



Alabama's Pedagogical Approach to Sustainability: Defining the Effectiveness of Higher Education Programs Through Comparative Test Modeling

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Alabama's Pedagogical Approach to Sustainability: Defining the Effectiveness of Higher
Education Programs through Comparative Test Modeling

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A Thesis in the Field of Sustainability and Environmental Management
for a Degree of Master of Liberal Arts in Extension Studies

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Abstract

Determining and understanding the sustainability literacy level of a student body within a higher education institution can provide critical insight into the strength and effectiveness of a campus-wide sustainability program. By knowing the student's level of sustainability literacy, leadership can pinpoint investment strategies and develop course work necessary to improve sustainability awareness. The intention of this research was to discover and document the level of undergraduate sustainability literacy at the University of Alabama, Huntsville, (UAH) and compare this to a broader sample of scores taken from local and global samples. The focus of this research was to determine if the UAH undergraduate students fall below a global mean test score related to sustainability literacy.

To establish a recognized benchmark for sustainability literacy, I utilized an online testing platform developed by Sulitest, a non-profit organization located in France supported by the United Nations and other global organizations. The testing tool contained multiple-choice questions geared towards both global and local sustainability issues with additional voluntary demographic questions. Maintaining complete anonymity, all UAH test scores were compared to the Sulitest benchmarks calculated from this database of over 80,000 test scores. The UAH test scores were taken primarily from an on-campus sorority, students from two classes and students from the Honors College.

When comparing mean scores, results supported the hypothesis that Alabaman students would fall below the global mean for the most part. For the test related to international issues, UAH fell 11% below the global mean score. For the test covering US-specific issues, UAH fell slightly below, 2.5%, the mean test score. However, UAH performed well, 106 %, on the international test when compared with other US test takers. Further comparisons were made to determine the effects of other variables on test scores like selected major, class year, and previous education locations.

My conclusion is that although UAH fell below the mean benchmark in multiple areas, the institution currently exhibits many areas for promoting sustainability literacy along with areas for possible improvement. My research indicates possible measures that could improve UAH's overall sustainability literacy test scores and the overall sustainability program in general. My recommended measures to improve sustainability literacy include: examination of existing course accessibility to all disciplines related to sustainability content, improved involvement of leadership to emphasize the importance of sustainability on campus, more robust student testing on sustainability literacy, capitalize on the existing Earth Systems Science program, introduction of sustainability as part of the student orientation and increase support to the Sustainability Department to reach more stakeholders across the entire campus.

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Chapter I

Introduction

Obtaining a well-rounded education in sustainability enables higher education graduates to be better prepared for the global market place. Knowledge of sustainability and its practices extend into multiple areas related to social well-being, environmental stewardship and economic prosperity. Since sustainability can affect students throughout their lives, it is imperative that a higher education institution clearly understands its effectiveness and develops methods for ensuring a high level of sustainability knowledge and literacy, not only through its curriculum but all facets of campus life.

How student's level of sustainability is ascertained is a challenge even for universities with robust programs and resources much less for those institutions with little or no focus on the subject.

The Sulitest Sustainability Literacy test (Sulitest, 2017) represents a method of determining and evaluating sustainability knowledge. This online, multiple choice testing tool bases its questions on the United Nation's seventeen sustainable development goals, addressing both global topics and those specific to a country or region. Based on its far-reaching footprint of test samples, data from Sulitest provides a benchmark for comparing its overall test results with those developed from the samples set within this research. At the same time, it is imperative to ensure the validity of the Sulitest as a viable and accurate testing tool.

Research Significance and Objectives

The significance of this research was to provide a methodology to comprehend sustainability literacy specific to a chosen Alabama university and then apply this model to allow scalability to other institutions. This research analyzed the results of the standard Sulitest question set while incorporating additional narrative questions to compare answers and validate the subject's literacy command of the material. This check and balance increased the value to the research as well as providing significant feedback to Sulitest and its effort to improve its test methods.

In general, universities throughout Alabama appear to follow different approaches in providing an education in sustainability. Identifying these individual systems and the comparative effectiveness of various programs provides the basis for determining possible improvements. This research also enabled a university to better understand its current ability in preparing students to be versed in areas related to sustainability.

The primary objectives of this research were:

- To capture and analyze campus-wide curriculum, extracurricular activities, campus operations, and the community activities at large that increase student awareness and knowledge of sustainability
- To develop a benchmark for acceptable levels of sustainability literacy based on existing test data from a global standardized test
- To utilize a standardized testing method to determine the level of sustainability literacy in a representative sample of the student population at a major state university in Alabama and make comparisons to a global benchmark

- To analyze the Sulitest sustainability literacy testing material to determine applicability of its test questions to indicate sustainability literacy
- To provide suggested improvements to campus activities by comparing UAH with an institution demonstrating higher-level test scores and other proven methods of increasing sustainability literacy

Background

There is a common belief that the goal of higher education is centered around the student's ability to contribute to society while developing his or her own character during the process. At the same time, this educational process creates the baseline qualifications for the student's future career across an ever-changing global market (Fortino, 2012). Others emphasize that higher education is much more than the engine of economic growth but a means for solving today's urgent societal problems. Concurrently, the graduates must envision challenges well into the future in conjunction with innovation to ensure change for the better (Faust, 2010). The environment surrounding higher education promotes the desire to explore new thoughts and new avenues for growth, expanding the mind's own propensity towards exploring knowledge and a mission towards the unknown (Giannetti, 2017). All the above align with the intentions and benefits of adopting a robust sustainability plan into an overall curriculum throughout a higher education platform. Colleges and universities represent an unprecedented learning environment to promote sustainability (Moore, 2005). However, few options are available to higher education institutions for determining the relevancy, importance,

obstacles, and challenges associated with implementing a successful sustainability program. Even fewer options exist for measuring these variables.

Sustainability - Defining the Term

Asking someone to define the term “sustainability” can produce a myriad of responses and mixed emotions. People generally recognize and often equate sustainability with specific programs such as recycling waste products, preserving land and forestry use, building renewable energy sources and creating viable transportation alternatives. Sustainability can also invoke certain emotional behavior, scientific separation and governmental debates within society with its linkage to the global warming and climate change. It is imperative to apply a definition that captures all aspects of sustainability, transcending any single project or individual components of this combined system consisting of environmental stewardship, social well-being and economic prosperity (Figure 1).

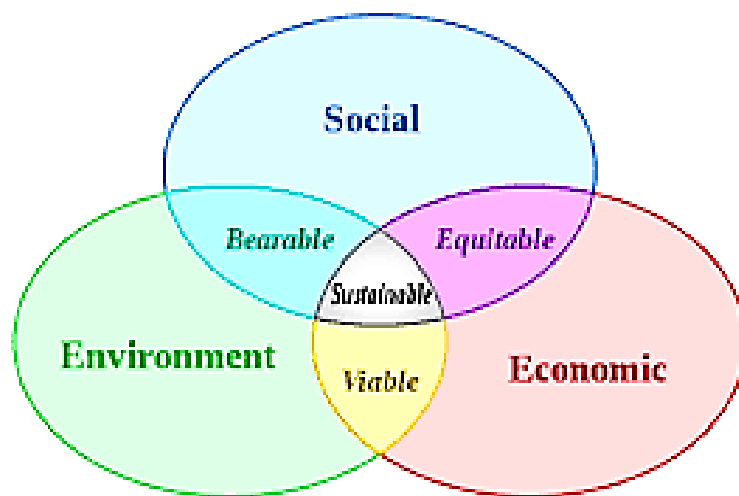


Figure 1. Visual representation of sustainability (Thwink.org).

The definition often used to describe the bigger picture of sustainability refers to our current society's desire and actions to meet its needs and to do so without affecting the ability of the next generation and generations beyond to also fulfill their needs (Farver, 2013). But an expansion of this definition better explains the role higher education could and should play in educating its students on sustainability. First, recognizing universities as a part of a global system they must accept the challenge and responsibility for protecting all life forms while recognizing the importance of human work and people's desired goals. Respect becomes the key word when evaluating human rights and our individual obligation to protect our communities regardless of their location in the world (TJFC, 2017).

Sustainability plays a role of interweaving aspects of social, environmental, economic and political activities into a blended, cohesive system both locally and on a global platform. The cost to benefit ratio must be part of every decision-making process not only measured in today's metrics but also anticipated far into the life cycle of our actions. Sustainability recognizes our resources as precious and limited not to be disregarded in our quest to support materialistic needs. Finally, sustainability remains a living document for our behavior across these aspects – a book that continues to be viewed, edited and improved by each graduate coming through the higher education process (TJFC, 2017).

Higher Education's Perception of Sustainability

With the expanded definition of sustainability in mind, the higher education system continues to grow in its effort to support sustainability education requirements but

the pace may not meet the needed demand (Filho, Manolas, & Pace, 2015). Upper level leadership plays a role in establishing the mission and goals for the university that sets the proper emphasis and priority for sustainability across the entire campus. The beliefs and practices of presidents, vice-president, deans, and department heads in relationship to sustainability creates the initial ingredients of a campus culture towards sustainability. With continued focus and concern regarding the financial viability of institution, the impact of austerity forces leadership teams to radically limit spending and prudently obligate limited funds and resources. Often, upper management leadership fails to see the value of investing in the educational side of sustainability while approving operational sustainability measures that produce a positive return on investment (ROI). Even then, the ROI typically faces heavy scrutiny to ensure alignment with the institutional fiscal responsibilities.

Too often, operational sustainability projects and activities are perceived as educational substitutes for the classroom learning environment. For instance, an institution may implement a robust energy efficiency program throughout its facilities resulting in cost savings and pollution reduction. Legitimately labeled as a sustainable attribute for the campus and a commitment to improve its sustainability footprint, this effort does not necessarily promote the larger definition of sustainability as defined above. More importantly, the greater student body fails to gain knowledge of the sustainability practices since the operations team often remains separated from the classroom environment.

Besides separation from operations, educational goals towards sustainability can also be separated from each of the offered disciplines. With set directives and carefully

planned curricula necessary to achieve department requirements, specific colleges within the institution may fail to see the relevancy to implement the sustainability ideology within their respective discipline. A successful approach to sustainability education involves dialogue across all disciplines with an integrated approach to ensure that the larger picture of these concepts and practices cohesively reach every student (Fisher & McAdams, 2015).

Mainstreaming Sustainability in Higher Education

Like corporate settings, the infusion of sustainability throughout a higher education system requires a cultural change in virtually every department. This notion of placing sustainability within the mainstream of all missions, strategies and investments affects all stakeholders from students to faculty to administration (Farver, 2013). However, the obstacles are many and change is always difficult. The following discussion items taken from the International Journal of Sustainability in Higher Education provides some of the critical components of implementing a successful, campus-wide sustainability program (Ferrer-Balas et al., 2008).

- Critical and autonomous thinking: The faculty must be able to exercise academic freedom. Working within the given discipline, early adopters must be given the ability to change within their respective departments both in research and educational goals.
- Incentives: Adapting an incentive structure for instructors and department that rewards the behavior of promoting sustainability serves a key role in ensuring long-term adoption.

- Desire to change: Many departments work within well-established rules for research and course work but change must be viewed as another important component of that system.
- Transformative education: Interacting with students allows dialogue and ideas to flow in both directions emphasizing critical thinking a problem resolution.
- Change agent: To truly implement a campus-wide plan of any sort requires a person dedicated to meeting goals and skillfully communicating throughout the system. This champion of sustainability can draw resources from the existing organization and remain vigilant, driving force during difficult challenges and unforeseen obstacles.
- Upper level leadership: The president or chancellor sets the tone and tempo for achieving the mission and goals of the college or university. Through that person's vision and authority, it is important that key players are assigned with responsibility and accountability. These resources then serve as a common thread to ensure the strategies and goal permeate throughout the organization.

Some institutions are being forced to take a serious look at sustainability. Peer pressure from other universities can play a role as institutions position themselves in attracting students and research funding. Federal programs can view a robust sustainability as an advantage when deciding to fund programs. In addition, industry partners look to higher education for their ability to train future candidate in the broader sense of sustainability and align with their local and global goals (Ferrer-Balas et al., 2008).

Knowing the Level of Sustainability Literacy – Benefit Outweighs Cost

Realizing the impact of time commitment and cost associated with defining sustainability literacy, this information can contribute directly to the overall success of the institution by improving wide-ranging perceptions along with measurable results.

The benefits of sustainability literacy are:

- Alignment with vision, mission and purpose: In examining the online vision and mission statements for other universities, common themes appear related to being institutions of preeminence, comprehensiveness, technological-research intensive, inspiring, instilling discovery, solving complex problems, and improving human conditions. A comprehensive sustainability program promoting all attributes and measuring results reinforces the entire campus's true commitment. Through a testing regiment an institution could demonstrate adherence to its strategic plans as an academic and administrative scorecard process, valuable as a feedback mechanism (UAH, 2018).
- Attracting new students: Surveys indicate that sustainability can be part of the decision-making process for incoming students. When potential candidates were asked if environmental issues could play a role in their decision, survey results indicated that 64% acknowledge an institution's commitment environmental issues weighted in between strongly and somewhat influential. Interesting to note, this represents a three percent increase from the previous year's results (Princeton Review, 2017). In addition, studies also indicate that students consider activities beyond an institution's specific academic curriculum and include other contributing factors like recycling, energy

conservation attitudes and student-led environmental activities (Sivamoorthy, Nalini, & Kumar, 2013).

