerd Statistics, 2015; Rencher & Christensen, 2012). Regardless, the MANOVA is considered to be robust enough to overcome this violation as long as there is an adequate sample size in each cell, which there was in this study (Laerd Statistics, 2015; Tabachnick & Fidell, 2014). Since Pillai's Trace was also recommended in the event of potential unequal covariance, unequal sample size, and/or a significant Box's *M* (Laerd Statistics, 2015; Olsen, 1976; Tabachnick & Fidell, 2014), this test statistic was used.

Homogeneity of covariance matrices. Levene's test of homogeneity test was significant and, therefore, produced heterogeneous results for the knowledge and attitude variables, meaning that the knowledge and attitude scales violated Levene's test. However, homogeneity of variance for behavior was present and the assumption was met. Laerd Statistics (2015) stated that variable transformation is an option that may or may not resolve homogeneity of variance issues, and that proceeding without conducting a transformation is still acceptable. As a result, no transformations were conducted.

MANOVA Results

A three-way MANOVA was performed on following three IVs: university type, SE, and gender. The DVs were knowledge, attitudes, and behavior. The higher order interaction effects were also analyzed. IBM SPSS 21 was used for the MANOVA analysis.

The MANOVA knowledge, attitude, and behavior multivariate main effect results were significant for all three IVs: (a) university type (i.e., green/non-green), $F(3, 596) = 5.904$, $p < 0.001$, Pillai's Trace = 0.029, partial $\eta^2 = 0.029$ (3%); (b) SE, $F(3, 596) = 16.459$, $p < 0.001$, Pillai's Trace = 0.077, partial $\eta^2 = 0.077$ (8%); and (c) gender, $F(3, 596) = 9.671$, $p < 0.001$, Pillai's Trace = 0.046, partial $\eta^2 = 0.046$ (5%). A significant multivariate interaction effect between university type and SE was also present, $F(3, 596) = 3.686$, $p < 0.012$, Pillai's Trace = 0.018, partial $\eta^2 = 0.018$ (2%). Table 3 delineates the MANOVA results.

Table 3

The MANOVA Results for Knowledge, Attitudes, and Behavior According to University Type (GNG = Green/Non-Green), Sustainability Education (SE), and Gender

Variable	Pillai	*F*	*df*	Residual *df*	*P*	η_p^2
GNG	0.03	5.90	3	596	< 0.001	0.03
SE	0.08	16.46	3	596	< 0.001	0.08
Gender	0.05	9.67	3	596	< 0.001	0.05
GNG X SE	0.02	3.69	3	596	.012	0.02
GNG X Gender	0.00	0.70	3	596	.551	0.00
SE X Gender	0.00	0.59	3	596	.625	0.00
GNG X SE X Gender	0.01	1.90	3	596	.129	0.01

Note. Results were rounded to the nearest tenth.

The MANOVA revealed significant knowledge, $F(1, 598) = 11.754$, $p < 0.001$, partial $\eta^2 = 0.019$ (2%) and attitude, $F(1, 598) = 16.145$, $p < 0.001$, partial $\eta^2 = 0.026$ (3%) differences between green and non-green student populations. However, behavior was not found to be significantly different between green and non-green populations, $F(1, 598) = 0.284$, $p = 0.594$, partial $\eta^2 = 0.000$.

The MANOVA showed that SE did not have a significant impact on knowledge, $F(1, 598) = 0.013$, $p = 0.91$, partial $\eta^2 = 0.000$, or attitudes, $F(1, 598) = 0.058$, $p = 0.811$, partial $\eta^2 = 0.000$. However, SE did have a significant impact on behavior, $F(1, 598) = 44.444$, $p < 0.001$, partial $\eta^2 = 0.069$ (7%).

The MANOVA also revealed that gender had a significant impact on knowledge, $F(1, 598) = 16.972$, $p < 0.001$, partial $\eta^2 = 0.028$ (3%), and attitudes, $F(1, 598) = 26.456$, $p < 0.001$, partial $\eta^2 = 0.042$ (4%), but not behavior, $F(1, 598) = 0.197$, $p = 0.658$, partial $\eta^2 = 0.000$. Table 4 delineates the analysis of variance for the variable knowledge, according to university type, SE, and gender.

Table 4

The Analysis of Variance Table for Knowledge by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Term	*SS*	*df*	*F*	*p*	η_p^2
GNG	49.02	1	11.75	< 0.001	0.02
SE	0.05	1	0.01	.910	0.00
Gender	70.79	1	16.97	< 0.001	0.03
GNG X SE	37.09	1	8.89	.003	0.02
GNG X Gender	6.15	1	1.47	.225	0.00
SE X Gender	1.05	1	0.25	.616	0.00
GNG X SE X Gender	0.27	1	0.07	.798	0.00
Residuals	2494.11	598			

Note. Results were rounded to the nearest tenth.

Table 5 delineates the analysis of variance for the variable attitudes, according to university type, SE, and gender.

Table 5

The Analysis of Variance Table for Attitudes by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Term	*SS*	*df*	*F*	*p*	η_p^2
GNG	70.39	1	16.15	< 0.001	0.03
SE	0.25	1	0.06	.811	0.00
Gender	115.35	1	26.46	< 0.001	0.04
GNG X SE	33.02	1	7.57	.006	0.01
GNG X Gender	6.16	1	1.41	.235	0.00
SE X Gender	0.51	1	0.12	.734	0.00
GNG X SE X Gender	1.34	1	0.31	.580	0.00
Residuals	2607.25	598			

Note. Results were rounded to the nearest tenth.

Table 6 delineates the analysis of variance for the variable behavior, according to university type, SE, and gender.

Table 6

The Analysis of Variance Table for Behavior by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Term	*SS*	*df*	*F*	*p*	η_p^2
GNG	2.05	1	0.28	.594	0.00
SE	320.74	1	44.44	< 0.001	0.07
Gender	1.42	1	0.20	.658	0.00
GNG X SE	28.42	1	3.94	.048	0.01
GNG X Gender	0.28	1	0.04	.844	0.00
SE X Gender	2.33	1	0.32	.570	0.00
GNG X SE X Gender	22.93	1	3.18	.075	0.01
Residuals	4315.63	598			

Note. Results were rounded to the nearest tenth.

Interaction Effects

There were significant MANOVA interaction effects between SE and university type, and knowledge, $F(1, 598) = 8.894$, $p < 0.003$, partial $\eta^2 = 0.015$ (2%); attitudes, $F(1,$

598) = 7.572, $p < 0.006$, partial $\eta^2 = 0.013$ (1%), and behavior, $F(1, 598) = 3.939$, $p < 0.048$, partial $\eta^2 = 0.007$ (less than 1%).

MANOVA Interaction Effects without Residual Outliers

By removing the residual outliers, the MANOVA interaction effects between behavior, university type, SE, and gender, become significant, $F(1, 586) = 4.10$, $p < 0.04$, $\eta_p 2 = 0.01$ (1%). The implication of this finding was that a combination of green university, SE, and female status improved the likelihood of observing higher sustainability behavior scores by a factor of 1%.

Additional Analyses

Due to the significant pairwise interaction effects between SE and behavior (partial $\eta^2 = 0.07$, $p < 0.001$), a Spearman's Rho correlation was performed. The results revealed a significant negative relationship between SE and sustainability behavior ($r = -34$, $p < 0.001$, two-tailed). That is, students who did not receive SE had lower sustainability behavior scale scores compared to those who had received SE. In other words, students who received SE scored collectively higher on the behavior scale than those who did not receive SE.

Due to the significant MANOVA interaction effects between university type and SE, a follow-up LR was performed to assess the impact of university type on SE. The results were significant, $F(1, 604) = 46.388$, $p < 0.001$, $\beta = 0.267$, $t(6.811)$, $p < 0.001$, 95% [.083, 0.150], $R^2 = 0.07$. The results indicated that 7% of SE may have been influenced by Green university affiliation. Table 7 delineates the average knowledge scores according to university type, SE, and gender.

Table 7

Mean, Standard Deviation, and Sample Size for Knowledge by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Combination	*M*	*SD*	*n*
Green University: No SE: Female	13.27	1.79	197
Non-green University: No SE: Female	12.87	2.10	93
Green University: Yes SE: Female	13.93	1.44	85
Non-green University: Yes SE: Female	12.38	2.08	29
Green University: No SE: Male	12.20	2.54	103
Non-green University: No SE: Male	12.42	2.17	31
Green University: Yes SE: Male	12.76	2.24	45
Non-green University: Yes SE: Male	11.61	2.61	23

Note. Results were rounded to the nearest tenth.

The knowledge scale results show that females (n = 85) who attended green universities and received SE scored collectively highest on the knowledge scale (M = 13.93, SD = 1.44). In contrast, males (n = 23) who attended non-green universities and received SE scored the lowest on the knowledge scale (M = 11.61, SD = 2.61). Table 8 delineates the average attitude scores according university type, SE, and gender.

