Understanding the Nature and Evolution of Sustainability Mindset in First-Year Engineering Students

Krystal Colon, University of Puerto Rico
Andrea Karola Rivera Castro, University of Puerto Rico
Dr. Aidsa I. Santiago-Román, University of Puerto Rico

Dr. Aidsa I. Santiago-Román is a Professor and Former Chair in the Engineering Sciences and Materials (CIIM) Department at the University of Puerto Rico, Mayagüez Campus (UPRM). Dr. Santiago earned a BS and MS in Industrial Engineering from UPRM and Ph.D. in Engineering Education from Purdue University. Dr. Santiago has over 20 years of experience in academia and has been successful in obtaining funding and publishing for various research projects. She's also the founder and advisor of the first ASEE student chapter in Puerto Rico at UPRM. Currently, she serves as Academic Senator and Faculty Representative at the Administrative Board at UPRM.

Her research interests include investigating students' understanding of difficult concepts in engineering sciences, especially for underrepresented populations (Hispanic students). She has studied the effectiveness of engineering concept inventories (Statics Concept Inventory - CATS and the Thermal and Transport Concept Inventory - TTCI) for diagnostic assessment and cultural differences among bilingual students. She has also contributed to the training and development of faculty in developing and evaluating various engineering curriculum and courses at UPRM, applying the outcome-based educational framework.

She has also incorporated theories on social cognitive career choices and student attrition mitigation to investigate the effectiveness of institutional interventions in increasing the retention and academic success of talented engineering students from economically disadvantaged families. She's also involved in a project that explores the relationship between the institutional policies at UPRM and faculty and graduate students' motivation to create good relationships between advisors and advisees.

Dr. Christopher Papadopoulos, University of Puerto Rico

Christopher Papadopoulos is Professor in the Department of Engineering Sciences and Materials at the University of Puerto Rico, Mayaguez Campus (UPRM). He earned B.S. degrees in Civil Engineering and Mathematics from Carnegie Mellon University (1993) and a PhD in Theoretical and Applied Mechanics from Cornell University (1999). He is active in the Mechanics Division and is also active in the area of Sustainability Engineering, including membership in the Engineering for One Planet Network.

Dr. Sandra Loree Dika, University of North Carolina at Charlotte

Dr. Sandra Dika is Associate Professor of research methods in the Department of Educational Leadership at UNC Charlotte. Her current research is focused on college access and success for underrepresented and underserved student groups in higher education.

Dr. Nayda G. Santiago P.E., University of Puerto Rico
Kaishmarie Alicea Romero, University of Puerto Rico

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I. Introduction

Sustainability has emerged as a paramount theme across diverse disciplines including engineering, garnering significant attention from students, educators, and professionals alike. Within engineering education, fostering a 'sustainability mindset' has become imperative, providing students with a guiding compass to steer their academic pursuits towards careers and lifestyles rooted in sustainability principles.

This article delves into the development of sustainability mindsets among students, employing a longitudinal qualitative approach that captures insights through open-ended questions in student surveys. The analysis of survey responses has revealed the multifaceted nature of students' experiences and perspectives from a first-year cohort within the new Sustainability Engineering program (in Spanish, “Ingeniería de Sostenibilidad”, denoted by “ISOS”) at the University of Puerto Rico, Mayagüez (UPRM). From gaining a deeper understanding of sustainability concepts to developing critical skills and fostering positive attitudes, students demonstrate a profound engagement with sustainability education and its implications for their academic and personal growth.

The emergent themes, categorized broadly under Knowledge, Skills, Behaviors, and Attitudes (KSBA), underscore the program's transformative impact, highlighting its role in shaping students' awareness, growth, and aspirations related to sustainability. Moving forward, these insights can inform program enhancements and curriculum development efforts to enrich students' learning experiences further and empower them to become effective agents of positive change in their communities and beyond.

1. The University of Puerto Rico, Mayagüez Campus

Founded in 1911 to offer advanced study in Agricultural Sciences and Mechanical Arts, the University of Puerto Rico, Mayagüez Campus (UPRM) is a venerable public, bilingual, Land, Sea, and Space Grant institution that today serves approximately 13,000 students in four academic schools: Engineering, Agricultural Sciences, Arts and Sciences, and Business Administration. UPRM is committed to community service, continuing education, professional studies, and research.