- Building the sense of student responsibility, awareness and action: Due to its ability to reach across all disciplines, sustainability represents a method to draw students together and accept greater responsibility across the campus and beyond. Many of the conservation measures implemented by a facilities team require acceptance and buy-in from the student population. A survey indicates that Generation Y (currently 18-24 years of age) shows a greater awareness towards environmental issues but at the same time, wastes the most energy and water (Wheeland, 2009). Greater results can occur when students become part of the design, implementation and feedback of an intended measure. Their broader acceptance of responsibility towards the holistic definition of sustainability enriches each discipline by instilling ethical behavior and social well-being beyond the classroom. The increased focus on sustainability creates increased involvement for student interaction across the campus (Krasny & Delia, 2015).

Challenges of Conducting Sustainability Literacy Assessment

The association for the Advancement of Sustainability in Higher Education (AASHE) established a rating system based on an institution's impact on seventeen (17) areas related to academics, community engagement, facility operations and leadership (AASHE, 2018). Within this tracking system, points are awarded for assessing sustainability literacy but the program itself recognizes the difficulties involved in

meeting this criterion. One concern involves the difficulty of achieving meaningful test results based on the lack of testing tools. Without clearly defined testing tools individual survey efforts may lack interpretation clarity. In addition, institutions are facing issues with investing the adequate time needed for gaining useful results (Pelton, 2012).

Some institutions first start their literacy analysis within the organization itself before attempting to determine the level of its students. In this effort, the attitude of the academic and administration is examined by identifying those stakeholders that fall in various categories from grassroots enthusiasts to full commitment. Of course, establishing a plan to address those completely objecting to the notion or willing to move with the greater cause is needed. However, the goal in this process is to identify players willing to completely transform the methodology and bring creative approaches to the table (Glover et al., 2013).

Sulitest Sustainability Literacy Test

In 2012, the Higher Education Sustainability Initiative (HESI) was created through a collaboration of multiple United Nations organizations to ensure continued measurement of meeting pedagogical sustainable development goals. As developed by the United Nations system, the education process involves 17 distinct sustainable development goals (SDGs) ranging from the elimination of world poverty to gender equality to the promotion of inclusive societies (UN, 2018). One of the challenges facing the implementation of the SDGs is measuring their advancement and implementation on a global scale. With sponsorship from the United Nations Educational, Scientific and Cultural Organization (UNESCO), financial support of various industry partners and

input from academics and researchers, Sulitest was formed as an independent, non-government owned, non-profit entity dedicated to the effort of assessing sustainability literacy (Sulitest, 2017a).

The Sulitest questions are the product of input from a variety of subject matter experts within the field of sustainability located around the world. The final formulation of the global set of test questions falls under the direction of a Senior Advisory Board that ensures the validity and applicability of its contents. This effort resulted in a testing tool geared towards the higher education academic community, as well as the corporate environment, with the intent to evaluate the sustainability literacy of its test subjects.

The tool addresses three major areas of sustainability, environmental stewardship, social well-being and economic prosperity, with the intent of gaining an insight of the subject's specific knowledge within these areas (Sulitest,2017b). Knowledge themes are:

- Sustainable humanity and ecosystems on Earth
- Global and local human-constructed systems to answer people's needs
- Transitions towards sustainability
- Roles to create and maintain individual & systemic changes

The Sulitest consist of two separate sets of questions: section one consisting of 30 questions related more to the global perspective of sustainability, while the second section covers questions geared more towards specific localized questions of the subject's country or physical location. This approach allows for greater literacy clarity as it explores the subject's exposure to international sustainability issues as well as pinpointing localized issues (Decamps, Barbat, Carteron, Hands, & Parkes, 2017).

The debate regarding the ability of Sulitest to define levels of sustainability literacy continues even with its extensive set of over 80,000 test samples. Few research projects exist that analyze the possibility of multiple influencers and independent variables that could shape the test results. Soon to be released for publication, one of the few independent research projects compared test results from three separate universities against in person interviews to better define the impact of various influencers on test results (Verhoff, 2017). The interviews supported the test results and reinforced sustainability knowledge was reflected in the test results. The Sulitest research team continues to explore its set of questions and its test results to further clarify their usefulness as an exclusive test of sustainability literacy. As a minimum, this tool serves as a means of assessing literacy knowledge with the intent to improve its ability to uncover and inject both skills and mindset-related questions into the test.

Ohio State University's Sustainability Literacy Test

One institution developed its own specific sustainability literacy test. Ohio State University (OSU), through the support of its Social and Sustainability Lab, took on the challenge to create a test for its students that specifically examines “cognitive and factual knowledge” of sustainability (OSU, 2013). A multi-step program involved a team of subject matter experts coupled with a pilot project followed by a more expansive test sample of undergraduate students. The test comprised 16 questions related to environmental, social and economic themes. The test was administered over multiple semesters and revealed that sustainability knowledge did increase from first through fourth year students (Zwickle, Koontz, Bodine, & Stagle, 2013) (Figure 2).

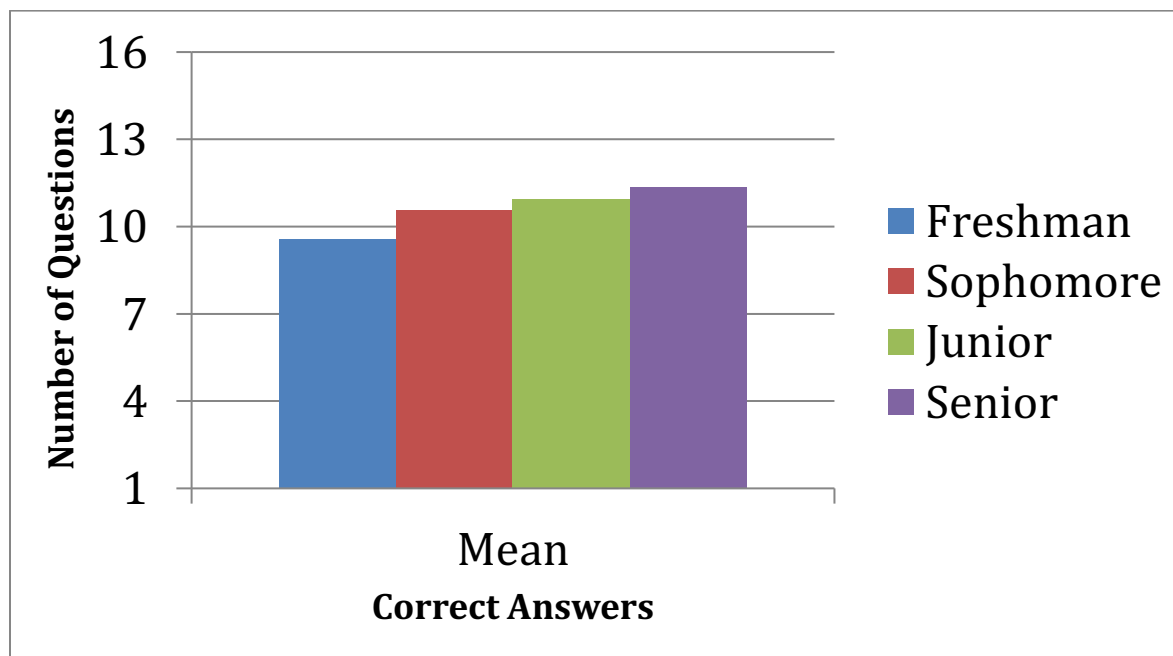


Figure 2. Mean score by class based on 16 questions (Zwickle et al., 2013).

The OSU research team first gained supporters within their sustainability office as well as survey exempt status approval from its Institutional Review Board for working with human subjects. The registrar’s office approved their methods of reaching out to students using student email, majors and demographics. OSU discovered that important survey variables like time of release, incentives, email text subject line and question format drove increased student response and participation (Zwickle et al., 2013). This should help shape the design of sustainability literacy surveys.

The above background information indicates that defining, implementing and tracking sustainability learning activities in a higher education setting can be difficult, even under the best conditions.

Research Questions, Hypotheses and Specific Aims

The major research question I addressed is if Alabaman universities meet a global mean score, as presented by this challenge: Does Alabama's higher education programs adequately prepare its students for a holistic understanding of sustainability, specifically in areas related to environmental stewardship, social well-being and economic prosperity? Would a standardized sustainability test taken by Alabama students reveal lower scores compared to other similar institutions? What constitutes an acceptable score and would there be a marked difference in scores within the various themes? What test design is needed to ensure credible test results reflecting actual sustainability literacy? What actions and programs would be expected to improve Alabama's scores if implemented?

These questions indicate an overall concern that Alabama's educational emphasis is lacking in regards to sustainability. Based on this assertion, the first hypothesis I examined is that the general student population of The University of Alabama, Huntsville, exhibits lower overall sustainability literacy scores when compared to a national and global mean average under a controlled testing scenario.

The second hypothesis I examined is tied to the possible influencers and enabling conditions existing on campus and in the community that create a greater learning environment for educational instances to improve scores. The prediction is that curricula containing different facets of sustainability knowledge, skillsets and mindset, regardless of the discipline, along with campus-specific sustainability extra-curricular activities, proves beneficial in improving sustainability literacy.

Specific Aims

The following set of specific aims address the steps needed to examine my hypothesis and identify reasons for comparative sustainability literacy:

1. Analyze literacy test scores: Establish Sulitest Sustainability Literacy Test benchmark criteria consisting of 8 topics with four themes and perform comparison analysis with test results from a control group consisting of subjects from the Alabaman university
2. Define existing sustainability offerings: Analyze online data and interview campus resources to define existing courses across disciplines, extra-curricular activities, facility operational practices and community activities that promote the awareness and knowledge of sustainability within the Alabaman university
3. Determine the effectiveness of Sulitest: Create a narrative test that will be used to further qualify the Sulitest test results as a viable method of establish a benchmark for comparing UAH test results
4. Analyze response variables based on data provided from the optional information attached to the Sulitest standard testing platform.

Chapter II

Methods

The method of evaluating the main hypothesis involved the use of an established online testing tool specifically designed to determine the sustainability literacy level of subjects. The intent was to test subjects at The University of Alabama in Huntsville (UAH), and compare the results to an established benchmark determined by a larger test set both globally and within the United States. Testing occurred with various groups within the undergraduate test set consisting mainly of students associated with the UAH Honors College program, Lambda Kappa Chapter of Delta Zeta sorority, Honors College Course 101-07: Research Methods and Course ESS 321: Pollution Problems (Table 1).

Two test sessions were developed and each group was asked to participate in Test Session #1, Test Session #2 or both. Test Session #1 (narrative) was comprised of four narrative-based test questions along with ten demographic questions created independently of Sulitest. Test Session #2 (Core/US Specific) was comprised of the Sulitest Core test of 30 multiple-choice questions covering global issues, the US Specific test comprising of 20 multiple-choice questions tied directly to US sustainability concerns, and an optional Sulitest demographic section consisting of 22 questions. Each group received instructions on its designated test session or combination and tracked based on students registering online as compared to those completing the test session (Table 1).

Table 1. Test sessions by group.

Test Sample Group	Test #1 - Narrative		Test #2 - Global/Local	
	Sample	Registered	Sample	Registered
Delta Zeta			15	19
Green Club	16	24	15	28
HON 101-07	30	33	28	33
Honors College			5	8
ESS 321			2	32
HON 301			1	8
Total	46	57	66	128

In conjunction with testing, a comparative analysis was conducted of currently employed measures that directly or indirectly affect sustainability literacy on campus. This comparative analysis explored areas of possible academic influences on campus as well as the influence of other student-led activities contributing to knowledge or actions towards sustainability. In addition, consideration was given to local community activities and events that encourage sustainability in general.

Determining Sample Size

The number of full-time, on-campus, undergraduate UAH students was used to determine the reasonable sample size for this research. Currently, the number reflects approximately 7,090 available subjects for the experiment group corresponding to the 2018 spring and fall school year. Utilizing the sample size calculator from Creative Research System, a total sample size of 95 subjects was the target based on a population

value of 7,090 with a confidence level of 95% and a confidence interval/margin of error of 10% (Table 2) (Creative Research Systems, 2017). This sample size was difficult to achieve because although the number of test registrations met the sample size requirements, the actual tests taken fell below the desired sample size.

The final sample size was broken into two separate categories. Part 1, the narrative session, resulted in forty-six responses from a total of fifty-seven qualified registered students and based on this amount, the confidence interval/margin of error move to 14.4%. For Part 2, Core/US Specific, the structured Sulitest portion, had sixty-six test responses from a total of one-hundred and forty-six qualified registered students, resulting in a confidence interval/margin of error calculated to 12% (Table 2). The primary research concentration was related to the Sulitest portion of the test samples and was the primary focus of this research. The narrative portion was a subset in the examination of the Sulitest test itself.

Table 2. Sample size based on 7,090 population, 95% confidence level (Creative Research Systems, 2017).

Confidence Interval/Margin of Error	Sample Size
14	46
13	56
12	66
11	79
10	95
9	117
8	147
7	191

To better understand the methodology for deriving the sample size and to allow for future adjustments to the sample size, the following equation was utilized (Creative Research Systems, 2017):

$$ss = Z^2 (p) (1-p/c^2)$$

Where Z = Z value (e.g. 1.96 for 95% confidence level),

p = percentage picking a choice (in decimal) (.5 used for sample size needed), and

c = confidence interval/margin of error (in decimal) (e.g., .05 = ± 5).

Recalculated Sample Size based on changing population parameters:

$$SS = ss \div 1 + (ss-1)/\text{population}$$

Challenges and Concerns for Identifying and Controlling Test Samples

The major concerns and challenges regarding the collection of test samples from the UAH campus were:

- Identifying subject's year of education: It is imperative to attempt to clarify the subject's year (first year, second, etc.) so that the consideration can be given to possible levels of learning. This information was gathered from many of the test samples as part of the demographic section of the test/questionnaire. However, this information was not available from all test samples.
- Specific disciplines and campus-wide subjects: The original sample design was to select specific disciplines for testing consistency. However, variation in the tested student population was achieved by testing groups that contained a variety of disciplines. By sampling students from the Honors College, Delta Zeta and research classes, the test samples extended across many different declared and undeclared majors, resulting a reasonable mix of disciplines on

campus. A small quantity of samples came from the general campus population with undergraduate status the only requirement.