Table 8

Mean, Standard Deviation, and Sample Size for Attitudes by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Combination	*M*	*SD*	*n*
Green University: No SE: Female	13.45	1.74	197
Non-green University: No SE: Female	13.04	2.10	93
Green University: Yes SE: Female	14.14	1.11	85
Non-green University: Yes SE: Female	12.31	2.27	29
Green University: No SE: Male	12.14	2.58	103
Non-green University: No SE: Male	12.00	3.02	31
Green University: Yes SE: Male	12.73	2.40	45
Non-green University: Yes SE: Male	11.65	2.66	23

Note. Results were rounded to the nearest tenth.

The attitude scale results showed that females (n = 85) who attended Green universities and received SE scored collectively highest on the attitude scale (M = 14.14, SD = 1.11). In comparison, males (n = 23) from non-green universities who received SE scored the lowest on the attitude scale (M = 11.65, SD = 2.66). This finding indicates that green university affiliation may improve sustainability attitudes. This finding also indicates that females generally score collectively higher on the attitude scales, regardless of university type affiliation. Table 9 delineates the average behavior scores according to university type, SE, and gender.

Table 9

Mean, Standard Deviation, and Sample Size for Behavior by University Type (Green/Non-Green), Sustainability Education (SE), and Gender

Combination	*M*	*SD*	*n*
Green University: No SE: Female	9.92	2.61	197
Non-green University: No SE: Female	9.88	2.61	93
Green University: Yes SE: Female	11.98	2.32	85
Non-green University: Yes SE: Female	11.83	2.89	29
Green University: No SE: Male	9.51	2.97	103
Non-green University: No SE: Male	10.35	2.88	31
Green University: Yes SE: Male	12.24	2.67	45
Non-green University: Yes SE: Male	11.00	3.03	23

Note. Results were rounded to the nearest tenth.

The behavior scale results indicated that males (n = 45) who attended green universities and received SE scored collectively highest on the behavior scale (M = 12.24, SD 2.67). Females (n = 85) from green universities who received SE scored second highest (M = 11.98, SD = 2.32) on the behavior scales. In contrast, males (n = 103) from

green universities who did not receive SE scored collectively lowest on the behavior scale (M = 9.51, SD = 2.97).

This finding indicates that both male and female participants who received SE and attended a green university scored collectively higher on the behavior scale than those who did not receive SE. The significant MANOVA behavior interaction effects between university type x SE ($p < 0.048$) and the significant interaction effects between SE x Behavior ($p < 0.001$) support this interpretation.

Another interpretation of these findings was that SE had a greater impact on behavior than university type. This interpretation was supported by independent LR analyses which indicated that SE, β = -.331, t (-8.607), $p < 0.001$, 95% CI [-2.519, -1.583], $R^2 = 0.109$, significantly predicted behavior by 11%, more than university type ($p = 0.913$). The results of the ANOVA were also significant, $F(2, 603) = 37.052$, $p < 0.001$.

Multiple Regression Model

The MR model was used to determine the impact of six predictor variables (university type, SE, gender, knowledge, behavior, and academic level) on the DV of attitudes. IBM SPSS 21 was used for this MR analysis.

The multiple regression model assumptions. The MR model assumptions were used to evaluate linear relationships, residual independence, residual normality, residual homoscedasticity, multicollinearity, and the existence of outliers. Normality was assessed using P-P scatter plots and Shapiro-Wilk test results and homoscedasticity was assessed with a residuals scatterplot. The variance inflation factors (VIFs) were also

calculated in order to determine the presence of multicollinearity. The outliers were also observed and evaluated using studentized residuals plot.

The DV in this study was a continuous variable (assumption #1), as were two of the IVs (assumption #2). Linear relationships further existed between the DV: attitudes and some of the IVs (assumption #3) in this study. Linearity was established by the scatterplots below. Figures 3 and 4 demonstrate the Expected and Observed Standardized Residual Linearity for the DV attitudes.

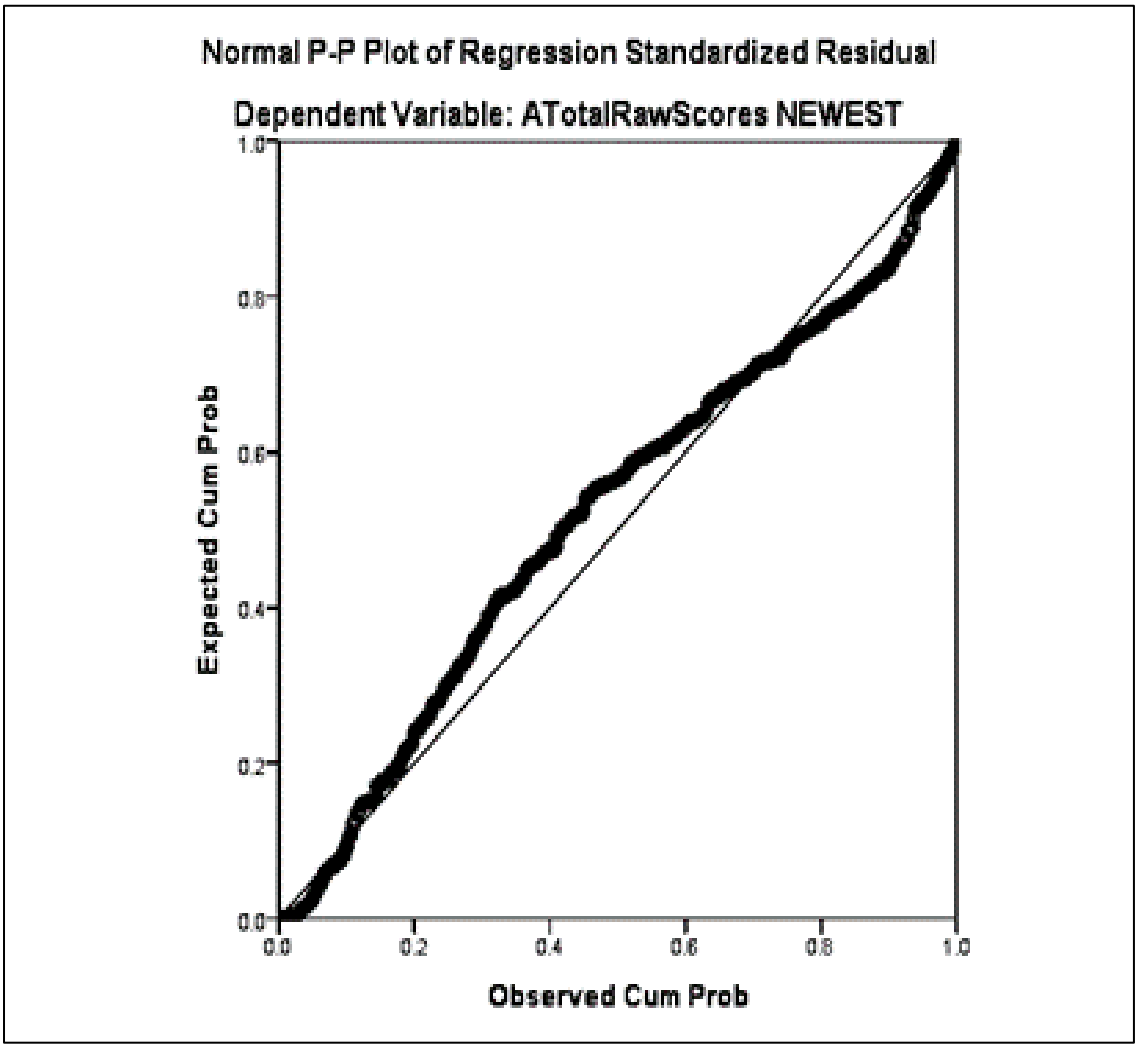

Figure 3. Residual plot for attitudes.