Enrollment statistics for the first semester of 2023-2024 totaled 10,727 individuals, with 4,830 identifying as female, 5,886 as male, and 11 as non-binary, according to official institutional data. Notably, the engineering school hosts 4,648 undergraduate students, among whom 1,277 are female, 3,369 are male, and two identify as non-binary. According to the ASEE, UPRM nationally ranks first in the number of Hispanic engineering faculty and second in the number of undergraduate engineering degrees granted to Hispanics (American Society for Engineering Education, 2023). Table 1 delineates the undergraduate engineering enrollment across various

academic programs using data provided by the UPRM Office of Planning, Research, and Institutional Improvement.

Table 1. Summary of undergraduate engineering enrollment for the first semester of 2023-2024

Academic Program	Total	Female	Male
Civil Engineering	629	181	448
Electrical Engineering	586	69	516
Industrial Engineering	621	321	299
Mechanical Engineering	1019	218	801
Chemical Engineering	526	292	234
Surveying and Topography	165	37	128
Computer Engineering	468	49	419
Computer Science and Engineering	177	26	151
Software Engineering	457	84	373
Total	4648	1277	3369

At UPRM, a dedicated consortium of professors spearheads a Sustainability Engineering initiative, denoted as “ISOS” (acronym in Spanish, from “Ingeniería de Sostenibilidad”), including the creation of a new minor, and the eventual creation of a new bachelor’s degree program. This initiative is supported by grant #2150461 from the National Science Foundation (NSF), the Engineering for One Planet initiative, and other corporate stakeholders invested in advancing sustainability principles and practices. The initiative, in general, and the Minor, in particular, are aimed at fostering a sustainability mindset among engineering students that will facilitate their understanding, synthesis, and application of sustainability principles throughout their engineering studies.

2. Proposed Sustainability Engineering Minor

Students within the cohort will navigate the Sustainability Engineering minor, comprising a curated set of activities and courses totaling 18 credits, with many seamlessly integrating into their core program requirements, as presented in Table 2.

Table 2 – Sustainability Engineering Minor Requirements

Activity	Duration	Crs.	Description
Summer Camp	1-week	0	Cohort building/community of practice, field trips, and exercises
Creating a Sustainable World - course	1 sem.	3	Broad introduction to frameworks of sustainability, systems thinking, earth systems cycles and planetary boundaries, energy and materials flows, planning a sustainability-focused career, other selected topics
Wellbeing and Sustainability Economics	1 sem.	3	Circular economy, doughnut economics, wellbeing metrics, and other alternative economic models.
Justice, Diversity, Equity, and Inclusion Seminar	1 sem.	1	Implicit bias, power, privilege, merit, universal design, social justice, and other selected topics.
Social or Political Science course	1 sem.	3	A designated course from a list provided.
Sustainability Engineering elective	1 sem.	3	Courses developed so far are (1) Energy and Sustainability, (2) Products, Services and Sustainability, and (3) Smart Cities.
Research, Practical Training, or Design experience	1 sem. or summer	3	Apply knowledge acquired from practical experience.

Additionally, the program incorporates periodic cohort gatherings and community engagement activities; targeted tutoring and mentorship initiatives including review sessions for core courses like Math, Chemistry, and Physics; and completion of an individual development plan (IDP).

3. Background / Justification

As part of the development of the Minor, a research and evaluation process has been established. One general objective established in the supporting NSF project is to research the development and evolution of a "sustainability mindset". This will demonstrate the impact of the initiative on students' knowledge, skills, attitudes, and behaviors, both in general and as they apply directly to the topic of sustainability. In this current study, a survey was conducted among a cohort of first year participants at the conclusion of their first semester. The results will guide the researchers to identify emergent patterns in student learning and development, and these will guide future efforts to measure growth and evolution in their mindsets.

II. Literature Review

Definitions of sustainability and sustainable development are numerous, and as discussed in Garren & Brinkmann (Brinkmann and Garren, 2018, Chapter 1), attempting to arrive at a

universal definition might not be feasible or even practical. With that in mind, perhaps the most widely accepted definition of sustainable development is "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs," from the report of the World Commission on Environment and Development (1987), also known as the Brundtland Report. The report further recognizes that sustainable development must proceed within ecological limits, in a manner that promotes social equity, and with commensurate economic models (paragraphs 27-29). Therefore, the Brundtland Report is also arguably the basis for the now commonly accepted notion that sustainability rests on three pillars, the "3 E's" of "environment, equity, and economics," or the "3 P's" of "people, planet, and prosperity." Clearly, sustainability is a transdisciplinary notion of broad scope, and as such, it is rife with 'wicked' problems (Faludi, 2017). In this context, what can be said about defining essential attributes of education for sustainability?