- Campus acceptance: The Honors College represented the largest population of approximately 750 students, while Delta Zeta represented approximately 50 students and the two classes approximately 30 students each. Of this approximate total of 830 students, sample sets were collected with differing totals based on mandatory and optional sections of the test/questionnaire (Table 1).
- Time frame: All surveys were conducted during the 2018 spring semester and continued into the 2018 fall semester.
- Extracurricular targeting: Specific student-led organizations, especially those that lean towards sustainability, for example, UAH Green Club, UAB Charger Cycle and Student Green Fund gained insight into on-campus sustainability activity.
- Campus operations: An online examination of specific measures being implemented by the physical plant operational team for the campus with input from the sustainability coordinator and any engagement with the student body related to educational experience or exposure.

Sulitest as a Testing Tool

This research analyzed the Sulitest Sustainability Literacy Test scores to determine comparison benchmarks by subject, assess key learning outcomes, identify areas of strengths and weaknesses, and determine mean scoring matrix across subjects for

comparative analysis. Mr. Aurelien Decamps, head of the research department at Sulitest, played a pivotal role in providing guidance for establishing test modules as well as providing sanitized test results for the various sessions throughout the testing period. Sulitest offers a variety of analytical tools to assist in performing assessments within specific tests. These analytical tools include the ability to compare the benchmark criteria of the Sulitest Sustainability Literacy Test on a global and local scale to test results of the Alabaman university. In addition, the analytical tool has the ability to provide benchmarking criteria to compare other specific universities exhibiting higher Sulitest scores. However, gaining access to specific test scores from individual universities requires a separate memorandum of agreement prior to release of data from Sulitest and this effort did not meet the timeline for this research.

Gaining Access and Taking the Sulitest Test

To gain access to the online Sulitest, a university or private corporation must register as group responsible for administering the test and monitoring its results. In the case of this research, Harvard University allowed access through their premium registration. This level of access allows the grouping of three separate test modules:

- Core Module consisting of 30 multiple-choice questions related to the global aspect of sustainability, with all questions developed by Sulitest
- United States Specific Module consisting of 20 multiple-choice questions designed explicitly to address sustainable issues in the United States, with all questions developed by Sulitest

- Customized Narrative Module developed by a 4-member team containing a combination of narrative and multiple-choice questions along with demographic questions particularly related to the Alabaman test subjects

Utilizing Harvard's access authority to Sulitest, I became the "examiner" that allowed access to create specific sessions geared towards various test groups at the university. Through these design rights, I structured the test based on a combination of the various modules listed above. As the examiner, I also retained the right to access test results once sanitized by Sulitest to protect all identifiable data reflective of the test subjects. Once designed, Sulitest assigned a specific test code for each of the test sessions. The test code allowed analyzing data pertinent to each session group and its applicable test design as well as individual test scores from each test subject.

Before the exchange of data, a memorandum of understanding (MOU) was developed and implemented to enable the protected transfer and handling of test results and demographic information between Sulitest and this research team. In addition, a separate MOU was required by Sulitest to protect the information potentially shared in reference to the comparison model university but not exercised in this research.

Controlling Test Questions and Categories

There is a provision that allows the examiner to select or modify test questions based on intended test subjects or for targeting areas of educational concern. The test categories are broken into knowledge-based categories and themes as follows:

- Global and local human-constructed systems
- Role to play, individual and systemic change

- Sustainable humanity and ecosystems
- Transition towards sustainability
- Mindset
- Personal Skills
- Think and act systematically
- Working with others

The analytical intention was to break down the results from each of the topics/themes and correlate this information against other available variables. The other variables such as age, gender, level of education and selected discipline cannot be compared holistically to the main topics/themes because these variables appear as optional information from the test subjects. The test results were calculated and supplied to the subject without supplying the additional information. No information was collected that revealed the personal identity, resulting in complete anonymity of the subjects.

Validation of Sulitest as a Sustainability Literacy Indicator

The results of this research depend heavily on the Sulitest test format, content and benchmarks to demonstrate a level of sustainability literacy. As a living document, Sulitest continues to refine its test questions, and researchers apply statistical analysis to compare test scores on a global scale while also creating benchmarks specific to countries and their relevant sustainability issues. Discussions with the Sulitest head of research, Dr. Aurelien DeCamps, indicated that in its current form the test has not been verified to be more than an awareness tool and a teaching mechanism for sustainability issues and the

degree to which it is a qualitative, definitive testing tool for literacy has yet to be determined.

To gain a level of confidence in the Sulitest test and its results, a customized module created by a research team for an ongoing pilot study (Suter et al., 2019) was incorporated into the thesis research methods. This narrative set of questions was developed independently of the publicly-available Sulitest test, and students' test scores were compared between the narrative sample set and the Sulitest test scores.

The narrative test set was developed by a research team consisting of myself and three others: Ms. Brooke Suter, Dr. Michelle Merrill and Dr. Brandon Verhoff. Ms. Suter, a designated Sulitest examiner for Harvard University, is the Strategic Advisor to Sulitest.org and works directly with the Sulitest research team to analyze the robustness and applicability of the global and local sustainability literacy test. Outside of this research effort, Ms. Suter formed and facilitated the four-person team to develop viable narrative test questions along with a scoring rubric allowing the comparison between the two tests. Dr. Merrill and Dr. Verhoff served in a voluntary role as research consultants during this research and will continue to serve on a team in review of the Sulitest applicability as a literacy testing tool beyond this research project.

The Pilot 1 narrative test set consisted of fourteen questions that included:

- Are you active now or have you been active in any sustainability practices? A list of seventeen possible sustainability practices were listed as a method of determining possible influences on sustainability knowledge. The subjects were asked to select all that were personally applicable to them. Practices include: gardening, habitat cleanup and restoration, water conservation and

access, energy efficiency/affordability/access, purchasing practices, support of small/minority businesses, organic/fair trade production, waste minimization/diversion, recycling/reuse/reducing/upcycling, food security/sustainable agricultural systems, clubs/volunteering/education, social justice, human rights activism, social movements/inclusive societies, donating money, promoting healthy lives and well-being.

- Pick an activity of your choice and describe how one's personal involvement could support sustainability.
- Please respond to this scenario: You work in a company that could improve their sustainability practices but does not have a sustainability program. What steps could you take to initiate changes that would improve sustainability, without having formal authority over that area? Which stakeholders would you need to involve and how would you get them engaged?
- How are inequality issues relevant to environmental sustainability? Include one example from an individual, local or international perspective.
- Choose one of the following categories and describe how the system (where individual elements impact other elements) could be better designed to meet the needs of future generations: Water, energy, transportation, education, waste, food, health, gender equality (Suter et al, 2019).

For this thesis, additional survey questions were included to gain knowledge on demographics and sustainability involvement that could influence sustainability literacy:

- Years of schooling in Alabama, other states or international, K-12 and college?

- Current year of college education?
- Pursuing second or minor degree?
- Total time spent outside the United States for any reason?
- Amount of parental influence on sustainability views?
- Number of sustainability-related courses taken?
- Number of courses that included discussions about sustainability?
- Provide feedback on test and comments for improvement, if any.
- Sequence of taking test – narrative before or after Sulitest?

Narrative Scores vs. Sulitest Scores

As described earlier, the narrative Customized Module and multiple-choice Sulitest test were given to a portion of the subjects to determine the possible correlation between the two tests. The methodology involved creating a scoring rubric where each person within the four-person team scored each narrative response. Through the team's effort, a rubric with five or six scoring categories per question was used. Subject scores were then normalized to compare the total narrative score and subject's total Sulitest score. The scoring point structure was based on the highest possible score of ten points, although there is a possibility that the total for all categories could exceed ten points (Table 3). This approach allowed extra points to be assigned in one category for an exceptionally good answer but the maximum total was capped at ten points (Suter et al., 2019).

Table 3. Scoring rubric for narrative questions.

1A. A mention (1 or 2 words = 1 pt) or elaborates or provides context (2pt) regarding environment ('planet') Pts: 0-2	1B. Discusses social well-being/ society/ justice factors ('people') Pts: 0-2	1C. Mentions economic/ business/ market/ production =1; Discusses=2 ('profit/ prosperity') Pts: 0-2	2a. Personal agency and transformation: Able to utilize their knowledge of sustainability to change their daily habits and consumer mentality. Pts: 0-3	2b. Systems thinking: Makes clear connections between personal actions and sustainability outcomes, and/or links personal choices to changes at larger scales (community, industry and government responses). Pts: 0-3
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Defining Existing Activity at UAH

An important component in this research involved exploratory analysis of current efforts at the university promoting knowledge of sustainability on campus. This effort included discovering the following from online sources and direct contact with university teaching and operations staff: current curriculum, extracurricular activities, and campus activity related to facilities operation and maintenance. As a reliable and knowledgeable source of information, I elicited the assistance of Mr. Taylor Myers who holds the position as the sustainability coordinator, a position he has held since February, 2017. My involvement with Mr. Myers started through the student-led Green Club organization and during the trial run the HON301 course on sustainability at UAH. Following in the footsteps of UAH's first sustainability coordinator of three years, he began his efforts in forming a grassroots team and began preliminary steps to broaden the definition and scope of sustainability on campus. In his efforts, he views this research as reinforcement to his overall short and long-term plan as well providing a better insight to areas needing

improvement. He was a strong and necessary supporter to achieve on-campus test results and access to available data.

Determining a Comparative University

Since Sulitest is being used to determine a benchmark for comparison, a request was sent to the Sulitest research director to request data associated with a university demonstrating a high percentile across all topics and themes. After several discussions, Sulitest expressed trepidations on releasing specific test result information with concerns of causing some damage to its source's anonymity. In addition, there is also the need to explore the institution itself to better understand the possible causes for increase scoring performance. Sulitest vetted possible candidates but even under a Memorandum of Understanding to protect the data, no candidate was established in the time frame needed to support this research activity. Readily available, public information will be utilized during the conclusion and recommendation section to provide comparison for possible improvements to the UAH sustainability program.

Determining Research Eligibility for IRB Exemption

Since this research involves testing human subjects, the research methodology was analyzed to determine the type of review process required to ensure minimal harm to subjects involved in the research. Under the requirements of the Harvard Research Protection Program, a plan was required utilizing Federal Regulation 45 CFR 46 (CRF 46.101(b)(4)(2)). As the principal investigator (PI), I completed the research protocol document that allow the IRB team to determine the status of the research related to the

use of human subjects. The protocol title was: Alabama's Pedagogical Approach to Sustainability: Defining the Effectiveness of Higher Education to Programs through Comparative Test Modeling and the protocol number was IRB18-0476, dated April, 19, 2018.

Based on the submitted research protocol, the IRB's determination was that the plan contained Level 2 Data and was therefore exempt based on reference to Harvard's Data Security Policy. This research fell within eligibility for exemption based on the following activities:

- Testing aligns with an established and commonly accepted educational setting under normal educational practices
- Subjects will not be required to release information related to their personal identity

As indicated in the final CUHS notification, the approval of the exempt status contained a contingency requirement that the PI must destroy all identifying information from the existing datasets transferred to the PI through the research effort. This task was accomplished and a modification update notice was provided.

Chapter III

Results

The first comparison involves the total test scores of the Core session to the benchmark scores established by Sulitest. In its calculations, Sulitest utilized a sample set of approximately 30,000 test scores from a global platform outside of the United States to determine the Core benchmark score of 55% of correct answers. Sulitest used a similarly-sized sample set to determine a benchmark score of 47% of correct answers for the Core test taken in the United States. Based on a sample size of 66 for the Core test, the comparative results indicate UAH students scored a mean of 50.2% of correct answers with a median score of 50%. However, the mode was a score of 57%, representing 9 of the 66 tests taken. Compared to the global score results, 57% fell below the global benchmark, while only 33% of the sample test results fell below the US benchmark (Figure 3).

These test comparisons indicate that the majority UAH test samples fell below the global test results for the Core test. However, when comparing the US benchmark for the Core test, UAH performed better against benchmark with 66.6% of the scores at or above the benchmark. It is worth noting that the Sulitest global and US benchmarks indicate a 15% disparity between scores, pointing toward the US lagging global sustainability literacy.

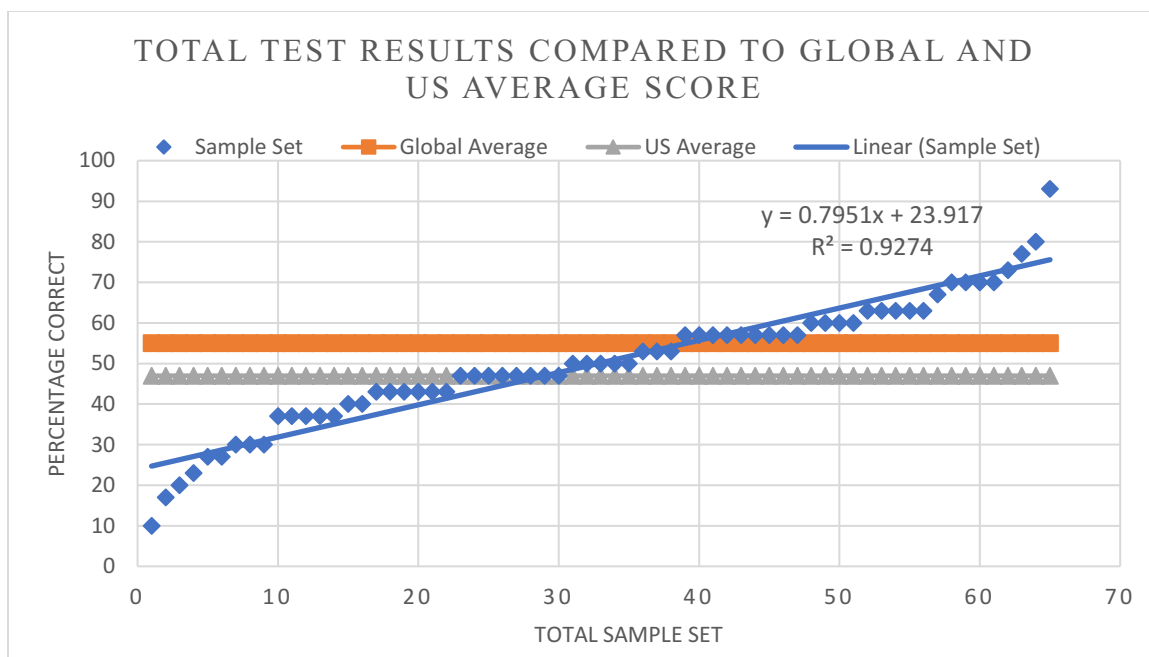


Figure 3. Total Core test results for UAH students vs. Sulitest global and US benchmark.