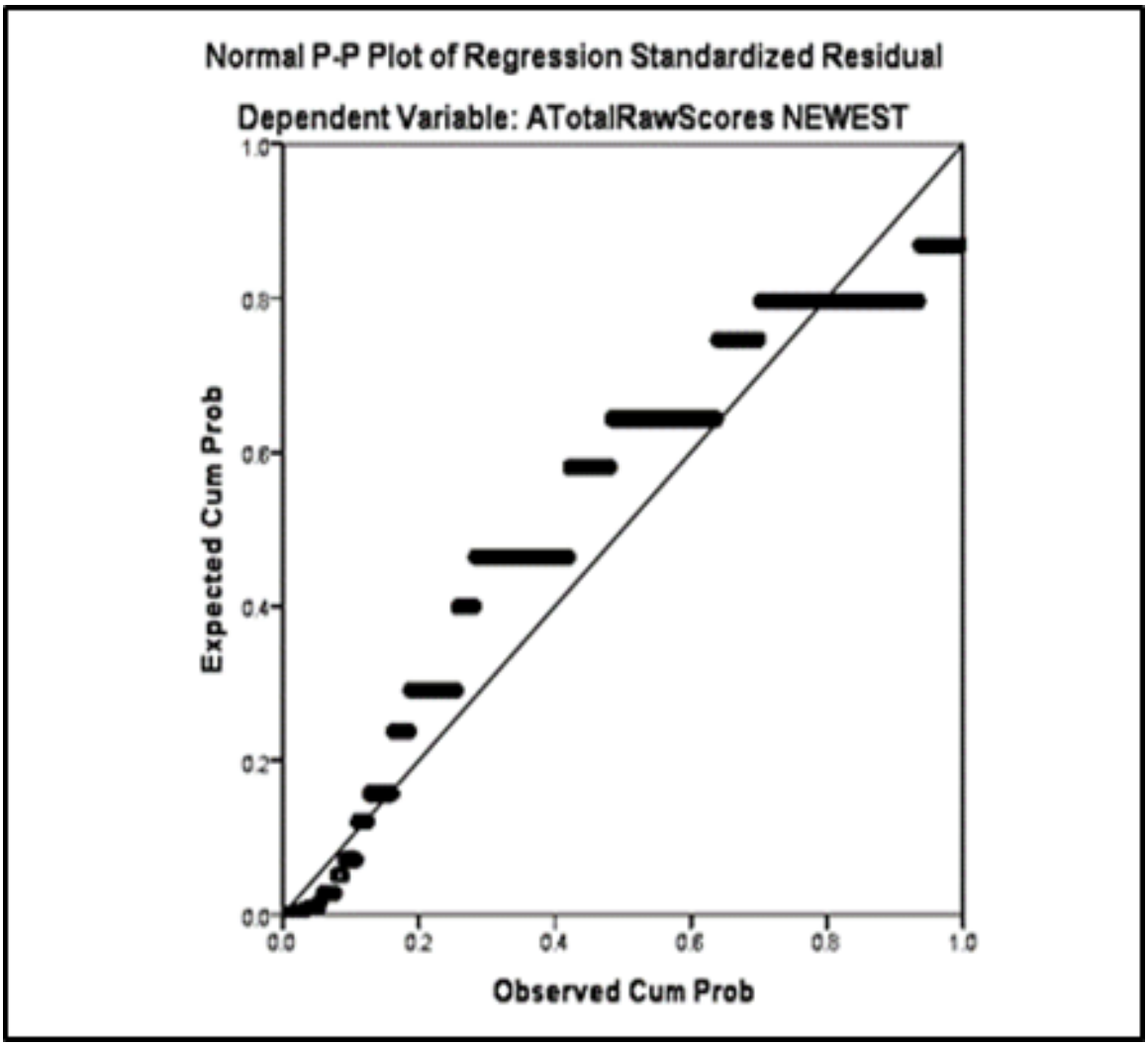

Figure 4. Residual plot for attitudes.

Residual independence. The Durbin-Watson Statistic for the MR data demonstrated a score of 1.349, which indicated the absence of any marked correlation or error between the residuals (Laerd Statistics, 2015).

Outliers. The studentized residuals were observed/calculated, and the absolute values were then plotted against the observed numbers. Casewise diagnostic evaluations, along with the studentized deleted residual evaluations were also conducted. The results revealed seven outliers – one in the +3.3 SD range, and six in the -3 – -3.9 SD range. A

comparative study with residuals removed demonstrated that outliers did not significantly impact the majority of the MR results. Therefore, the residuals were included in the main study.

Leverage points and distance values. Leverage points and distance values were also assessed. There were no problematic leverage values above 0.2, and no influential Cook's Distance values above 1 to pose any concern (Laerd Statistics, 2015).

Variance inflation factors. VIFs were assessed in order to identify the presence of multicollinearity between the IV predictor variables. A combined VIF score of = 6.62 was observed. While a VIF score over 5 could represent some cause for concern, 10 is considered the upper limit (Menard, 2009). Therefore, multicollinearity was not considered an issue in this study. The VIFs are presented in Table 10.

Table 10

Variance Inflation Factors

Variable	VIF
STARS Green/non-green University Status	1.03
Sustainability Education	1.14
Gender	1.06
Sustainability Knowledge	1.13
Sustainability Behavior	1.21
Academic Level	1.05

Homoscedasticity. Homoscedasticity was assessed through a visual inspection of a standardized residuals and standardized predicted values plot. Because the results of the standardized residuals plot (the errors of prediction) lacked curvature, appeared to be somewhat equal in distribution, and appeared relatively random, the assumption of

homoscedasticity was met. Figure 5 shows a standardized residual scatterplot for the DV of attitudes, indicating homoscedasticity.

Normality. The normality of the residuals (errors), are depicted in Figures 6 and 7.

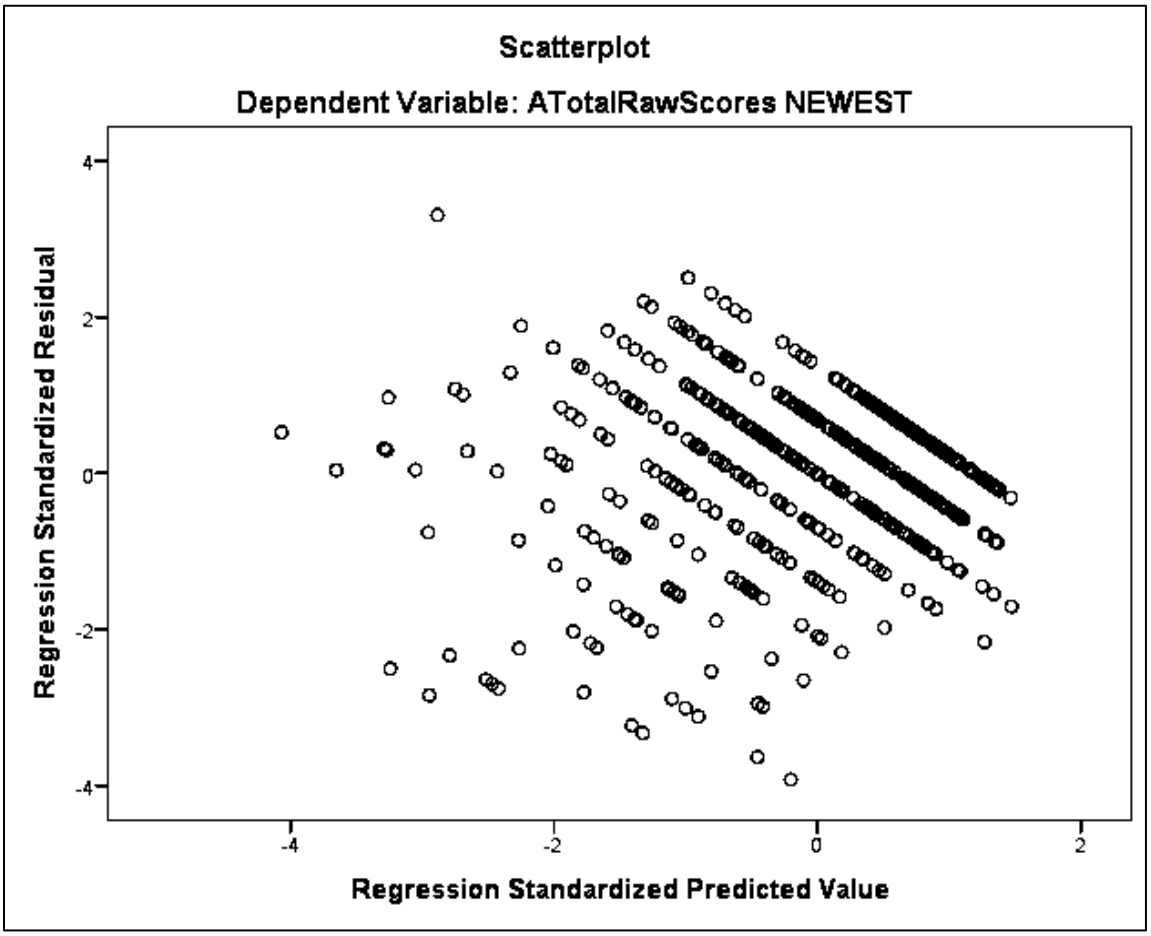

Figure 5. Residual homoscedasticity scatterplot for the dependent variable: attitude.