In *Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels*, the National Academies of Science, Engineering, and Medicine (2020) defines sustainability education broadly as "all aspects of student learning about sustainability in postsecondary or higher education" (p. 126), and includes "student engagement in curricular and pedagogical aspects of instruction, student research, and student experiential learning, … a focus on intra- and intergenerational human well-being … [an] orientation [that] is normative and interventionist … [and] empathy and consideration of different value systems with a commitment to justice and equity" (p. 126). In framing Education for Sustainability (ESD), UNESCO (2020) posits that "[t]o shift to a sustainable future, we need to rethink what, where and how we learn to develop the knowledge, skills, values, and attitudes that enable us all to make informed decisions and take individual and collective action on local, national and global urgencies" (p. 8).

Two extensive reviews of sustainability competencies were undertaken by Wiek, Withycombe and Redman (2011) and Redman and Wiek (2021). Through these reviews, their notion of competence evolved from a "functionally linked complex of knowledge, skills, and attitudes that enable successful task performance and problem-solving" in the first review (p. 204), to a broader notion in the second review (p. 3), of a "complex combination of knowledge, skills, understanding, values, attitudes, and desire which lead to effective, embodied human action in the world, in a particular domain", directly quoting Crick (2008, p. 313). The first review concluded that despite commonly held views that suggest a lack of consensus on sustainability competencies, after accounting for and synthesizing synonymous terminologies, a reasonable convergence can be captured by five competencies: systems-thinking, anticipatory, normative, strategic, and interpersonal. The second review extended this framework by proposing three additional emerging competencies: implementation, intra-personal, and integration.

UNESCO's (2020) framework for ESD consists of three competencies or dimensions: cognitive learning (including "complex interlinkages", which is a cousin of systems thinking), social and emotional learning (values and attitudes), and behavioral learning (practical actions). The Engineering for One Planet (EOP) Framework (2022), developed through the Lemelson Foundation and VentureWell, establishes nine learning outcomes, each of which includes core and advanced outcomes (these appear to be interchangeable with competencies, despite the distinction between competencies and outcomes articulated by Wiek et al. 2011); the EOP learning outcomes are Systems Thinking, Environmental Literacy, Responsible Business and

Economy, Social Responsibility, Environmental Impact Assessment, Materials Selection, Design, Critical Thinking, and Communication and Teamwork. It is notable that systems thinking or a similar notion appears in all of the frameworks cited herein and frequently arises elsewhere in our reading and research of sustainability competencies, e.g., (Faludi, 2017), (Quelhas *et al.*, 2019).

Less frequently employed in curricular design, and less understood, are mindsets. However, in some contexts, they are gaining currency, e.g., the growth mindset (Yeager and Dweck, 2020) or the entrepreneurial mindset (Bosman and Fernhaber, 2018). Nevertheless, the explicit articulation of mindsets akin to that of competencies or program outcomes is sparse, particularly in engineering. For example, this lack of attention has been acknowledged in the context of design thinking (Howard, Senova and Melles, 2015), even while some interpret design thinking as a set of mindsets (Gottlieb *et al.*, 2017).

According to Kassel, Rimanoczy, and Mitchell (2016), a mindset is "the lens through which individuals view the world and their role/place in it, including the underlying assumptions, beliefs, and values that inform that lens" (p. 3). Similarly, (Ibrahim, Jamieson and Donald, 2022) express a mindset as "a set of attitudes, beliefs, and experiences framing a way of thinking and interpreting information" (p. 1), while Gupta and Govindarajan (2002) contend that mindsets are cognitive filters that mediate "how people and organizations make sense of the world with which they interact", and evolve dynamically (p. 116). (Bosman and Fernhaber, 2018) further argue that "a mindset is a habit that requires practice" (p. 8). The "values, attitudes, and desire" portion of Crick's definition (2008, p. 313) of competence (previously cited) suggests that there is an essential nexus between competence and mindset, but many conventional notions of competence are associated with skills and thus have less overlap with conceptions of mindset. We further note that some authors include mindset within a set of competencies (Nelson and Stolterman, 2014, pp. 230-231), and elsewhere mindset has been used interchangeably with "interpersonal competence" (National Academies of Science, Engineering, and Medicine, 2020, p. 65).