Overall Results for US Specific Test

Sulitest designs sustainability literacy tests tailored to individual countries or regions around the world. In this case, the US specific test was included to follow the Core test during the test session. Both the Core and the US specific tests serve not only as a multiple-choice test platform but also as a learning platform. After the test answer is selected, the subject receives instant feedback on the selected answer regarding the current or incorrect answer but also a brief background description supporting the correct answer. Upon review of the both test section, knowledge gained in the Core section does not provide possible influence or gained advantage in answering the US specific session.

The overall test results achieved by the UAH sample for the US specific sample set was close to the Sulitest benchmark. In comparison to the Sulitest benchmark of 66% of correct answers, the UAH sample set indicated a mean score of 64.4% and median at

64.0%. The mode resulted in two separate sets with one at 9 scores equaling 64% and one at 9 scores at 79%. The results indicated that 53.8% of the test fell at or below the US benchmark while 47.2% were above the benchmark (Figure 4).

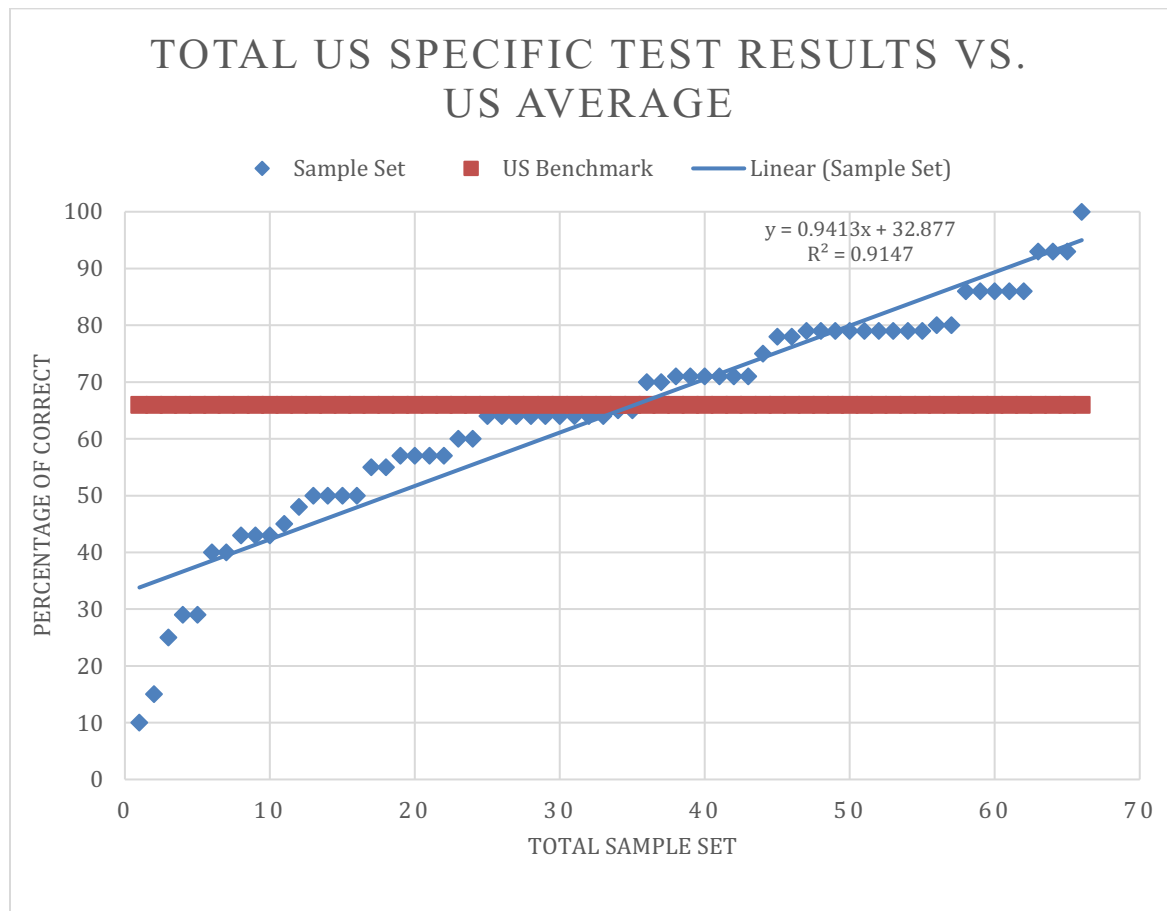


Figure 4. Total US specific test results for UAH students vs. Sulitest US benchmark.

Test Results based on Sustainability Themes

The selected questions built into both the Core and US specific tests support four central sustainability themes: sustainable humanity and ecosystems, local and global human-constructed systems, transition towards sustainability and the role to play, individual and systemic change. For this research, the scores of the five major testing

groups, Delta Zeta, Green Club, Honors 101-07, Honors College and ESS 321, were separated and sorted to determine group scores by theme. (Figure 5).

As depicted in Figure 5 related to the Core test, the Delta Z scores fell below the global benchmark for each of the four themes while HON 101 performed slightly better in two of the four categories – role to play and transition towards sustainability. The

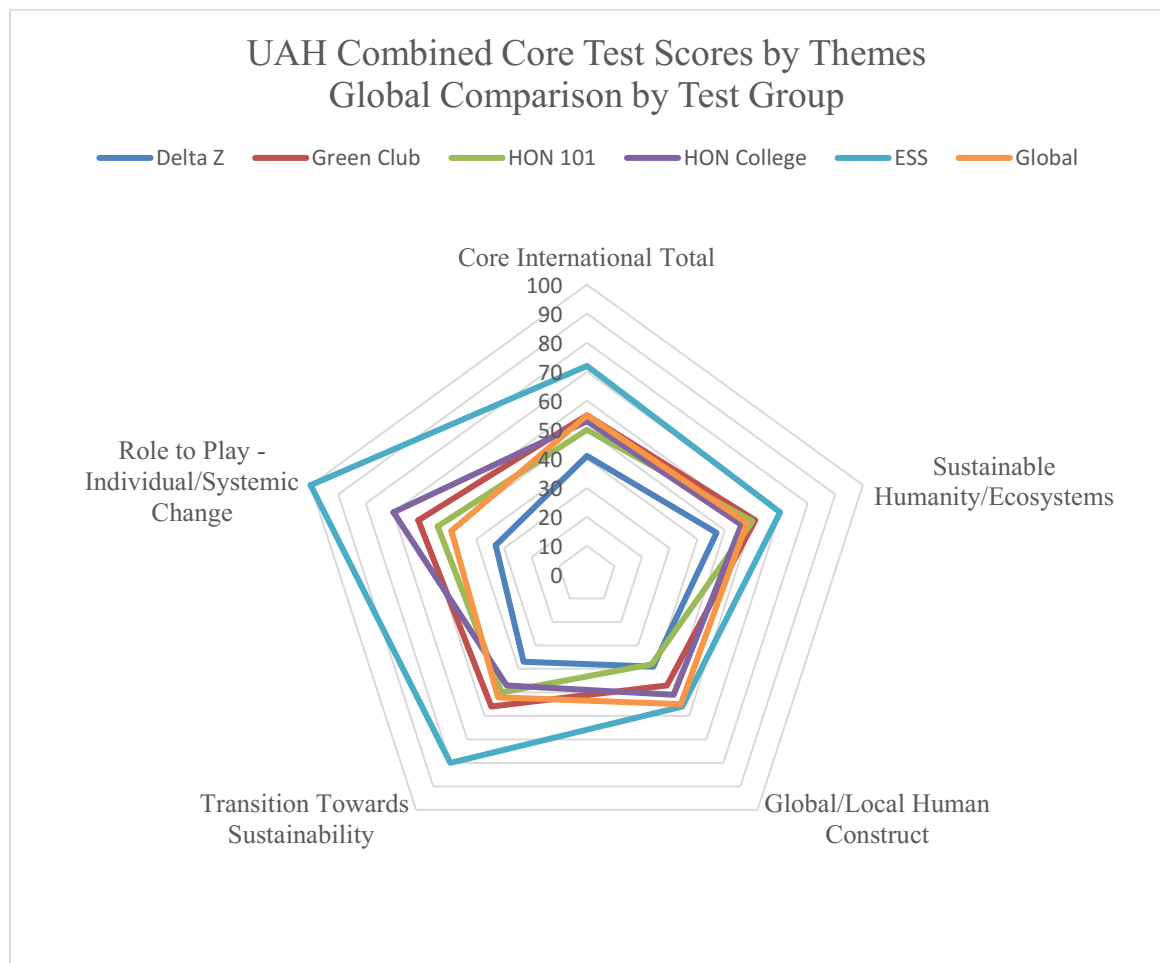


Figure 5. Core global comparison vs. test group vs. themes for five UAH student groups.

theme of role to play scored consistently higher than the benchmark for all groups except Delta Z. In contrast, the global/local human construct theme scored consistently at or below the benchmark. Consistent with the scores noted in Figure 3, Green Club, HON101

and Honors College themes track closely to the benchmark. The highest scoring group was represented by the ESS group but it must be noted although this score could be reflective of the course concentration within the Earth System and Science related to sustainability, the sample size included only one subject.

The US Specific test scores produced slightly different results in relationship to each theme. Again, Delta Z fell below the benchmark in all the themes with the largest gap of 27% in the transition towards sustainability. The ESS results also demonstrated the highest scores in each of the themes. All the other groups tracked closely to the benchmark except for the Honors College; students scored lower in the role to play but substantially higher in transition to sustainability theme (Figure 6).

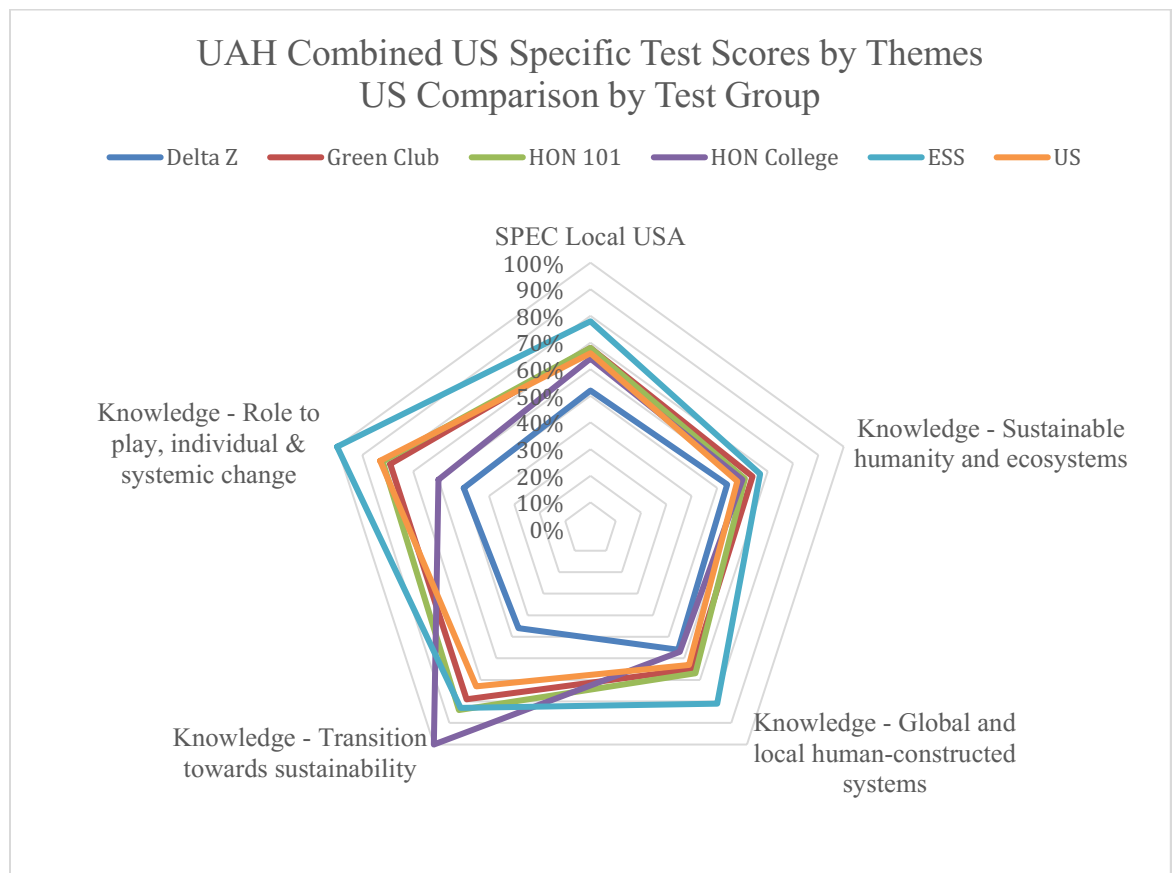


Figure 6. US test score comparison vs. test group vs. themes for five UAH student groups.