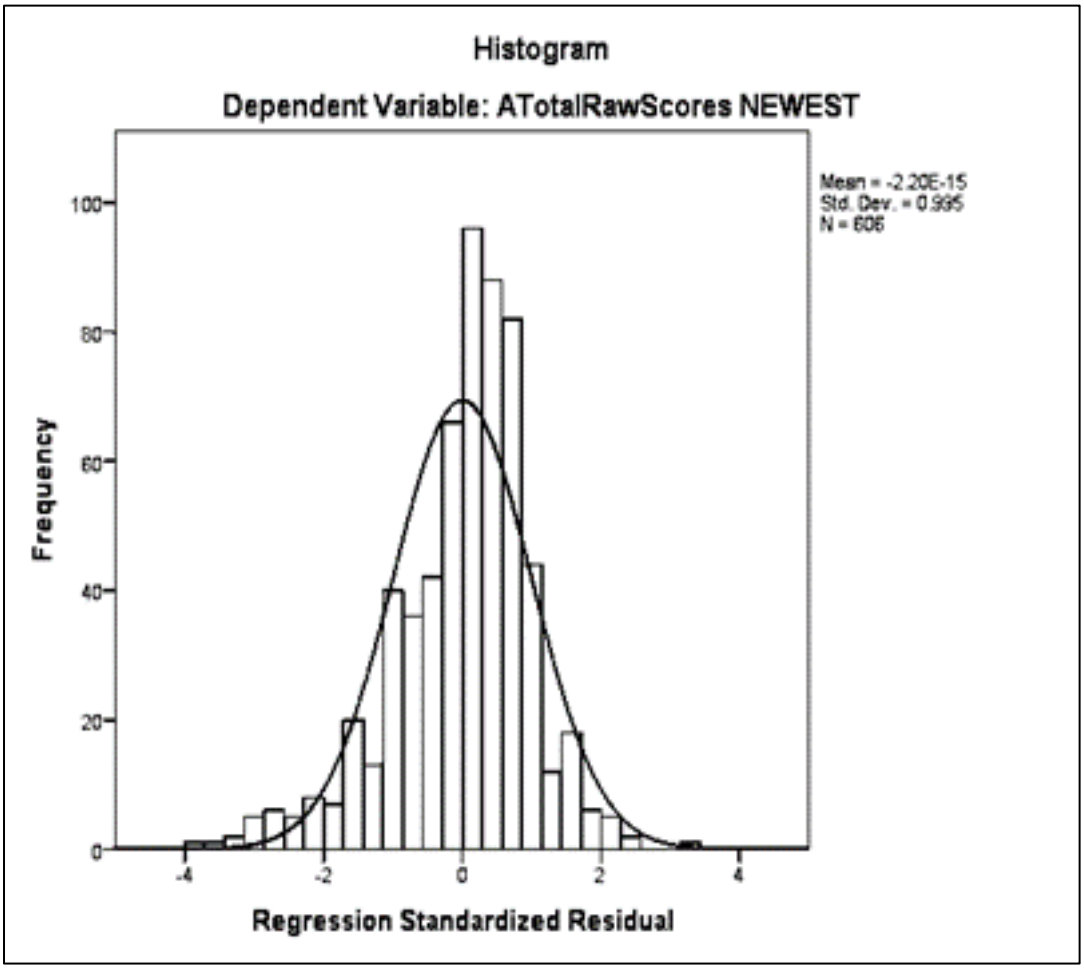

Figure 6. Attitude Residual Histogram.

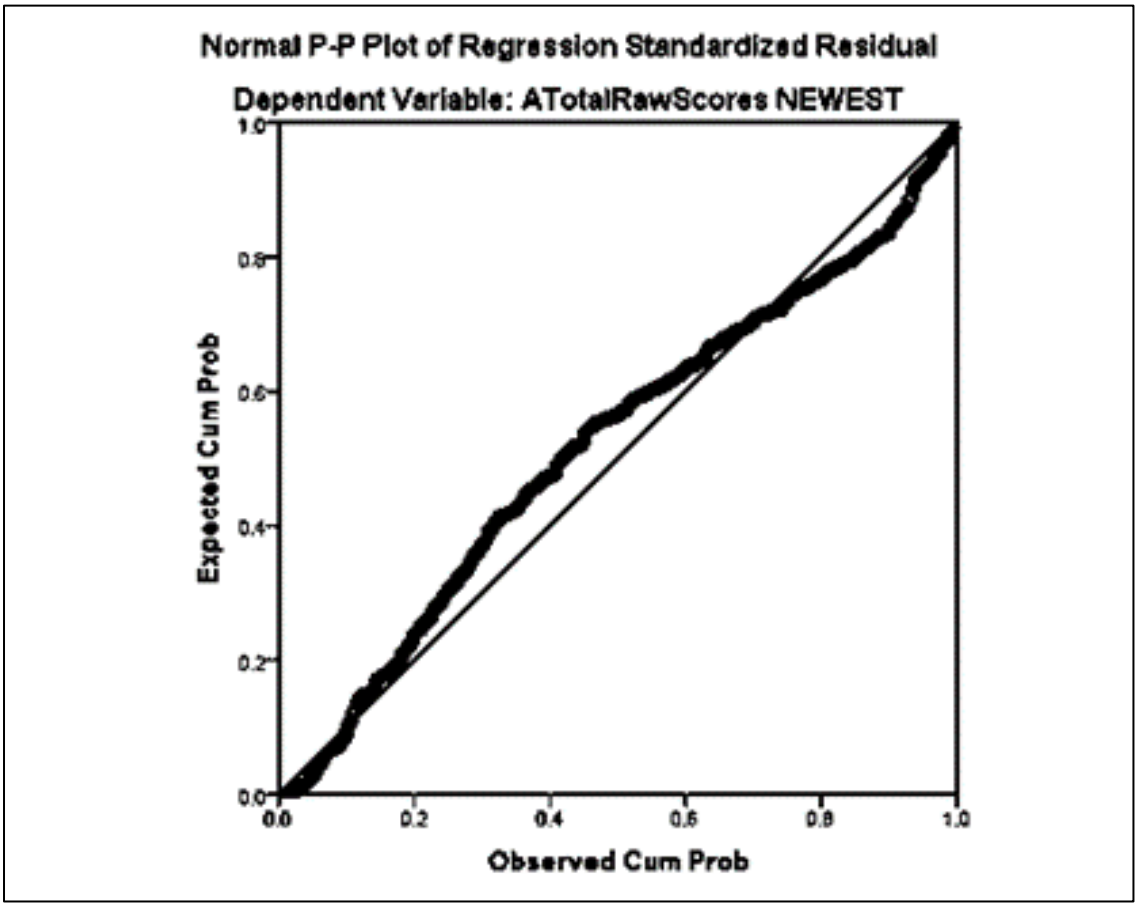

Figure 7. Attitude Residual P-P Plot.

The regression standardized residuals histogram appears to be normally distributed for the attitude scale. The regression standardized residual P-P plot also demonstrated that the points are diagonally aligned, which further indicates a fairly normal distribution. However, follow-up tests of normality (i.e., Shapiro-Wilk and Kolmogorov-Smirnov) were violated among the predictor variables (a) SE, (b) gender, (c) green/non-green university, and (d) academic level. Some parts of the knowledge and behavior scales also demonstrated some normality assumption violations as well, which was evidenced by significant Shapiro-Wilk and Kolmogorov-Smirnov results.

It is presumed that some normality assumption violations occurred because the following predictor variables SE, gender, and green/non-green university, were in a forced-choice format (true of false, yes or no, green/non-green, and male/female), which prevented a normal distribution from manifesting. While variable transformation was an option, it did not appear to make sense to force a curve on these types of categorical variables (Laerd Statistics, 2015).

Multiple Regression Results

A MR model was used to assess whether, and to what degree, the variables university type, SE, academic level, gender, knowledge, and behavior, were able to predict sustainability attitudes. The Enter method was chosen for the MR study.

The results of the MR model were significant, $F(6, 599) = 133.28$, $p < 0.001$. Sustainability attitudes, $\beta = 0.00$, t (3.256), $p < 0.001$, 95% CI [.719, 2.906], were significantly predicted by: (a) sustainability knowledge, $\beta = 0.64$, t (22.55), $p < 0.001$, 95% CI [.607, 0.723]; (b) sustainability behavior, $\beta = 0.21$, t (7.185), $p < 0.001$, 95% CI [.118, 0.207]; (c) gender, $\beta = 0.123$, t (4.469), $p < 0.001$, 95% CI [.322, 0.827]; and (d) university type, $\beta = -0.06$, t (-2.216), $p < 0.03$, 95% CI [-.548, -.003].

Table 11

Multiple Regression Results

Variable	*B*	*SE*	β	*t*	*p*
Constant DV: Attitudes	1.81	0.56	0.00	3.26	< 0.001
(1) STARS Green/non-green University Type	-0.29	0.13	-0.06	-2.22	< 0.03
(2) SE Education Yes	0.20	0.14	0.04	1.50	.14
(3) Gender	0.58	0.13	0.12	4.47	< 0.001
(4) Knowledge Scores	0.67	0.03	0.64	22.6	< 0.001
(5) Behavior Scores	0.16	0.02	0.21	7.19	< 0.001
(6) Academic Level (all levels)	-.006	0.03	-.006	-.23	.82

Note. Results were rounded to the nearest tenth.

Effect Sizes

According to the MR results, 57% of the variance ($R^2 = 0.572$, $p < 0.001$) in attitudes could be explained by a varied combination of sustainability knowledge, sustainability behavior, gender, green or non-green university type, SE, and academic level.

Follow-up independent LR analyses revealed a significant medium effect size (52%) for the singular variable knowledge, $R^2 = 0.519$, $p < 0.001$, which had the largest significant impact on attitudes. Behavior ($R^2 = 0.118$, $p < 0.001$), (b) gender ($R^2 = 0.069$, $p < 0.001$), and (c) university type affiliation ($R^2 = 0.018$, $p < 0.001$) also had a significant impact on attitudes. In summary, the independent LR analyses revealed that sustainability attitudes were significantly predicted by sustainability knowledge (52%), sustainability behavior (12%), gender (7%), and university type (i.e., green/non-green) (2%).