Analogous to "sustainability competence", the notion of a "sustainability mindset" has been articulated. In the context of Management Education, Kassel, Rimanoczy and Mitchell (2016) define "Sustainability Mindset [as] a way of thinking and being that results from a broad understanding of the ecosystem's manifestations as well as an introspective focus on one's personal values and higher self, and finds its expression in actions for the greater good of the whole" (p. 8); they describe a model that consists of four "content areas", Ecological Worldview, Systems Perspective, Spiritual Intelligence, and Emotional Intelligence, overlayed by three "dimensions", Values (Being), and Knowledge (Thinking), and Competencies (Doing). Moon, Walmsley, and Apostolopoulos (2019) propose identifying and measuring sustainability mindset with three "scales" or dimensions, Empathy, Compassion, and Connectedness to Nature. Kunrath and Ramanujan (2021) determined that the development of a sustainability mindset can be driven by personal commitment, learning opportunities (integrated into the curriculum), and internalization time (early exposure to sustainability in their studies).

It is worth noting that several mindsets, that are not necessarily widely acknowledged, tacitly guide how engineers conceive and conduct their work, potentially in ways that are contrary or orthogonal to developing a sustainability mindset. For example, (Cech, 2014) identified three "ideological pillars: the *ideology of depoliticization*, which frames any ''non-technical'' concerns

such as public welfare as irrelevant to ‘‘real’’ engineering work; the *technical/social dualism*, which devalues ‘‘social’’ competencies such as those related to the public welfare; and the *meritocratic ideology*, which frames existing social structures as fair and just” (p. 45, emphases added), and has argued that these attitudes militate against engineers’ commitment to public welfare. Other mindsets that frequently appear among engineers are “technological optimism” (Krier and Gillette, 1985), in which human progress is uncritically associated with technological innovation, “technological neutrality” which posits that technology is value-free, and that values only arise based on decisions of the users of the technology (Papadopoulos and Nettleship, 2020). A related attitude expressed by engineering students is that engineering is an “exact” science (Besterfield-Sacre *et al.*, 2001).

Lastly, while not explicitly appealing to the concept of “mindset”, (Gericke *et al.*, 2019) developed a questionnaire to measure “Sustainability Consciousness”. The structure of their model and corresponding survey is essentially a 3x3 matrix that subdivides each of the Three Pillars (Environment, Social, Economic) with each of three “psychological constructs” of “Knowingness, Attitudes, and Behaviors”, yielding nine pairs. We suggest that sustainability consciousness is a precursor to actively developing a sustainability mindset and is a means to interrogate pre-existing mindsets.

Synthesizing this body of literature regarding competencies, outcomes, and mindsets, and particularly extending the construct of Gericke et al. to include “behaviors”, we adopt a four-pronged model consisting of Knowledge, Skills, Behaviors, and Attitudes (KSBA), essentially adding “Skills” (competencies) to the framework of Gericke et al., while simplifying “Knowingness” to “Knowledge”. These four domains provide a meta-structure that captures the essential elements of the sustainability mindset that we seek to measure and can serve as a useful high level classification scheme of observed characteristics. Further analysis can then map particular items to more specific aspects of the various models cited and other more fine-grained models that we are investigating but not yet summarizing.

III. Methods

1. Participants

This qualitative study investigates the evolution of the Sustainability Mindset, utilizing the KSBA model, by examining the experience of the inaugural cohort of students in UPRM Sustainability Engineering (ISOS) Minor program. Participants for the Minor were selected from first year students entering one of UPRM’s engineering degree programs in Fall 2023. Students were then selected through an additional application process designed to identify talented students motivated to study sustainability and effect change, improvement, and renewal in the world through engineering. Key requirements included maintaining a minimum GPA of 2.50; attending a 1-week summer camp in July, prior to the start of classes; completion of an approved college course, equivalent credit from the Advanced Placement Test, or completion of a summer course prior to the start of the Fall Semester. These requirements were established to ensure academic equilibrium among participants.

To elaborate on the application process, each prospective participant underwent an interview to assess their interests and understanding of sustainability concepts. Questions concerned their

perceptions of sustainability, its potential applications within their engineering-focused university curriculum, and how they envisioned integrating sustainability principles into their future careers. The responses collected during these interviews were analyzed to establish a preliminary ranking of candidates. This ranking was further evaluated by two university faculty members, each with distinct expertise: one specializing in sustainability and the other in outreach programs. These experts conducted the final selection process, prioritizing forming a diverse participant group encompassing various genders, academic backgrounds, and engineering fields.