Consistently lower scores exhibited by Delta Z poses an interesting finding. Upon examination of their sample set, Delta Z represented the broadest list of varied disciplines compared to the other groups. In addition, the major and minors tend to be less associated with engineering disciplines and more closely related to liberal arts and sciences. Due to the nature of a sorority, Delta Z represented a female population but no correlation was performed to determine sustainability scores of females versus male subjects since personal demographics remained anonymous. Unfortunately, this group was not involved in the added narrative section that included specific more specific questions related to sustainability activity both on campus and in the subject's personal life.

Individual Test Scores vs. Test Session

After each student completed the Core and US Specific test, Sulitest produced a surface chart to demonstrate how each individual test compared to their benchmark for each topic/theme. The individual test results not only indicated how the individual compared to the global benchmark but also compared the individual to their test session group, i.e., UAH Honors College program, Delta Zeta sorority, Honors College Course 101-07: Research Methods and Course ESS 321: Pollution Problems. This Sulitest feature allowed students to see how they compare specifically to other students in their respective groups. This data was provided directly to individual students in their Sulitest online protected register and was not part of this report, but an example of this graphic representation is provided (Figure 7).



Figure 7. Graphic example of Sulitest individual test results (Sulitest, 2018).

Test Scores Indicated by Sustainability Development Goals (SDG)

The Sulitest Core and US Specific test questions align with the United Nation's Sustainable Development Goals (SDG). Based on the UAH test results, individual scores were categorized to determine areas of low and high performance across all test samples. Once tabulated, the SDGs were ranked from lowest score to highest and separated to reflect Core and US Specific test results both globally and locally (Figures 8-15).

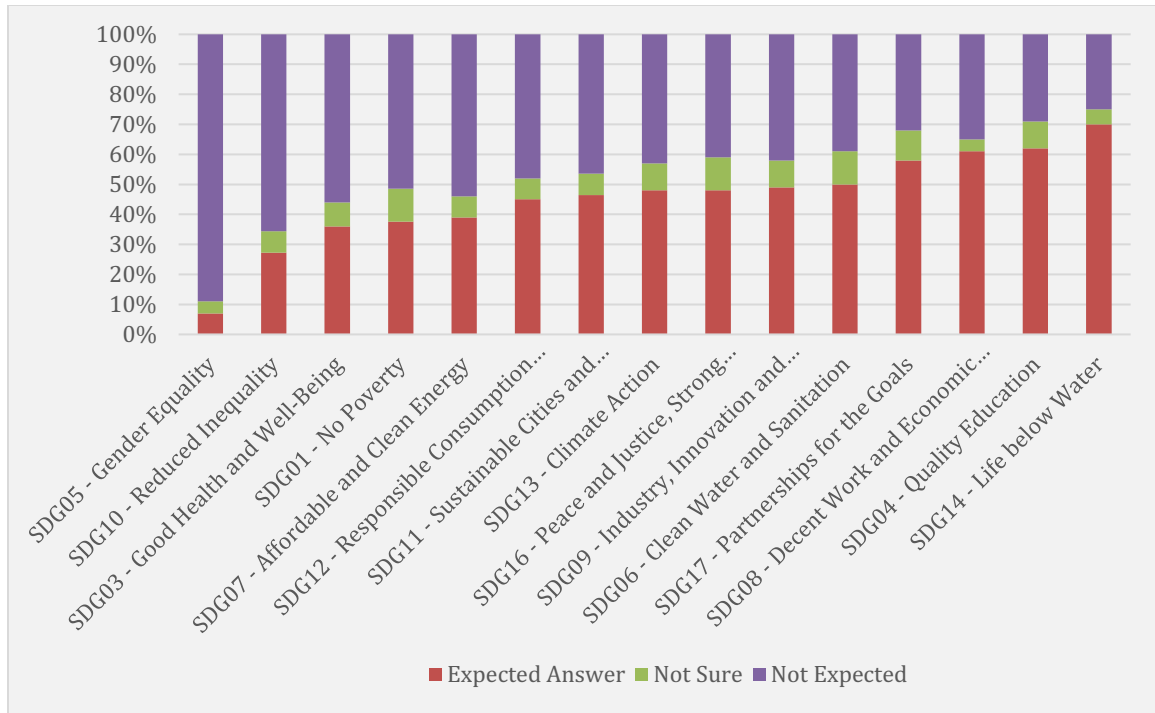


Figure 8. HON 101 core SDG results.

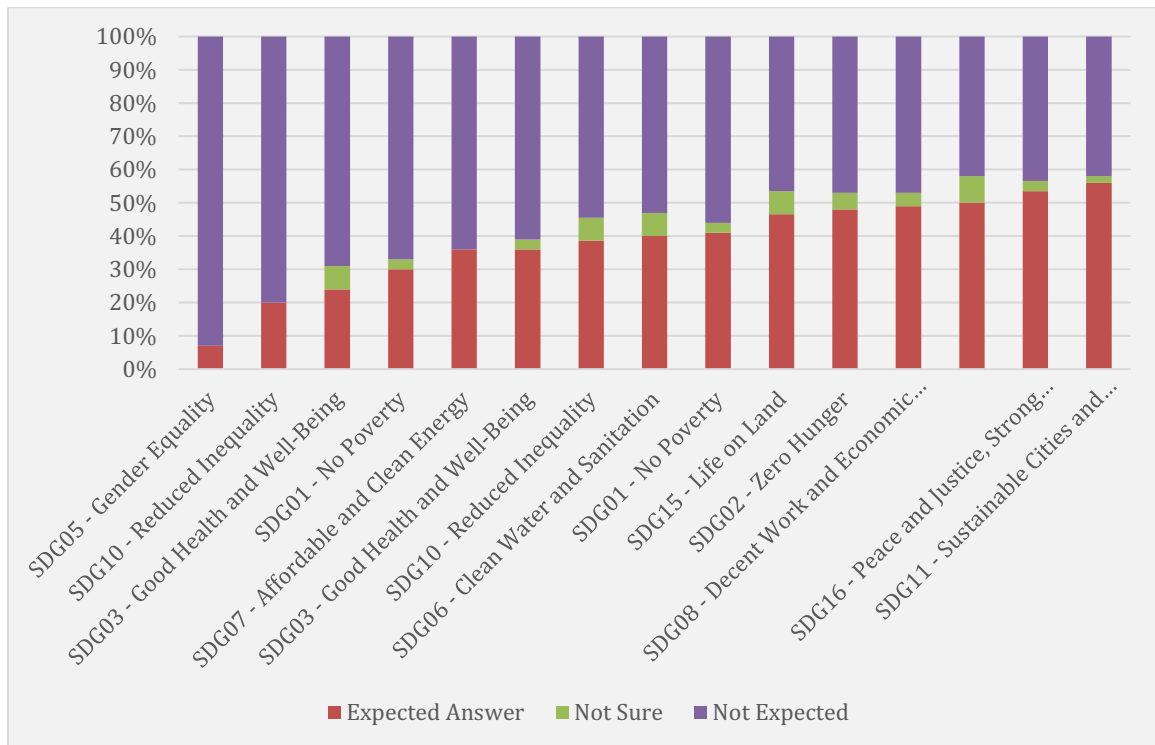


Figure 9. Delta Z core SDG results.

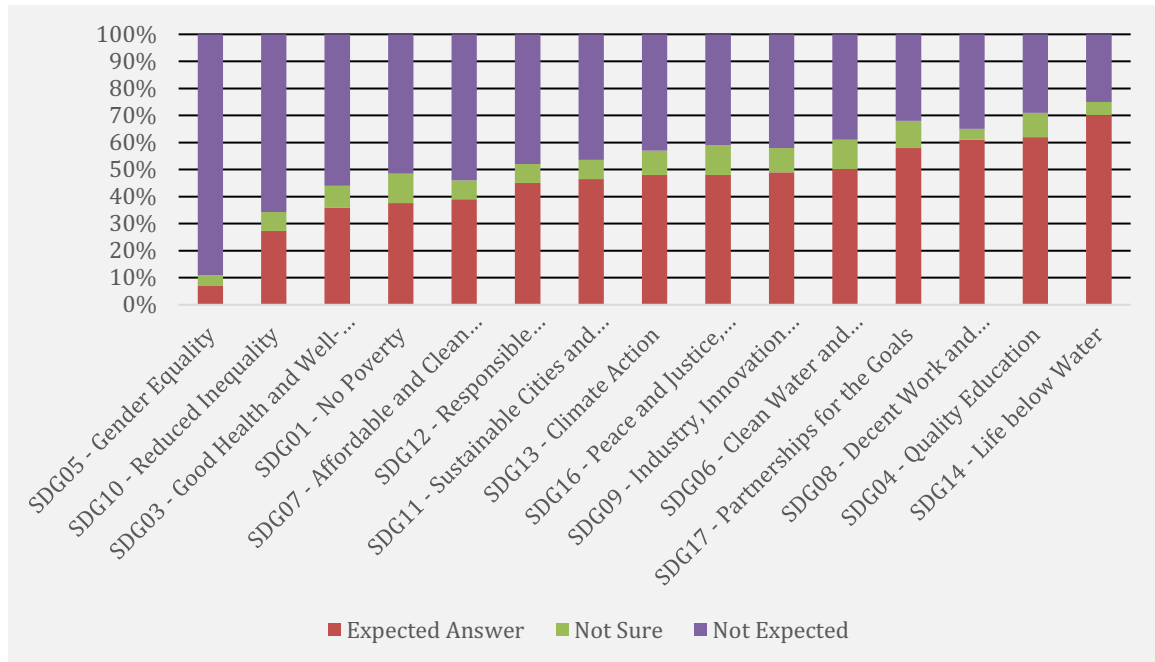


Figure 10. Green Club core SDG results.

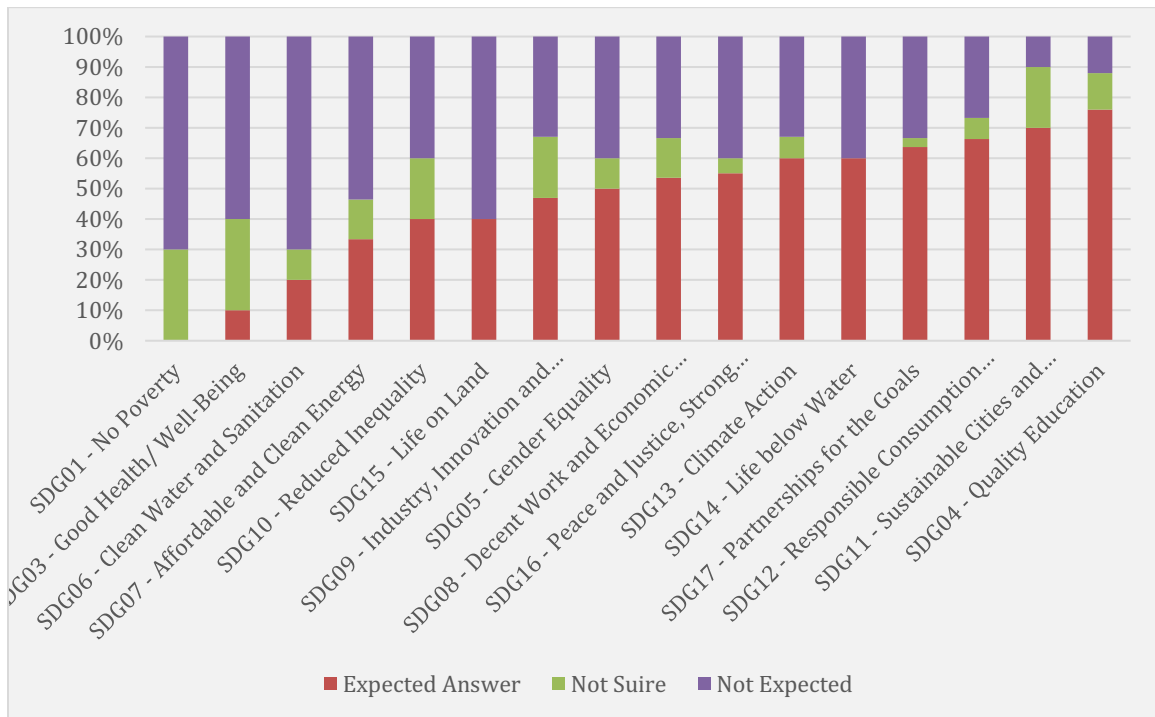


Figure 11. Honors College core SDG results.