Additional Studies

Additional Attitude Linear Regression Results

Independent LR studies were conducted for each of the significant MR predictor variables impacting sustainability attitudes. An independent LR analysis revealed that sustainability knowledge had a significant impact on sustainability attitudes, $\beta = 0.72$, t (25.508), $p < 0.001$, 95% CI [.69, 0.805]. The results of the ANOVA were also significant, $F(1, 604) = 650.637$, $p < 0.001$. A LR also revealed the significant impact of behavior on sustainability attitudes, $\beta = 0.344$, t (8.995), $p < 0.001$, 95% CI [.208, 0.324]. The results of the ANOVA were also significant, $F(1, 604) = 80.917$, $p < 0.001$.

An additional independent LR study demonstrated the significant impact of gender on sustainability attitudes, $\beta = 0.263$, t (6.7), $p < 0.001$, 95% CI [.868, 1.587]. The results of the ANOVA were similarly significant, $F(1, 604) = 45.042$, $p < 0.001$. A final LR analysis revealed the significant impact of university type (i.e., green/non-green) on sustainability attitudes, $\beta = -.132$, t (-3.283), $p < 0.001$, 95% CI [-1.024, -.258]. The results of the ANOVA were also significant, $F(1, 604) = 10.780$, $p < 0.001$.

Knowledge and Behavior Linear Regression Results

LR analyses showed that knowledge was predicted by attitudes, $\beta = 0.72$, t (25.508), $p < 0.001$, 95% CI [.64, 0.747], $R^2 = 0.519$. However, behavior was also predicted by: (a) attitudes $\beta = 0.344$, t (8.995), $p < 0.001$, 95% CI [.348, 0.542], $R^2 = 0.118$, (b) SE, $\beta = -.331$, t (-8.615), $p < 0.001$, 95% CI [-2.519, -1.584], $R^2 = 0.109$, and (c) academic level $\beta = 0.136$, t (3.380), $p < 0.001$, 95% CI [.073, 0.277], $R^2 = 0.019$.

Multiple Regression Analyses without Residuals

Removing multivariate residuals from the MR study had a small, yet significant impact on: (a) SE, $\beta = 0.06$, t (-2.11), $p < 0.04$, 95% CI [-0.52, -0.02], and (b) 3rd year graduate students, $\beta = -0.07$, t (-1.99), $p < 0.05$, 95% CI [-1.19, -0.01].

Summary of the Statistical Analyses by Research Questions and Hypotheses

The MANOVA revealed significant mean sustainability knowledge main effect differences between gender ($p < 0.001$) and university type ($p < 0.001$). However, there were no significant mean effect differences between sustainability knowledge and SE. Therefore, the null hypothesis was rejected for research question 1, which asked: Are there significant mean sustainability *knowledge* main effect differences between gender, university type, and SE?

The MANOVA revealed significant mean sustainability attitude main effect differences between gender ($p < 0.001$), and university type ($p < 0.001$). However, there were no significant main effect differences between sustainability attitudes and SE. Therefore, the null hypothesis was rejected for research question 2, which asked: Are there significant mean sustainability *attitude* main effect differences between gender, university type, and SE?

The MANOVA revealed significant main effect differences between sustainability behavior and SE ($p < 0.001$). However, there were no significant mean sustainability behavior main effect differences between gender and university type. As a result, the null hypothesis was rejected for research question 3, which asked: Are there

significant mean sustainability *behavior* main effect differences between gender, university type, and SE?

The MANOVA results revealed significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, ($p < 0.001$), university type ($p < 0.001$), and SE ($p < 0.001$). There were also significant interaction effects between university type and SE ($p < 0.012$). Significant knowledge interaction effects also existed between university type and SE ($p < 0.003$). Significant attitude interaction effects similarly existed between university type and SE ($p < 0.006$). Significant behavior interaction effects additionally existed between university type and SE ($p < 0.048$). A significant pairwise interaction effect was further present between SE and behavior ($p < 0.001$).

A comparative MANOVA without residual outliers also revealed significant interaction effects between behavior, university type, SE, and gender ($p < 0.04$). Due to multiple interaction effect findings, the null hypotheses were rejected for research question 4, which asked: Are there significant mean sustainability knowledge, attitude, and behavior interaction effects between gender, university type, and SE?

The results of the MR model were significant ($p < 0.001$). The MR analysis revealed that attitudes ($p < 0.001$) were predicted by (a) knowledge ($p < 0.001$), (b) gender ($p < 0.001$), (c) behavior ($p < 0.001$), and (d) university type ($p < 0.03$). While SE and academic level did not predict sustainability attitudes in the main MR analysis with multivariate residuals, the MR without multivariate residuals had a significant impact on SE ($p < 0.04$) and on third-year graduate students' ($p < 0.05$) attitudes. Therefore, the

null hypothesis was rejected for the MR, both with and without residuals for research question 5, which asked: To what degree do SE, university type, academic level, gender, knowledge, and behavior predict sustainability attitudes?

Summary

This was a quantitative study involving 606 college students from a variety of 265 accredited U.S. colleges and universities. Exactly half of participants were either recent or current Arizona State University students. The other half of the sample population attended other U.S. green and/or non-green colleges and universities. A comprehensive overview of the data collection procedures, descriptive statistics, research questions, hypotheses, analyses, and interpretations of the findings were delineated in this chapter. The results of the three-way MANOVA and multiple regression findings were also further interpreted within the scope of the research questions and hypotheses.

In the upcoming chapter, I present an expanded interpretation of the results and also discuss the theoretical and research alignments associated with the key variables and findings in this study. The findings are further compared and discussed within the context of previous study results. The delimitations and their associated remedy recommendations are also presented, along with generalizability, scale reliability, and validity factors. Scale recommendations, as well as theoretical and practice recommendations are also presented herein, along with the implications for positive social change.

Chapter 5: Summary and Conclusion

Introduction

This was a quantitative study that included 606 college students who were attending (or had recently attended) a variety of 265 U.S. green/non-green accredited colleges and universities. One primary purpose of the study was to measure the impact that SE, university type (green/non-green), and gender had on university students' sustainability knowledge, attitudes, and behavior. Another primary purpose was to measure the degree to which SE, university type (green/non-green), academic level, gender, knowledge, and behavior were able to predict sustainability attitudes.

Key Findings

Most of the participants in this study (96%) believed that all students should receive SE – at all academic levels (92%). Another 93% of respondents reportedly believed that SD is a national priority, while 86% identified corporate responsibility as a key factor in SD. Eighty-six percent of participants believed that sustainable/renewable resources should be used at least as much as oil-based fuels, whereas another 86% believed that humans are able to lower the rate of climate change. Ninety-seven percent of participants also believed that economic development, social development, and environmental protection are integral to SD. Participants further believed that SD promotes a culture of peace (88%) and social justice (80%), whereas 83% believed that SDE/SE emphasizes respect for human rights.

Interpretation of the Findings

Research Alignment to the Results

Baiocchi et al. (2010) reported that higher academic levels could positively impact sustainability attitudes and behaviors. This assertion was minimally supported by the results of the current study. Academic level only minimally and significantly predicted attitudes with third-year graduate students (in the MR without multivariate residuals analysis). Michalos et al.'s (2009) student and adult sustainability regression studies similarly showed that behavior was predominantly predicted by attitudes. Their unweighted adult regression results showed that attitudes, education level, and knowledge predicted adult behavior. In contrast, their weighted adult regression results showed that attitude was a greater predictor of behavior than education level, although both were significant. Their student behavior regression results also showed that gender, attitudes, and knowledge significantly predicted student behavior (Michalos et al., 2009).

The current comparative regression results were in partial alignment with previous research findings. Behavior was predicted by attitudes, SE, and academic level in the current study. While gender and knowledge did not predict behavior in current regression analyses, gender significantly impacted knowledge and attitudes in the MANOVA analyses. While gender did not directly impact behavior in the current MANOVA, there were still significant interaction effects between gender, behavior, university type, and SE in the MANOVA without residuals.

A Michigan State University study showed that students benefitted from SE/EE/SDE, and this training was measurable and positive (in terms of pre and post SE

scores; Mifsud, 2012). This finding is similarly supported by the results of this study. SE was found to be a significant (11%) predictor of behavior in an independent LR analysis, and produced some significant MANOVA interaction effects. Therefore, the current SE findings are in alignment with previous research findings.

Mifsud's (2012) meta-analysis study also showed that females generally possess more positive environmental attitudes than males in a few of his reviewed studies. A smaller comparable sustainability study with Finnish ninth graders (n = 3,626) found that females again demonstrate more positive sustainability attitudes than males (Uitto et al., 2011). Another New Zealand Environmental (n = 360) study similarly reported that females possess stronger positive ecological worldviews than males (Harraway et al., 2012). Therefore, previous gender and attitude findings align with the results of this study.

Sahin et al. (2012) conducted a study of Turkish Technical University students' EV (n = 958), sustainability attitudes, and sustainability behaviors. Their study showed that sustainability knowledge, positive EV, and positive sustainability attitudes influenced positive sustainability behaviors. Females were also found to have more positive sustainability attitudes and EV than males (Sahin et al., 2012). Therefore, the gender and attitudes predicting behavior finding supports and is in alignment with the results of this study.