A final cohort was selected, comprised of 11 first-year students enrolled in undergraduate engineering programs (seven male, four female, age ranging from 17-19 years). Table 3 presents a summary of the demographic characteristics of the student cohort.

Table 3. Distribution of Participants by Gender and Academic Program

Academic Program	Gender		High School	
	Female	Male	Public	Private
Chemical Engineering	1	1	-	2
Civil Engineering	-	1	1	-
Electrical Engineering	-	1	1	-
Industrial Engineering	1	2	3	-
Mechanical Engineering	2	2	2	2
Totals	4 (36%)	7 (64%)	7 (64%)	4 (36%)

2. Research Study

This section delves into the methodology employed to investigate the evolution of the Sustainability Mindset among students enrolled in the Sustainability Engineering Minor program at our institution. This study aims to glean insights from students' experiences and perceptions using a grounded theory approach, constructing a comprehensive understanding firmly rooted in their perspectives. The theoretical framework, student interventions, instruments, and analysis procedures are meticulously outlined to provide a clear roadmap for understanding the research methodology. By adopting a qualitative approach and leveraging diverse data sources, including surveys and participant observations, this study endeavors to unearth the nuanced shifts in attitudes, behaviors, and beliefs regarding sustainability among engineering students. With the groundwork laid, we elucidate the critical components of our research methodology, shedding light on the processes underpinning our investigation.

a. Theoretical Framework

In this study, we adopted a grounded theory approach to analyze students' responses collected through deployed surveys. Grounded theory research, as Creswell (2003) outlined, involves formulating a comprehensive, abstract theory grounded in the participants' perspectives. Following IRB-approved protocols, student responses were de-identified before analysis. The data were scrutinized to identify emerging themes for each research question, with the analytical

process detailed in the research design section. Data to observe student mindsets were gathered from various sources, including instructor or researcher observations during cohort activities, classes, structured surveys, or interviews. The study primarily relies on qualitative analysis of students' responses to open survey questions following their first semester.

b. ISOS Program Interventions

The first cohort of students participated in two significant activities: the Summer Camp and the Creating a Sustainable World course.

Summer Camp: The ISOS summer camp, held from July 10 to 14, 2023, offered participants diverse activities and discussions covering various sustainability topics. Through talks, demonstrations, games, and site visits, participants gained insights into the multifaceted nature of sustainability, extending beyond environmental concerns to encompass societal, economic, and technological dimensions. Talks introduced different sustainability topics and showcased university sustainability initiatives through project demonstrations. The Barnga game presented a game to directly experience dynamics of diversity, equity, and inclusion. Site visits to Casa Pueblo (a center of science and community activism with a forest school) and Plenitud PR (a dedicated permaculture farm community that practices regenerative agriculture, bioconstruction, and community service) provided firsthand exposure to sustainability efforts with social and economic impacts, ranging from food and farming to energy and education. Participants were encouraged to adopt sustainable practices throughout the camp, such as waste reduction and composting. The experience culminated in presentations where participants creatively shared what they had learned.

Creating a Sustainable World Course: This course offers a comprehensive exploration of sustainability frameworks, including Systems Thinking, Earth Systems Cycles, Planetary Boundaries, Energy and Materials Flows, alongside guidance on planning a career with a sustainability focus. Additionally, students delve into various selected topics pertinent to sustainability, culminating in a hands-on project to apply their newfound knowledge in a practical setting.

Mentoring. In addition to these direct experiences, each student is assigned a faculty mentor. Mentors and students meet periodically and at key points, such as during the class enrollment periods and at the end of each semester. Students maintain a portfolio of key examples of their work related to ISOS and an ongoing Individual Development Plan, in which they establish short—and long-term goals in consultation with the Mentor.

Tutoring. The ISOS mentors organize periodic, optional study sessions, particularly for key first year courses such as Chemistry and Calculus or Pre-calculus (at UPRM, a large fraction of engineering students begin their studies at the pre-calculus level). Four sessions, two for Chemistry, and two for Mathematics, were organized during the Fall 2023 semester.