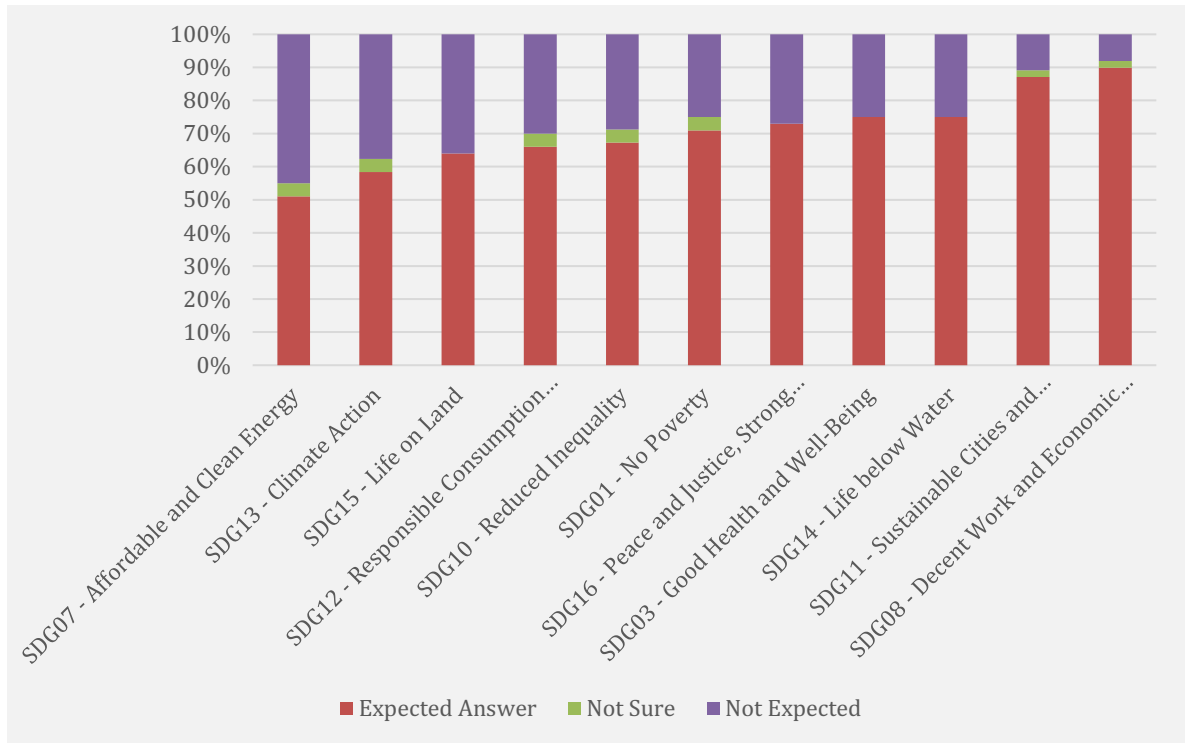


Figure 12. HON 101 US-specific SDG results.

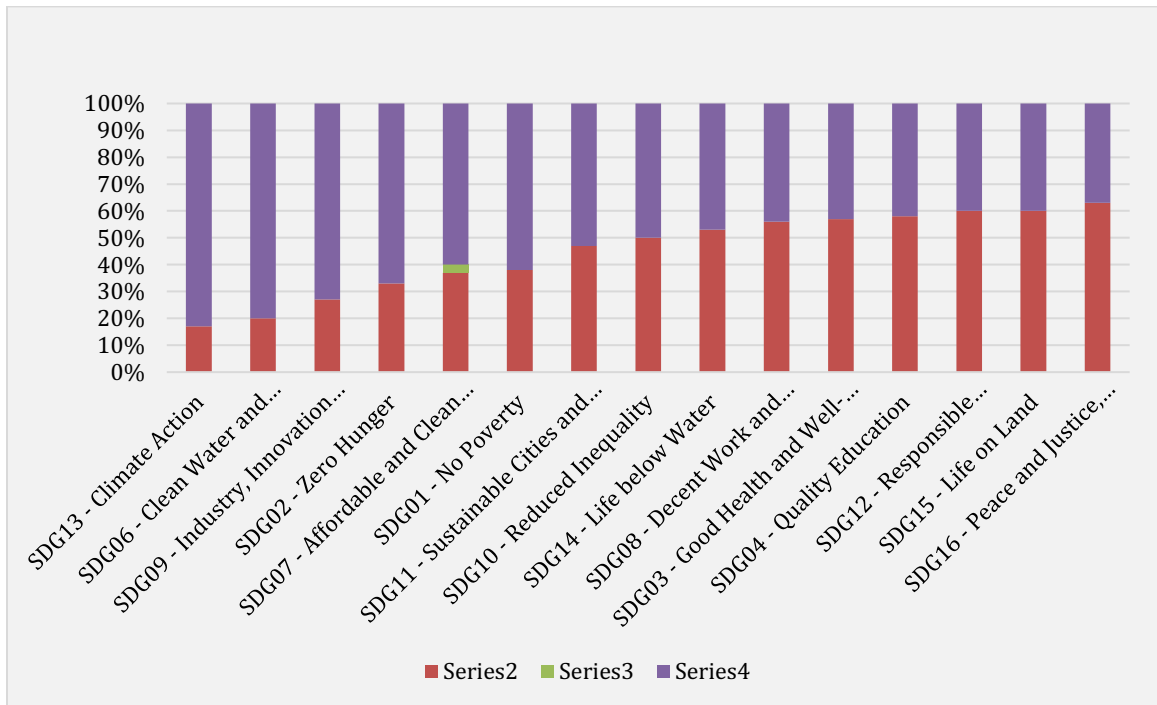


Figure 13. Delta Z US-specific SDG results.

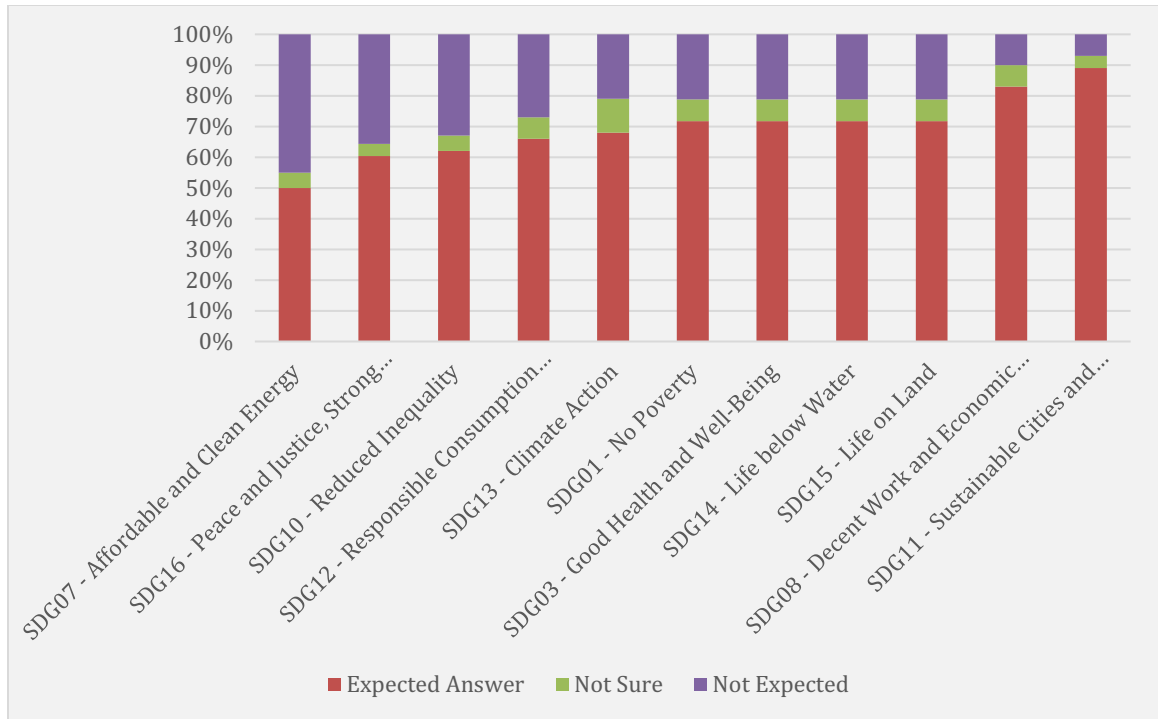


Figure 14. Green Club US-specific SDG results.

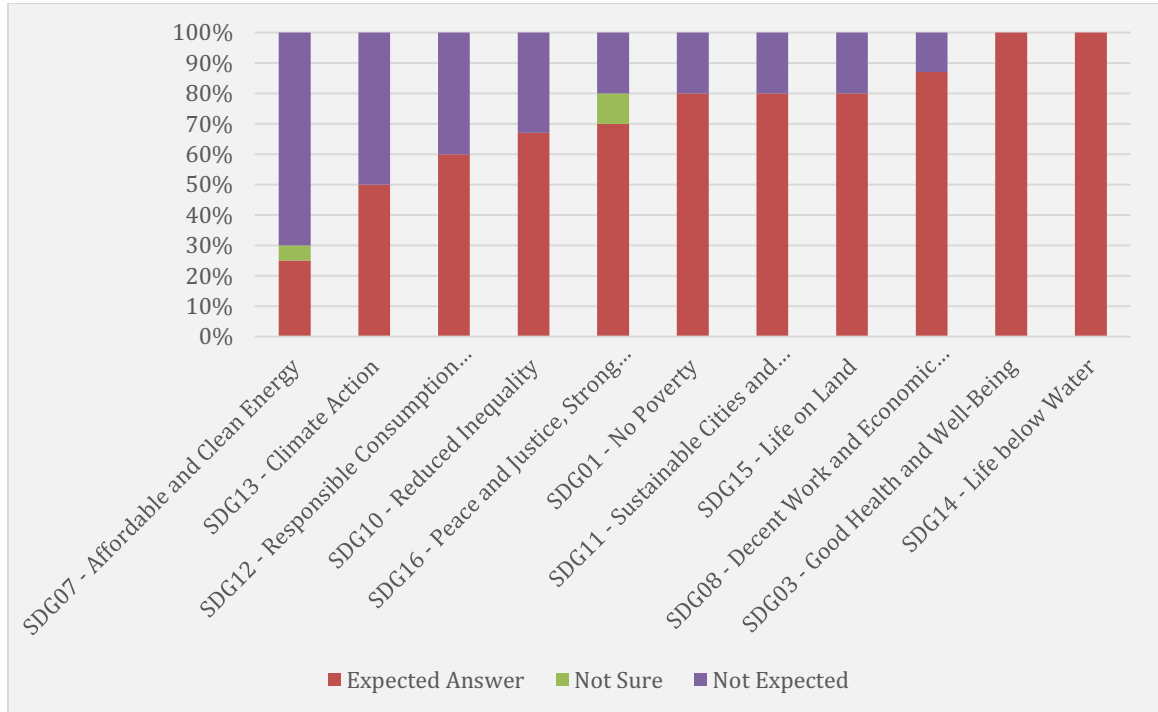


Figure 15. Honors College US-specific SDG results.

The intent of tracking and understanding the lower scores associated with SDGs is to provide a framework for where a course, program or investment is needed to improve sustainability literacy. In this case, the five lowest scores from each of the groups, both in the Core and the US Specific tests, were assigned one point for each SDG. The total points were then calculated and placed in a tree map to allow ease of assessing what SDGs need to be addressed and how to prioritize a strategy for improvement. Based on this analysis the lowest score is associated with SDG07-Affordable and Clean Energy followed by SDG10-Reduced Inequality. The next three, SDG01-No poverty, SDG03-Good Health and Well-Being, and SDG13-Climate Action scored equally (Figure 16).

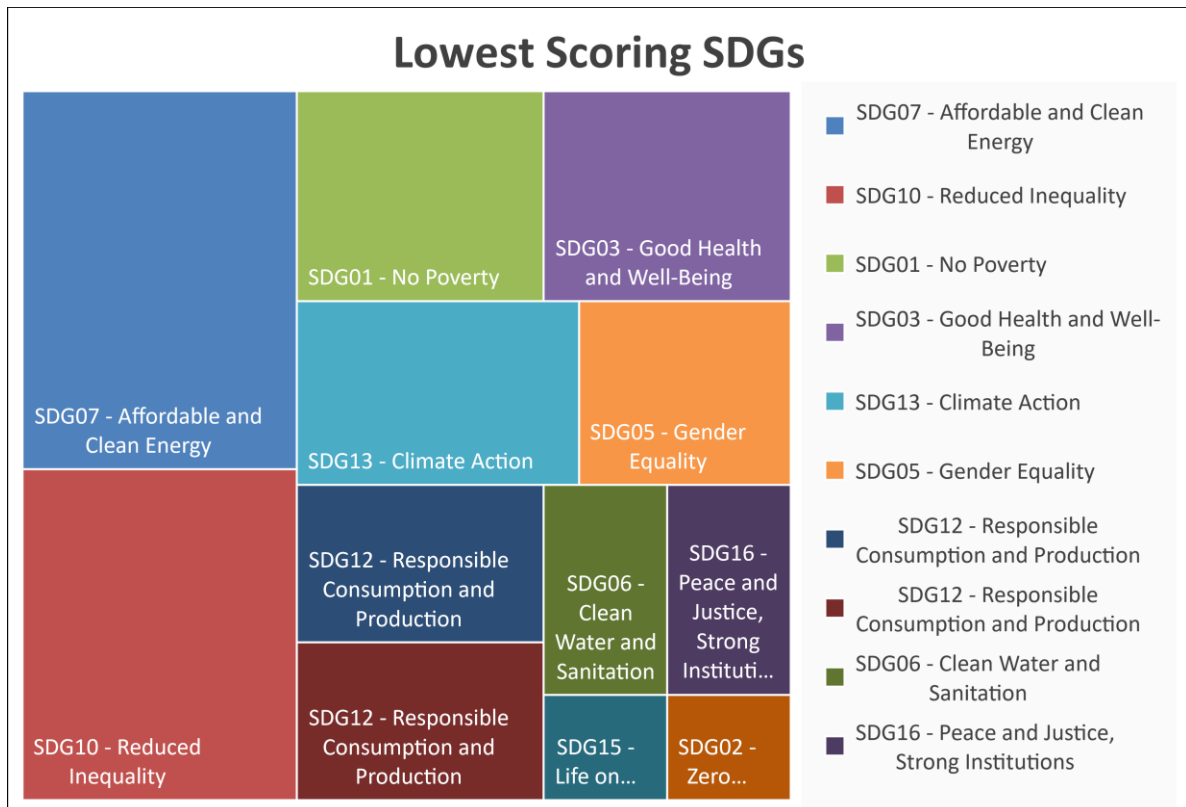


Figure 16. Lowest scoring SDGs across all test scores for UAH students. The lowest scores are SDGs with the largest rectangle.