Another Turkish University study (n = 1,345) showed that environmental knowledge significantly impacted environmental attitudes and behavior, among other variables (Teksoz et al., 2012). Therefore, the knowledge predicting attitudes finding is

in alignment with the results of this study. The current study showed that knowledge can largely predict attitudes and vice versa.

Theoretical Alignment with the Study Variables

Most of the TPB factors were represented either directly or sub-categorically by the DVs in this study. For example, learning, conditioning, reasoning, information, experience, and intelligence were represented by the DV knowledge. Perceptions, beliefs, and values were represented by the DV attitudes. Intentions, norms, and individual/group normative behavior were further represented by the DV behavior.

The IVs in the MANOVA study were SE, university type, and gender. Each IV was either directly or indirectly represented by the following TPB and/or SIT factors: learning (SE; TPB), information (SE; TPB), knowledge (SE; TPB), education (SE; TPB), group membership (university type and gender; TPB/SIT), culture (university type and gender; TPB/SIT), gender (gender; TPB/SIT), and norms (university type and gender; TPB/SIT) (Ajzen & Fishbein, 1977; Boon, 2011; Fielding, Terry et al., 2008; Smith et al., 2008).

According to the TPB model, all the above-mentioned factors shape normative beliefs, intentions, attitudes, and behavior (Boon, 2011). Therefore, the TPB aligns with the variables and results of this study. SIT also aligns with the variables and results of this study insofar as it explains how collective group cultures and norms shape individual and group identities, beliefs, attitudes, and behavior (Ashforth & Mael, 1989; Chatzisarantis et al., 2009; Dumont & Louw, 2009; Nieuwenboer & Kaptein, 2008). TPB and SIT both relate and align to the variables and results of this study insofar as both

theories address factors that shape individual/collective learning, attitudes, behavior, and norms (Ajzen & Fishbein, 1977; Baron et al., 2009; Chatzisarantis et al., 2009; Cho, 2019; Fielding & Hornsey, 2016; Fielding, McDonald et al., 2008; Lertpratchya et al., 2017; Rex et al., 2015).

Theoretical Alignment to Key Findings

The MANOVA knowledge, attitude, and behavior multivariate main effect results were significant for all three IVs: (a) university type (i.e., green/non-green; 3%); (b) SE, (8%); and (c) gender (5%). A significant multivariate interaction effect between university type and SE was also present (2%). The theoretical implication of these findings suggests that school type (academic environment and group norms related to TPB and SIT), SE (knowledge, learning, and training related to TPB), and gender (group norms related to SIT and TPB) were significant factors in this research. Both the SIT and TPB were supported by the significant main effect MANOVA findings.

The MANOVA results also revealed significant knowledge (2%; TPB) and attitude (3%; TPB and SIT norms) differences between green and non-green populations (training/norms related to TPB; norms related to SIT). However, behavior (TPB) was not found to be significantly different between green and non-green populations (TPB; SIT). The theoretical implication of these findings is that knowledge, training (SE; TPB), and attitude (related to group norms; SIT/TPB) differences exist between students from different populations groups. These findings support the foundational theories used in this study.

While SE did not have a significant impact on knowledge (TPB) or attitudes (TPB; SIT), SE did have a significant impact on behavior (7%; TPB) in the MANOVA study. The theoretical implication of this finding is that SE (knowledge and training related to TPB) can impact behavior (TPB). This finding supports the TPB. While gender (TPB; SIT) had an impact on knowledge (3%; SE related to TPB) and attitudes (4%; SIT; TPB), gender (TPB; SIT) did not have a significant impact on behavior (TPB). The implication of this finding is that gender identity and gender-related norms (TPB; SIT) can impact knowledge and attitudes.

As such, these findings largely support the SIT and TPB theories. There were also significant MANOVA interaction effects between SE (TPB) and university type (SIT; TPB) – and knowledge (2%; TPB), attitudes (1%; TPB; SIT), and behavior (TPB; less than 1%). The theoretical implications of these findings are that knowledge (SE; TPB) and environment (green/non-green university type; TPB; SIT) can impact knowledge, attitudes, and behavior. As such, these findings support the TPB and SIT theories.

A multiple regression was used to assess whether or not, and to what degree, university type, SE, gender, knowledge, behavior, and academic level predicted attitudes. The MR results were significant and revealed that 57% of the variance in attitudes (TPB; SIT) was explained by knowledge (TPB), behavior (TPB), gender (TPB; SIT), university type (SIT; TPB), SE (TPB), and academic level (TPB). The theoretical interpretation of this finding is that attitudes can be shaped by environment, education, training, group

norms, conditioning, and gender identity. As such, most of the findings in this study predominantly support and align with the TPB and SIT models.

While SE and academic level were not found to be significant predictors of sustainability attitudes in the MR analysis, the majority of participants (n = 424) in this study had not received SE training. Therefore, it was difficult to accurately assess the impact of a non-uniform SE treatment that 70% of participants did not receive. Even though many students (n = 424) had not received SE, n = 430 participants (71%) had attended a green university, and n = 404 (67%) of the participants were also female.

Previous studies showed that gender and university type were prevalent factors which influenced sustainability attitudes and behavior. The results of this study indicated lesser yet similar results. For example, the MR and LR analyses revealed that gender (7%) and university type (2%) influenced sustainability attitudes in this study. These findings support and align with the TPB to the degree that university type (green/non-green school) exposure may have contributed to sustainability knowledge which influenced sustainability attitudes.

Gender is further related to SIT and TPB insofar as it explains how group cultures and norms can influence independent/collective identities, attitudes, and behavior (Ashforth & Mael, 1989; Fielding, Terry et al., 2008; Nieuwenboer & Kaptein, 2008). The implication of gender differences in sustainability research suggests that socialization, gender roles, and expectations may contribute to individual/collective sustainability attitudes (Bloodhart & Swim, 2020).

A follow-up LR analysis in the current study showed that university type predicted SE by 7%, while SE predicted behavior by 11%. These results support and are in alignment with the TPB and SIT models. This finding suggests that university type (academic environment, collective attitudes, values, and norms) may have influenced students' likelihood of taking SE. Therefore, knowledge, education, and information may have subsequently and positively influenced sustainability behavior. These variable findings supported and were in alignment with the TPB theory. Additional significant MANOVA interaction effects existed between SE and university type, and knowledge, attitudes, and behavior.

Comparative MANOVAs were conducted with and without outliers to compare the results. By removing the outliers, the MANOVA interaction effects between behavior, university type, SE, and gender, become significant by a factor of 1%. The implication of this finding is that a combination of green university (group norms related to TPB), SE (knowledge related to TPB), and female status (TPB; SIT) increases the probability of observing higher sustainability behavior (TPB) scores. These results are largely in alignment with the SIT and TPB models. The TPB supports these findings insofar as knowledge, education, and training (SE) can influence attitudes and behavior (Fielding, Terry et al., 2008; Nieuwenboer & Kaptein, 2008).

The largest factor impacting sustainability attitudes was sustainability knowledge. An independent LR analysis showed that sustainability knowledge predicted sustainability attitudes by 52%. Therefore, the results of this study indicated that knowledge (information, learning, and education) can significantly improve attitudes.

These findings align with the TPB model insofar as planned behavior suggests that knowledge (SE) and training can shape attitudes and behavior. The interpretation of knowledge influencing attitudes in this study implies that knowledge (i.e., SE, training [observational learning and conditioning], and education) are essential for positive attitude formation. This finding supports the need for SE.

A separate LR showed that SE also influenced behavior scores by 11%, more than university type. This finding also supports the TPB model and indicates that SE (information, knowledge, and education) can have a greater impact on behavior than environment (university type). In the MR study with outliers, the non-significant variable of academic level suggests that education must be specific to a particular topic in order to have an impact on specific knowledge, attitudes, and behavior – regardless of academic level. In summary, the MR and follow-up LR results showed that sustainability knowledge was predicted by sustainability attitudes (52%). However, attitudes were also predicted by knowledge (52%), behavior (12%), gender (7%), and university type (green/non-green) (2%). Behavior was alternatively predicted by attitudes (12%), SE (11%), and academic level (2%).

Limitations and Generalizability

One limitation of this study was that most students had not received SE. This made the measurement of SE somewhat difficult. Students would also likely have performed better on the knowledge, attitudes, and behavior scales if they had received SE prior to participating in this study. A remedy to this would be that students receive pre and post SE testing in order to measure the impact of SE in the future. A second

limitation was that participants who received SE likely received a non-uniform variety. A remedy for this would be that all students receive uniform SE at each level of education. A third limitation of this study was that the gender and academic level groups were disproportionate in size. This could be remedied with a larger male-targeted sample size in the future. A fourth limitation of this study was that the scale questions did not adequately contain all of the relevant and contemporary sustainability knowledge, attitude, and behaviors questions possible. Therefore, adding contemporary criterion-specific questions may help to improve test results.