The narrative Customized Module test results were collected and scored utilizing the scoring rubric. Once each of the four team members scored the narrative answers, two people were paired to review the other's scoring results on one question, and then crossed paired again within the review team for another question. The total team then met to discuss all the results and determine if there were any major discrepancies in the scoring methodology. The narrative Customized Module score results were then compared to the Sulitest scores for each student (Figure 17). Using the CORREL function in Excel, the correlation coefficient was calculated at 0.65 which indicates a positive relationship between the two sets (Suter et al., 2019). This process of verifying correlation between the Sulitest and narrative set of questions will extend beyond this Pilot 1 research. The four-member team will continue to explore the robustness and validity of the Sulitest platform as a tool for determining sustainability literacy (Suter et al., 2019).

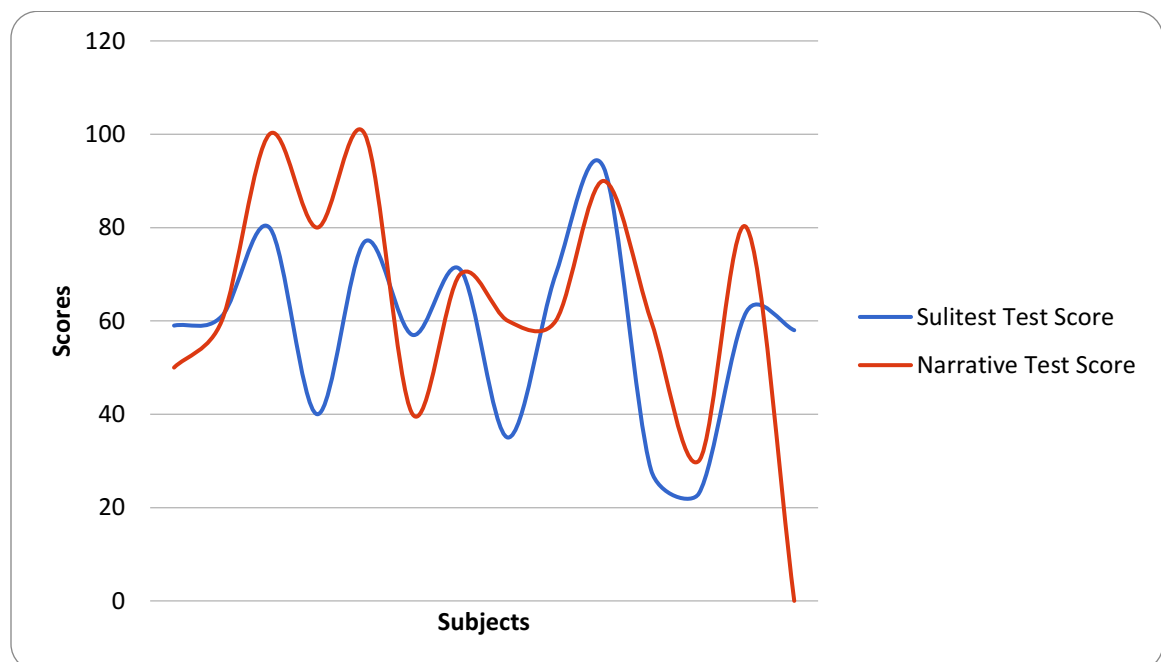


Figure 17. Correlation between narrative and Sulitest scores.

Narrative Survey Data Compared to Test Scores

During the design of the Customized Module, demographic information was requested to gain a better understanding of the test subjects. This sample consisted of two separate groups, Green Club and HON101, representing 40 sets of demographic information. A total of 46 responses were registered as complete in Sulitest but 6 tests were not included in the analysis due to incomplete entries and missing demographic data. The selections from each subject were captured and categorized then combined into respective sets to determine the average test score for each category (Figure 18).

The number of responses to the demographic questions do not represent the same level of statistical accuracy as demonstrated by actual Sulitest scores due to the lower quantity of responses. No test subject selected an overseas education location. The last question in the survey requested the subject to denote taking the narrative test before or after the Sulitest Core and US Specific test. Only one indicated taking the narrative after and an impact was not noticeable in the test results.

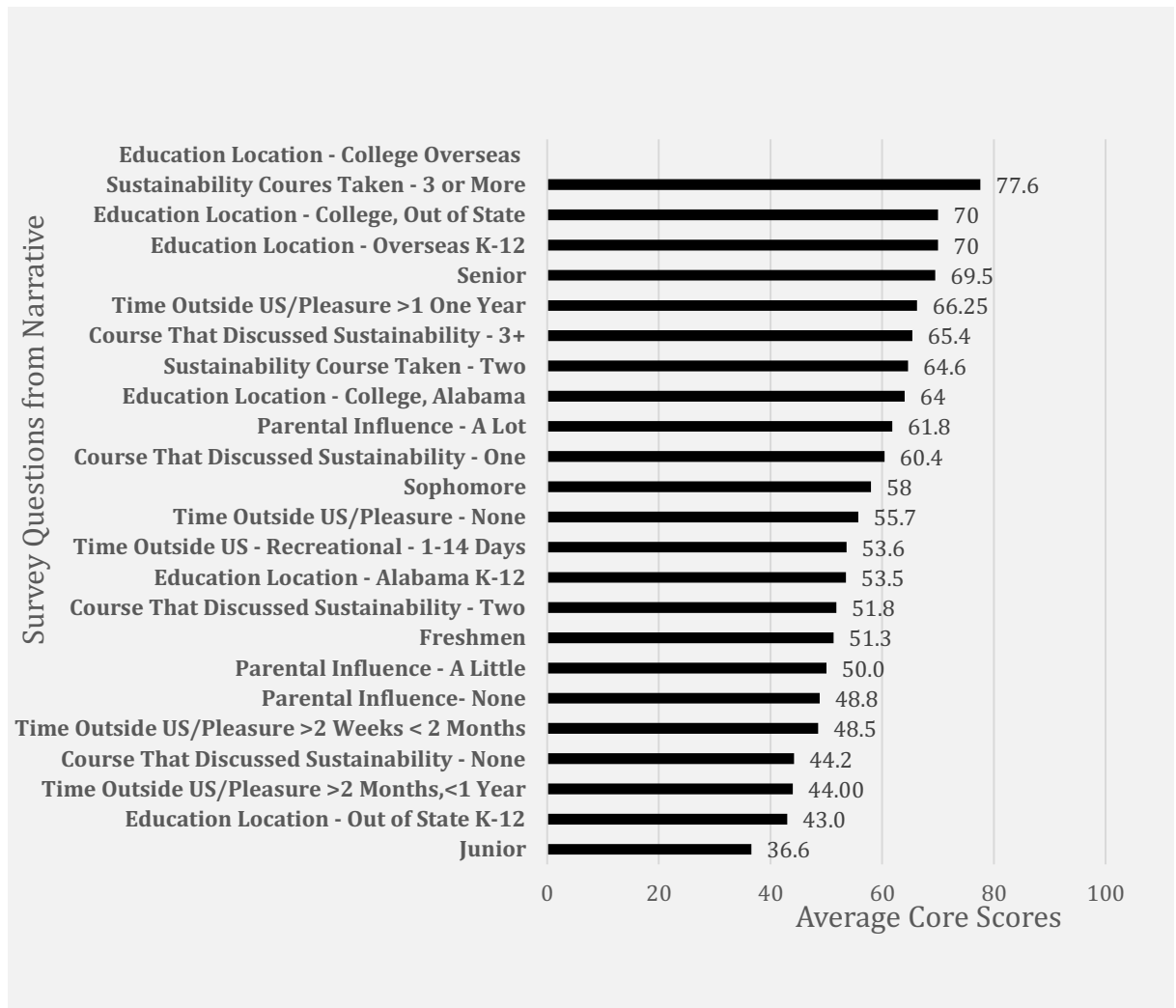


Figure 18. Average core scores by demographic question.

Identified Areas for Improving Sustainability Knowledge

Areas throughout UAH that offer some contribution to improving student knowledge of sustainability included:

- Available Courses: Over thirteen courses are listed in the student handbook that promote some activity related to sustainability (Table 4).
- World Café: Implemented the first comprehensive on campus meeting with various stakeholders to explore the possible areas of addressing sustainability.

This meeting included representation of students, faculty and staff as well as a third-party facilitator to capture thoughts, ideas and future actions.

Table 4. UAH sustainability-related courses.

Course	Supporting Sustainability Topics
ESS 103 Environmental Earth Sciences	ecosystem, soil science, water, pollution, population, energy
ESS 111 - Weather, Climate & Global Change	greenhouse effect, solar impact, climate change, atmospheric & ocean circulations
ESS 301 - Intro to Earth and Atmospheric Physics	earth atmospheric systems
ESS 302 - People, Plants & Environment	impact plants have on tech-based society
ESS 303 - Physical Causes on Climate	climate history, climate change, land use, microclimates
ESS 321 - Pollution Problems	pollution problems air, water, land
ESS 407 - Environ Threats, Public Policy	potential future threats of global environment
ESS 420 - Intro to Atmospheric Chemical and Air Pollution	air pollutants, atmospheric gases, aerosols, atmospheric processes
GS 200 - Global Systems and Cultures	culture, economic, political interactions between nations & cultures
WGS 200 - Intro to Women's & Gender Studies	gender changes, individual knowledge, interpersonal relationships
SOC 306 - Sociology of Gender	gender inequalities in income, poverty, occupation & violence
SOC 369 - Environmental Sociology	challenges/options human face with global environmental crisis

- Sustainability Internships: For 2018/2019 school year, UAH administration invested in nine internship, eight stipend and one hourly, to begin the process of performing building energy, water and waste surveys along with supporting STARS reporting activity.

- **Charger Cycles:** A free, on campus bicycle program to reduce traffic congestion and parking issues while providing an environmentally cleaner, healthier transportation method (UAH, 2018).
- **UAH Sustainability Committee:** Working under a sustainability charter, the sustainability coordinator assembled a committee consisting of three students, three faculty members and three staff employees with the mission to meet on a quarterly basis to discuss the direction for sustainable actions on campus.
- **Recycling Awareness:** The development and implementation of a campus-wide signage program to bring awareness to the students of proper recycling protocol.
- **Student Green Fund Program:** An establish funding mechanism to support on campus, student-led sustainability initiatives, this program promotes innovative approaches to sustainability issues.
- **Water Fill Station:** The campus currently deployed 22 water fill stations throughout the campus.
- **Greenway Development:** The campus master planning team is in the process of extending the current greenway to tie residential areas with the main campus area.
- **Locally Produced Food:** The sustainability coordinator is in the process of survey campus stakeholders to determine the first steps to incorporate locally produce food items into the campus environment. This activity includes meeting with the contractor that currently provides food service across the campus.
- **The Green Club:** A student-led, on campus organization promoting environmentally-focus programs that include a variety of video presentation, waste cleanup events on campus.

Chapter IV

Discussion

One of the projected hypotheses anticipated that the overall resultant scores of an Alabaman university would fall below an established benchmark for universities both local and global in nature. Upon evaluating the collected test results, the scores demonstrated varying results based on the Sulitest individual sessions and its respective location. For the Core session representing questions geared more towards global sustainability issues and concerns, the results were compared to the test given to those outside of the United States as a group and those within the United States as a separate group. The Core session benchmark score was 55 for the global test group and 47 for the US test group. A 55 score indicates that 55% of those tested provided the anticipated response. For UAH, the overall global mean is 50, falling 10.9% below the global benchmark. However, UAH's Core session results when compared to others in the US showed a 6.4% increase over the benchmark of 47.

The second session, the US Specific Sulitest test, addressed sustainability questions specific to conditions and issues within the United States only. The overall mean score for UAH was 64.4, falling just 2.5% below the Sulitest benchmark of 66 for this session. A separate and independently developed narrative session was given to most of the test subjects to explore the correlation between the Sulitest test results and the narrative test results. Analysis of these two tests resulted in a positive correlation coefficient.

The test results of the Core, US Specific and the narrative session support the hypothesis that the Alabaman university would fall below the mean test score of the global Sulitest sample cases. However, when compared to other US test scores for the Core session, UAH outperformed the mean score demonstrating a higher level of sustainability literacy based on this sample grouping.

One group of subjects demonstrated consistently lower scores than the benchmark while conversely, one group exceeded the benchmark in all categories. As part of the Sulitest optional survey section, the subject lists his or her current major along with other demographics. Although this section reflects strictly volunteered information, 59 of the 66 subjects participated in identifying their current major. With 17 represented majors, each was separated with its applicable scores summarized and averaged to reflect its combined scores against the other majors (Figure 19).

Keep in mind that the scores reflect the average of the all scores within that major. Consequently, one could see a cluster of lower score percentiles within a group that would drive the group's overall scores lower when matched with other majors in its lower percentile. This appears to be the case for the Delta Z group as its grouping of test scores remain low in those majors already demonstrating an overall lower average score than other majors. With eleven majors represents in a group of eighteen subjects, 75% of the Delta Z participants scored an average of 35% of the expected answers on the test.

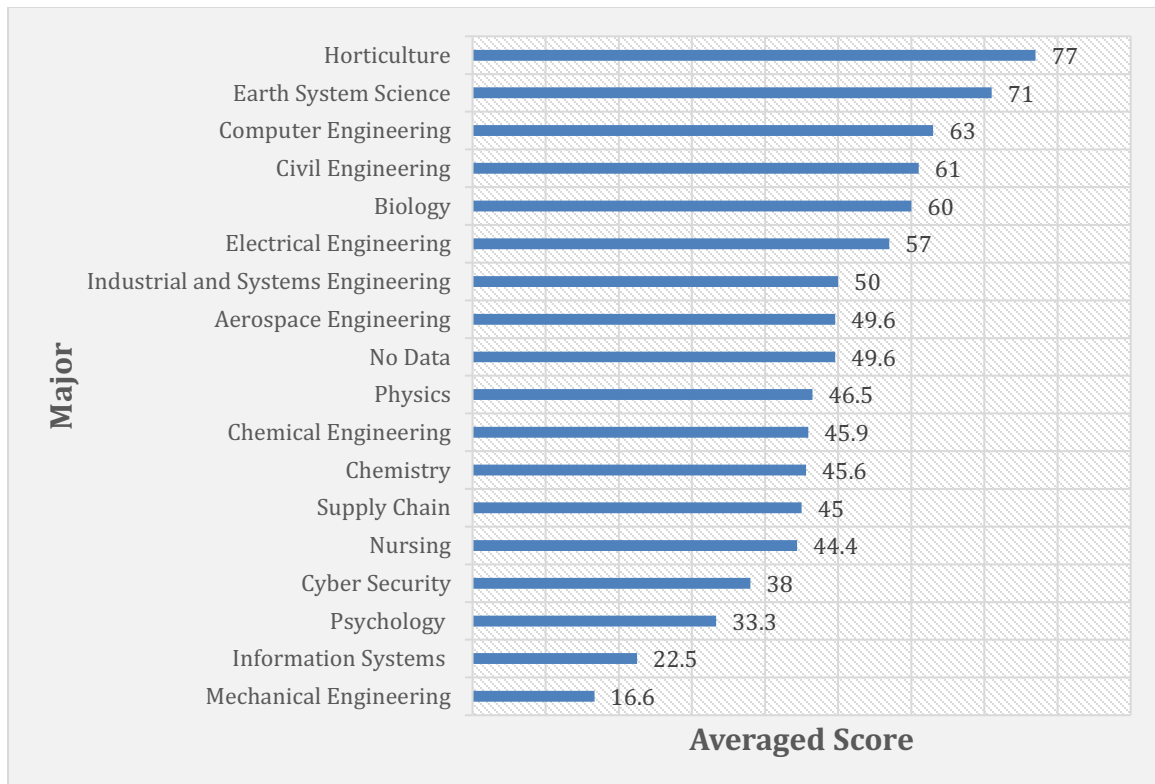


Figure 19. Averaged core score by major.

The average test scores by major presents a strong case for the lack of sustainability knowledge exposure within certain disciplines. With seventeen majors reflected in the survey results, horticulture, earth systems science, computer engineering, civil engineering, biology and electrical engineering demonstrated knowledge levels above the Sulitest global mean. These results appear to indicate that these students gain access to various forms of sustainability knowledge. Conversely, nine of the seventeen majors fall below all the stated Sulitest mean scores, globally or locally including: physics, chemical engineering, chemistry, supply chain, nursing, cyber security, psychology, information systems, and mechanical engineering. Continued testing, examination of course curriculum and correlation between the various influencing

variables outside the classroom is needed to determine the best methods to improve sustainability knowledge with these and other untested disciplines.

Theme Scoring Analysis

Within the Core and US Specific, Sulitest categorized their questions in relation to four basic themes consisting of:

- Sustainable humanity and ecosystems on planet Earth
- Global and local human-constructed systems to answer people's needs
- Transitions towards sustainability
- Individual role to play to create and maintain individual and systemic change

The UAH Core results indicated a lower level of knowledge in areas related to global human and local constructed systems. This category typically reflects structures tied to water, energy, food, education, social and economic systems. On the other hand, UAH subjects demonstrated a higher knowledge in role to play typically associated with what individuals do to enable change within a system. UAH's results in the other two Core themes tracked with the benchmark results.

For the US Specific, all UAH groups scored above the benchmark in the theme of transition towards sustainability as a positive indication that the subjects have a good understanding of how change within US systems can be achieved. Like the Delta Z group, the HON College group scored below in all categories except transition towards sustainability.

Challenges Presented during Research Activities

Certain research limitations were encountered when attempting to gain access to students and their participation in the survey. The original intent was to test students specific to the UAH Honors College representing a total population of 700+ students involved in a wide variety of disciplines. However, there was limited participation from this group even though the invitation came from the dean of Honors College. The Delta Z sorority was chosen again with the desire to gain access to different disciplines. The initial survey plan presented to Harvard's IRB included an incentive for participating in the study – a drawing for a backpack from the list of all participants. However, the State of Alabama does not allow drawings associated with research projects since it is considered a form of gambling that is prohibited.

As mentioned previously, the activity needed to complete and submit the requirements for achieving an exempt status required unanticipated extra effort and time. Training was required under Harvard's IRB process consisting of ten, online learning modules. In addition, a full research protocol document was required as part of the review process to allow Harvard to determine if this research warranted an exempt status. Finally, there was a requirement to allow the UAH IRB review the proposal and approve once the approval was granted by Harvard. The IRB process proved to be beneficial even at the exempt status as it provided subjects clear understanding of the test and the safe methods of handling and protecting information.

There is a need to further define the sample group labeled as The Green Club. The list of possible test candidates came from those students expressing a desire to register her or his name with the sustainability coordinator denoting an interest in sustainability.

The sustainability coordinator email list of approximately 130 students was used to promote the test and request participants. The actual student-led Green Club is also a part of this overall list but represents approximately 30-40 students on the overall list.

The narrative additional test and survey was an added feature after the development of the initial plan. This added module was effective in providing a better understanding and confidence level of the Sulitest results based on the resultant correlation calculation. In addition, the survey questions provided an increased view of possible factors and variables that could drive sustainability knowledge on campus. This feedback mechanism could play a role as a useful tool for UAH and others in the directing activity or implementing improvements to its sustainability program.

Influence of Sustainability Department

As stated earlier, the implementation and practice with key areas support sustainability knowledge including areas related to critical and autonomous thinking, incentives, desire to change, and interacting dialogue of ideas. The UAH Office of Sustainability under the direction of Taylor Myers is beginning to induce this level of activity across the campus. Activities like the World Café brought students into a safe and productive environment to discuss areas for improvement with both the university staff and academia. This event promoted a new level of dialogue and exchange of ideas but the challenge remains of how this type of activity permeates into the broader depth of the student, staff and academic population.

One notable yet missing key necessary to transform current actions into greater acceptance is the guidance and buy-in of upper level leadership. Investigation into the

published online information made available by leadership indicates improvement is needed in the area of promoting sustainability. There is no specific direction from the office of the president and no notable words in his vision for the campus. In review of the Chronology of Strategic Planning, no actions are listed related to the importance or investment of sustainability in any area, academically or operationally (UAH, 2018). A notable first step would be the inclusion of a sustainability objective within the university's scorecard system coupled with achievable goals and a progress measurement metric. Coming from the desk of the UAH president, this message and approved path forward would permeate into direct reporting positions and gain immediate acceptance as one of the university's priorities.

Although direct support is minimal from the upper level leadership, the Office of Sustainability is receiving indirect support in the building of its program. The mere fact that the university is willing to fund a dedicated sustainability coordinator speaks volumes over other institutions not willing to make this minimal investment. At the same time, the funding of the Student Green Fund Program demonstrates a commitment to supporting student-led activities that stimulates a sense of student's responsibility, ownership awareness and action towards sustainability. The suggested improvement is the active promotion of these types of programs throughout its web-based media and in recruitment promotional material to leverage its investment to existing students and to attract possible incoming students.

The sustainability coordinator is beginning the early stages of implementing the next radical change to UAH's sustainability program – entry into the STARS program through AASHE. This proven tool provides a stable platform for setting a benchmark for

sustainability performance through a wide range of measures and actions. Once established, the STARS program provides the building blocks that will allow UAH to incrementally move forward and upward in improving its status as a recognized leader in sustainability. Again, the university is demonstrating its commitment by funding internships to students utilized heavily during this development stage and will hopefully continue this level of its maintenance support. An important feature of the STARS program is its ability for UAH to gain peer review and influence from other universities both locally and globally, ensuring its ability to achieve similar goals established by other Alabaman universities.

In reviewing of the available courses delivering sustainability exposure, the Earth Systems Science department appears to be the hidden gem for providing a relevant, up-to-date knowledge on sustainability issues. Topics tied to greenhouse effects, solar impact, climate change, ecosystems, pollution, energy and future environmental threats all speak to concerns facing the future of community, nation and the world. In speaking informally with UAH students, this department could play a larger role by working with other disciplines and incorporating these topics into all departments at some level. In addition, this department could work with the sustainability coordinator and the admissions department to craft an incoming freshman elective course that would lay the foundation on the broader issues pertaining to sustainability enabling more attraction to its own program's growth potential.

Test Results based on an Introductory Sustainability Course

As part of the preparation for this thesis research, I along with Dr. William Carswell, UAH Staff Research Scientist, developed an introductory sustainability course at UAH. Offered as a one credit-hour, interdisciplinary course presented under the Honors College (HON301) platform, the course is based on the three pillars of sustainability: environmental stewardship, social well-being and economic prosperity. Development of the course content was not specifically based on the content of the Sulitest sustainability literacy test or any other test intended for this use.

The original plan intended to demonstrate how the effectiveness of a stand-alone course would impact sustainability knowledge by testing the students at the beginning of the course then again after the course completion. This plan did not come to fruition due to several issues occurring during the research time frame. The main limitation for not being able to perform testing was the time needed to receive a cleared status, exempt or nonexempt, from both the Harvard and the UAH IRB. Although the testing process had been submitted, the final approval fell outside of the course time frame. A limited, voluntary Sulitest session was offered to the class but the results were not included as reportable data based on the mandated guidelines of the IRB process. Further exploration of the HON301 as a possible sustainability teaching tool for incoming freshmen will be evaluated outside of this research effort.

Conclusions

My first hypothesis stated that through a structured test methodology UAH will exhibit overall lower sustainability literacy test scores through a control test environment. In addition, a second presented hypothesis postulated that employing a sustainability coordinator focused on campus-wide sustainability efforts brings an increase level of sustainability awareness that is translatable into higher test scores. My third hypothesis predicted multiple variables on and off campus influence sustainability knowledge and consequently test scores. The information I received from designed test methodology and survey data proved to be beneficial in achieving a false positive and negative results to the stated hypotheses.

My research concentrated in two major areas: the design and application of an online sustainability literacy test coupled with demographic data and research of a variety of on campus activities that contributes to sustainability knowledge and literacy. A global test platform developed by Sulitest was utilized as the basis for testing undergraduate students at UAH. The Sulitest Sustainability Literacy Test (Sulitest) is comprised of two sets of carefully designed questions: Core test addressing global sustainability issues and a US Specific test focused on sustainability issues within the United States. Independently, a separate sustainability narrative test was developed as a check and balance to test the correlation of its test scores to the Sulitest test results.

Additional research concentrated on understanding the on-campus activities that could shape sustainability literacy. This effort included the identification of available undergraduate courses that either deal specifically with sustainability or contains relevant supporting information. In addition, I investigated student-led organizations and campus

programs that promoted sustainability. Demographic data provided by Sulitest and the narrative tests were analyzed to determine possible variables that contribute to better understanding the actual test results.

The tests and demographic surveys were given strictly to undergraduate students at UAH. Diversity in student participation was achieved by selecting various groups containing multiple disciplines within its population. The main groups participating involved the Delta Z sorority, HON101-07 Research class, a group of students associated with the on-campus Green Club and various other individuals. The resultant number of test samples of 66 supported a 95% confidence level at a 12% of margin of error based on the current total student population at UAH.

The test results supported the hypotheses in all but one aspect. In comparison to a benchmark for the Sulitest Core, the UAH mean fell below the global mean. Likewise, the UAH mean for the US Specific test fell below the Sulitest mean. However, UAH was above the mean for the Core test when compared to those taking the test within the US. Comparing the students Sulitest and narrative test results indicated a positive correlation coefficient thus providing a level of validation to the Sulitest results.

The survey demographics were compared to the test scores to determine possible correlation. The analysis of the student's demographic variables compared to respective test results indicated improved scores in areas like selected major, college year, course selection, and overseas experience. In addition, analyzing the correct answers against central themes indicated a strength in transitioning towards sustainability but a weakness in global and local human construct.

The full-time employment of a sustainability coordinator at UAH appears to be improving the level of on-campus activities and student involvement. The associated hypothesis purported the ability to directly link this resource with improved test scores. Although the list of activities implemented by the sustainability coordinator have increased over the past 18 months, no direct correlation was obvious or notable in analyzing test results. In addition, no specific question was included in the questionnaire to indicate the student's views regarding the impact of this position.

After analyzing the collected data, the conclusion of this research does indicate the need to improve the exposure of sustainability at UAH. Some of the improvement involves a greater level of participation of upper-level leadership to establish and measure goals and actions emphasizing the importance of sustainability. Additional course work is needed while embedding sustainability within all disciplines, especially in those majors typically not associated with sustainability. Implementing the subject as part of freshmen orientation could set the stage for increased awareness and long-term, active campus involvement.

A more robust student testing program is needed to further validate this research. My research indicates areas of both strengths and weakness but a larger sample of students would provide a clearer picture of areas for improvement. This testing could be achieved as part of freshman orientation or administered directly through departments then compared holistically to determine specific areas to address. The sustainability coordinator is implementing a campus-wide reporting process and testing students is an eventual requirement and the feedback loop needed for incremental growth.

The overall scores for UAH may support the hypothesis but the bigger picture indicates the potential for a robust sustainability program. The Earth Systems Science program presents a strong platform for inducing more sustainability course work across the campus. The administration is investing financially into the sustainability program but a brighter spotlighting on this involvement would pay bigger dividends with the student population. Great support of the Office of Sustainability from leadership is both the short and long-term solution for ensuring a healthy sustainable program, serving as another reason for ensuring UAH as the university of choice for current and future students.

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