A fifth limitation of this study involved the survey format. The scale response options were in a forced-choice format, which limited the range of possible answers. Although forced-choice and Likert type formats are reportedly equally useful, research shows that the Likert format may improve the validity of certain criterion – depending on the study type (Geldhof et al., 2015). Therefore, the Likert format should be considered an option in future research. A sixth limitation was that the attitude questions did not exactly match the behavior questions. Therefore, aligning the attitude and behavior questions might improve the effectiveness of the TPB (Ajzen & Fishbein, 1977) alignment and survey results.

A seventh limitation was that the knowledge, attitudes, and behavior scales (Michalos et al., 2009) did not meet the Cronbach's alpha overall level of reliability (0.68–0.75). However, independent criterion analyses revealed that many of the criterion items did meet and/or exceed the benchmark of acceptability. One way to overcome this limitation is to improve the quality of the knowledge, attitudes, and behavior questions.

An eighth limitation was that this study was limited to a small number of U.S. university student participants. One way to overcome this limitation would be to conduct a larger study in the future. A ninth limitation of this study involved references to Canadian participants in the original Attitudes toward Sustainable Development Scale (Michalos et al., 2009). This issue was remedied with the replacement of U.S. references. Additional modifications included five new demographic questions related to gender, SE, university name, university type, and academic level. Each of these limitations, either independently or collectively, could limit generalizability.

Recommendations

Recommendations for Future Research

Based on the literature reviewed, in conjunction with the results of this study, pre and post SE/EE/SDE testing is recommended in order to assess the effectiveness of sustainability programs and courses. Further studies that measure the impact of green schools and SE on students' knowledge, attitudes, and behavior are also recommended. Wachholz et al. (2014) stated that most of the previous knowledge, attitudes, and behavior research to date has primarily focused on elementary and middle school populations rather than college students and adults. As a result, they recommended that future SE studies include higher education populations. Singular and comparative sustainability and SE school studies could also prove beneficial and provide more campus, program, and course-specific results.

A number of experts and regulatory bodies support SE and climate change research. For example, the U.S. Global Change Research Program (2013) recommended

that the United States invest in SE and climate change research. The APA also encourages SE and sustainability research within the field of psychology (Hailstorks, 2013). Whereas Swim et al. (2011) recommended that psychologists engage in more multi-disciplinary climate change research, Wu and Shen (2016) recommended that future SE/SDE research align with UNESCO's DESD strategic perspectives. Livestock research and education (Gerber et al., 2013; Herrero et al., 2015) were other areas recommended for SE inclusion. Another recommendation is for researchers to start using the term *sustainability education* (SE) in titles and articles that reference this topic. This would help SE articles to be more easily distinguishable from the broad sea of references to the term sustainability.

Future Construct Recommendations

Some ways to improve the construct include, but are not limited to, updating the criterion content. Relevant age/grade specific and knowledge-related content (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c) would likely produce more accurate and meaningful results. Future sustainability knowledge scales should ideally include health (EWG, n.d.; Joshi, 2008; U.S. EPA, n.d.-d), climate change (IPCC, 2007a, 2007b, 2007c, 2013), LEED building (U.S. Green Building Council, n.d.), renewable energy, transportation, and pollution-related criterion (U.S. EPA, n.d.-f, n.d.-h, n.d.-i, 2020). They should also include sustainable living, ethics, and environmental impact questions (Environmental Working Group, n.d.; IPCC, 2007a, 2007b, 2007c, 2013; Joshi, 2008; U.S. EPA, 2020), as well as livestock maintenance and pollution criterion (Gerber, et al., 2013; Harwatt, 2018; Teachout, 2015; UNFAO, n.d.-a, n.d.-b, n.d.-c). Ajzen and

Fishbein (1977) also recommended aligning attitude and behavior questions in order to improve the efficacy of the TPB theoretical model. Geldhof et al. (2015) further recommended using Likert type surveys to improve criterion and construct validity.

Theoretical Recommendations

Smith et al. (2008) stated that TPB is the best theory social scientists can use to predict human behavior. However, Chatzisarantis et al. (2009) recommended adding perceived autonomy, autonomy support, and SIT in order to improve this theory. Smith et al. (2008) also proposed adding the variables self-identity and past behavior to improve TPB studies.

Academic Leadership and Public Policy Recommendations

Saidin et al. (2015) recommended using leadership, infrastructure, SE, holistic methods, and shared values to transform communities. Penger et al. (2015) similarly recommended using shared leadership, modeling, sustainability values, and innovation to promote positive social change. Strategic planning, cultural resolutions, infrastructure building, and community engagement were also listed as viable pathways to positive social change (Penger et al., 2015). Konig (2015) further recommended that academic leaders and policymakers work together to integrate science information with SE modalities.

Positive Social Change Implications

This study revealed some of the differences between green and non-green university populations. It also revealed the impact of SE, university type, and gender on students' sustainability knowledge, attitudes, and behavior. It further helped to identify

the degree to which the above-mentioned variables (including academic level) were able to predict sustainability attitudes. The results of this study supported several previous research findings and helped to build upon previous theoretical assumptions. Therefore, it may be useful for future SE curriculum development and policy creation.

Sustainability Education as a Solution to Climate Change

The results of this study, in conjunction with the literature reviewed, both support SE as a viable solution to sustainability and climate change mitigation (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Healthy Schools Network, 2016; United Nations, n.d.-a, 1992, 2016; U.S. EPA, n.d.-g.). Timmerman and Metcalfe (2009) also postulated that academic institutions are responsible for shaping civilization through values, SE, public policy, education, and research.

McFarlane and Ogazon (2011) similarly contended that SE is central to improving civilizations' health, survival, and quality of life. As such, they have stated that the United States has a duty to lead SE initiatives, establish clear sustainability objectives, and create effective SE curriculums (McFarlane & Ogazon, 2011). Numerous scientific experts, leaders, educators, and researchers agree that SE should be taught to the public and in schools – at all levels (AASHE, n.d.; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; The National Environmental Education Foundation, 2017; United Nations, n.d.-a, 1992, 2016; U.S. EPA, n.d.-g).

Other researchers have also emphasized the need for SE in higher education in particular (Cassidy, 2015; Goldman et al., 2015; Sabbaghi & Cavanagh, 2015). The literature reviewed outlined a broad range of needs which include system-wide changes,

leadership, community engagement (Scott, 2015), SE modeling (McIntosh et al., 2010), SE curriculums (Wiek et al., 2013; Wiek et al., 2014), skills-based curriculums (Cassidy, 2015), and supportive sustainability infrastructures (Linnenluecke & Griffiths, 2010; UNESCO, n.d.-a, n.d.-b, n.d.-c; U.S. Green Building Council, n.d.).

Conclusion

While many nations contribute to pollution and climate change, scientific projections reveal that the United States and China will continue to be the largest global GHG contributors for many years to come (Global Carbon Atlas, n.d.; Minqi, 2007; U.S. EIA, 2013, 2014; U.S. EPA, n.d.-i, 2020). This means that populations will continue to be exposed to unhealthy products, by-products, and elements for the foreseeable future (Lunenburg, 2011; Shaowei et al., 2013; Sheffield & Landrigan, 2011; Spira-Cohen et al., 2011; Thapar et al., 2013). While some pollution and toxic exposure may be unavoidable, research has shown that transitioning to healthier alternatives could help to mitigate harmful effects (Begley, 2009a, 2009b; Carroll, 2010; IPCC, 2007a, 2013, 2018a, 2018b; NOAA, n.d.; Wood, 2007).

Whereas climate change research projects that global climate change will reach or exceed the 1.5°C limit by 2040, the IPCC (2018a, 2018b) reports that many regions have already surpassed this limit. GHGs are also projected to rise by 37%–50% by 2030 due to livestock pollution alone (Harwatt, 2018). This represents half of the allowable pollution limit recommended within the next 10 years (IPCC, 2018a, 2018b). At this rate of growth, the Centers for Disease Control and Prevention (n.d.) contends that nations will likely exceed the +1.5°- 2°C climate change rates proposed by the IPCC (2018a,

2018b). Therefore, many timely, comprehensive, multi-level, and multi-disciplinary industry and governmental interventions are needed (Centers for Disease Control and Prevention, n.d.; IPCC, 2018a, 2018b; New Climate Economy, 2016; World Bank, n.d.).

Begley (2009a, 2009b) provided a clear list of what would be required to put the U.S. on a sustainable path. While many positive climate change and sustainability changes have since taken place (AASHE, n.d.; United Nations, 2016; U.S. EPA, n.d.-b, 2018), research has shown that many more multi-disciplinary solutions are still needed (Centers for Disease Control and Prevention, n.d.; ICAP, n.d.; ITER, n.d.; RGGI, n.d.; United Nations, 2016; U.S. EIA, 2019a, 2019b; U.S. EPA, n.d.-c, n.d.-d, n.d.-e, n.d.-f, n.d.-g, n.d.-h; World Nuclear Association, n.d.).

Although the IPCC (2018a, 2018b) recommended CO2 reductions of 45% by 2030 and net zero-carbon emissions by 2050, the Centers for Disease Control and Prevention (n.d.) reported that nations are not on track to meet these targets. Even with nations scheduled to invest $90 trillion dollars in new sustainable infrastructures by 2033 (New Climate Economy, 2016; World Bank, n.d.), it is unclear how much of this wealth will trend towards green schools, SE, and a new green economy. It is also unclear where exactly these investments would be made, how long it would take to build said infrastructures, and whether or not these infrastructures would be built to mitigate climate change in time.

Therefore, governments, leaders, corporations, and society should take the initiative to address climate change and pollution issues now (European Commission, n.d.; ICAP, n.d.; ITER, n.d.; RGGI, n.d.; United Nations, 2016). The literature reviewed

strongly suggested that academic leaders and institutions have a responsibility to do their part as well (AASHE, n.d.; Hailstorks, 2013; Swim et al., 2011; U.S. Global Change Research Program, 2013). Since SE already has a proven track record with facilitating positive social change in schools (Bell & Dyment, 2008; Dallimer et al., 2015; Erdogan & Tuncer, 2009; Kerret et al., 2014; Strife, 2010), SE should be considered a frontline solution to sustainability and climate change (AASHE, n.d.; Cassidy, 2015; Center for Green Schools, n.d.-a, n.d.-b, n.d.-c; Goldman et al., 2015; Sabbaghi & Cavanagh, 2015; The National Environmental Education Foundation, 2017; United Nations, n.d.-a, 1992, 2016; U.S. EPA, n.d.-g).

This study provides partial support for the idea that SE is a key factor in combating climate change. For example, the *knowledge scale* results revealed that females who attended green universities and received SE scored collectively highest on the knowledge scale. In contrast, males who attended non-green universities and received SE scored the lowest on the knowledge scale. These findings suggest that a combination of SE and green university can improve knowledge in the female population group. In contrast, Male SE scores could reflect a lower quality of SE received at non-green universities.

The *attitude scale* results also showed that females who attended green universities and received SE scored collectively highest on the attitude scale. In comparison, males from non-green universities who received SE scored the lowest on the attitude scale. These findings indicate that a combination of SE and green university affiliation may improve sustainability female attitudes. However, several studies also

show that females generally possess more positive sustainability attitudes then males in general. Therefore, it is possible that females' attitudes may have influenced females' decision to take SE courses and attend a green university. The male attitude results in this study may, again, be reflective of a lower quality of SE received at non-green universities.

The *behavior scale* results indicated that males who attended green universities and received SE scored collectively highest on the behavior scale. Females from green universities who received SE also scored second highest on the behavior scales. In contrast, males from green universities who did not receive SE scored collectively lowest on the behavior scale. These findings indicate that both male and female participants who received SE and attended a green university scored collectively highest on the behavior scale than those who did not receive SE. This supports the idea that a combination of green university and SE can improve sustainability behavior in both gender groups. In summary, the results show that a combination of SE and green university type has the strongest positive impact on student behavior.

The results of the MANOVA, MR, and follow-up LR studies show that under certain conditions, SE and green universities can have significant impacts on sustainability knowledge, attitudes, and behavior. For example, the MANOVA knowledge, attitudes, and behavior multivariate main effect results were significant for university type, SE, and gender. There were also significant multivariate interaction effects between university type and SE. The implication of these findings suggest that university type, SE, and gender were significant factors impacting knowledge, attitudes,

and behaviors in this study. The results also suggested that university type may influence students' likelihood of taking SE. While the MANOVA results revealed significant knowledge and attitude differences between green and non-green populations, behavior was not found to be significantly different between green and non-green populations.

Although SE did not have a significant impact on knowledge or attitudes, SE did have a significant impact on behavior in the MANOVA study. The implication of this finding is that SE can significantly impact behavior. Whereas gender had a significant impact on knowledge and attitudes, gender did not have a significant impact on behavior. The implication of this finding is that gender identity and gender-related norms can impact knowledge and attitudes, but not necessarily behavior. There were also significant MANOVA interaction effects between SE and university type, and knowledge, attitudes, and behavior. The implication of this finding suggests that SE and university type can have a significant impact on knowledge, attitudes, and behavior.

The MR study further revealed that attitudes were significantly predicted by knowledge, behavior, gender, and university type. Additional LR results showed that knowledge was significantly predicted by attitudes. However, behavior was significantly predicted by attitudes, SE, and academic level. The cumulative results of this study, in conjunction with the comprehensive multi-disciplinary literature reviewed, support the idea that SE and green universities can contribute to positive social change. As such, this information may be of interest to organizations, academic communities, researchers, curriculum developers, and policy creators.

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Appendix A: Permission to Use the Construct

RE: The Knowledge, Attitudes, and Behaviors towards Sustainability Development Scale

Thu, Jan 12, 2012 9:26 am

From: Heather Creech

To: Rebekahhart7, Alex Michalos, Buckler, Carolee

Dear Rebeka

This sounds very interesting: very happy to have you work with the scale; only conditions are of course acknowledgement to IISD and the authors; and we would very much like to receive an email copy of any publications that you prepare based on your application of the scale. We are interested in knowing how the scale is being applied, lessons learned, etc.

Best

Heather

Heather Creech

Director, Global Connectivity

IISD

Appendix B: Modified Construct

Measuring Knowledge, Attitudes and Behaviors towards Sustainable Development

The original construct authors were: Dr. Alex C. Michalos, Heather Creech, Dr. Christina McDonald, and P. Maurine Hatch Kahlke. With permission, this scale was minimally modified. For example, all references to Canadian participants were converted to address U.S. participants instead. Some of the item criterion wording was also minimally changed to improve the readability of some of the questions. However, all of the original question contents, numbering system, and sequence were preserved. The following information and demographic questions were also added to the front matter of the scale:

1. A Survey Invitation
2. General Research Information
3. The Adult Consent Form
4. Question: Green or Non-Green University: Yes or No
5. Question: University Name
6. Question: Sustainability Education: Yes or No
7. Question: Academic Level: 13, 14, 15, 16, 17, 18, 19, 20, or 20+
8. Question: Gender Identification: Female or Male

Appendix C: The Knowledge Scale Results

Question	True	False	%True	%False
K1.	592	14	97.7%	2.3%
K2.	533	73	88%	12%
Reverse Coded K4.	Correct 478	Incorrect 128	Correct% 78.9%	Incorrect% 21.1%
K6.	574	32	94.7%	5.3%
K7.	347	259	57.3%	42.7%
K8.	528	78	87.1%	12.9%
K9.	574	32	94.7%	5.3%
Reverse Coded K10.	Correct 522	Incorrect 84	Correct% 86.1%	Incorrect% 13.9%
Reverse Coded K11.	Correct 518	Incorrect 88	Correct% 85.5%	Incorrect% 14.5%
Reverse Coded K12.	Correct 536	Incorrect 70	Correct% 88.4%	Incorrect% 11.6%
K13.	575	31	94.9%	5.1%
K14.	505	101	83.3%	16.7%
K15.	518	88	85.5%	14.5%
K16.	537	69	88.6%	11.4%
K17.	501	105	82.7%	17.3%

Note. Demographic questions were kept separate from the original scale. The original scale criterion content and number sequence were also preserved. Note that the original construct authors removed two items from this scale. References to Canadian populations were further replaced with references to U.S. participants.

Appendix D: The Attitude Scale Results

Question	True	False	%True	%False
A1.	582	24	96%	4%
A2.	575	31	94.9%	5.1%
A3.	502	104	82.8%	17.2%
A4.	572	34	94.4%	5.6%
A5.	552	54	91.1%	8.9%
A6.	518	88	85.5%	14.5%
A7.	485	121	80.0%	20.0%
A8.	517	89	85.3%	14.7%
A9.	558	48	92.1%	7.9%
A10.	562	44	92.7%	7.3%
A11.	561	45	92.6%	7.4%
A12.	495	111	81.7%	18.3%
A13.	528	78	87.1%	12.9%
Reverse Coded A14.	Correct 524	Incorrect 82	Correct% 86.5%	Incorrect% 13.5%
Reverse Coded A15.	Correct 354	Incorrect 252	Correct% 58.4%	Incorrect% 41.6%

Note. Demographic questions were kept separate from the original scale. The original scale criterion content and number sequence were also preserved. References to Canadian populations were further replaced with references to U.S. participants.

Appendix E: The Behavior Scale Results

Question	True	False	%True	%False
B1.	370	236	61.1%	38.9%
B2.	407	199	67.2%	32.8%
B3.	531	75	87.6%	12.4%
B4.	552	54	91.1%	8.9%
B5.	392	214	64.7%	35.3%
B6.	405	201	66.8%	33.2%
B7.	421	185	69.5%	30.5%
B8.	362	244	59.7%	40.3%
B9.	470	136	77.6%	22.4%
B10.	186	420	30.7%	69.3%
B11.	393	213	64.9%	35.1%
B12.	488	118	80.5%	19.5%
B13.	481	125	79.4%	20.6%
B14.	492	114	81.2%	18.8%
B15.	389	217	64.2%	35.8%

Note. Demographic questions were kept separate from the original scale. The original scale content criterion and number sequence was also preserved. References to Canadian populations were further replaced with references to U.S. participants.