Community of Practice. The ISOS initiative provides periodic events to bring the cohort together to combine social and learning experiences. During the Fall 2023 semester, one event was organized to watch and discuss the documentary “The Social Dilemma”, to engage students in issues of over-exposure and manipulation because of social media algorithms. The second

event was a virtual seminar given by Dr. Amit Batabyal, the Arthur J. Gosnell Professor of Economics, and interim head of the Department of Sustainability, at Rochester Institute of Technology (RIT), who discussed Sustainability from an economics perspective, and then provided an overview of research and academic opportunities at RIT related to sustainability.

c. Instruments

In January 2024, we administered an open-ended survey comprising seven questions to each student participant from the first cohort. The survey was available in English and Spanish and was designed based on students' interventions since the Summer Camp. Nine out of the 11 students responded to the survey questions. The survey questions are presented in Table 4.

Table 4 – Survey questions administered to participants.

#	Survey Questions and their Intended KSBA Model Elements
SQ1	What ideas, concepts, knowledge, or facts have you learned? (K)
SQ2	What skills have you developed? (S)
SQ3	How have some of your behaviors, habits, or practices changed, and/or what are new ones that you have developed or adopted? (B)
SQ4	How have some of your attitudes or beliefs changed, and/or what are new ones that you have developed or adopted? (A)
SQ5	Based on what you now know and have studied, how do you understand the idea of Sustainability? (K)
SQ6	What are some connections that you have made, or that you see, between your general coursework (Math, Chemistry, English, Spanish, Graphics, Creative Design, etc.), and the topic of sustainability? (K, S, B, A)
SQ7	Emphasize or summarize how participation in the ISOS program has supported or motivated your academic and personal growth and development? (K, S, B, A)

As is apparent, survey questions 1-4 were designed to “directly telescope” to the elements K, S, B, and A directly, but with only general contextual prompts to the ISOS experience. Question 5 was directly designed to focus on Sustainability knowledge. Question 6 was developed in parallel to an ongoing strategy, integrated into coursework and mentoring, to respond to the imperative to address Systems Thinking as part of a Sustainability-oriented curriculum (recall the results of the Literature Review); in the view of the authors, the exercise to make connections among courses is a practical and approachable way for students to develop a systems thinking habit of mind. Question 7 is designed to elicit a summary of how ISOS influenced the students.

d. *Analysis*

Three research assistants conducted an open-coding analysis of students' survey responses following grounded theory principles. The principal researcher validated and ensured the reliability of the results by reviewing the findings. Any discrepancies were resolved through

discussion to reach a consensus. Emerging themes for each question were identified, categorized, and tallied.

With the data collection and analysis methodologies outlined, we now delve into the findings obtained from analyzing students' responses to each survey question.

IV. Results

We summarize findings from the analysis conducted for each question in the survey, providing insights into students' experiences and perceptions regarding sustainability education and its impact on their academic and personal development. Through qualitative analysis of the responses, emergent themes have been identified, shedding light on the diverse ways students engage with sustainability concepts. Following the KSBA model, knowledge acquisition (K), skills development (S), and cultivation of behaviors (B) and attitudes (A) within the context of the ISOS program are noted.

For each survey question, a primary tag is assigned, indicating the researchers' expectation of what the question is designed to elicit with respect to the KSBA model, e.g. (K), (S), (B), or (A). Then, a summary of each emergent theme is provided, along with a notation to confirm the model element, or possibly additional or different model elements if such is expressed in the judgment of the researchers. Selected student comments to substantiate the codes are provided in the Appendix.

SQ1: What ideas, concepts, knowledge, or facts have you learned? (K)

(1) **Understanding Sustainability Concepts**: Students expressed a deeper understanding of sustainability concepts and principles gained through participating in the program. They mentioned learning about various sustainability topics such as the carbon cycle, planetary boundaries, sustainable practices, energy sources, and environmental conservation. Students highlighted the interconnectedness of environmental, social, and economic aspects of sustainability, emphasizing the importance of addressing these issues holistically to achieve long-term sustainability goals. **(K)**

(2) **Awareness of Environmental Impact**: Many students demonstrated an increased awareness of their environmental impact and the consequences of human actions on the planet. They discussed learning about the significance of environmental conservation, waste reduction, and resource management. Students reflected on the implications of unsustainable practices such as pollution, deforestation, and overconsumption, recognizing the need for individual and collective action to mitigate environmental degradation and promote sustainability. **(A)**

(3) **Recognition of Societal Responsibilities**: Students acknowledged their role in creating awareness and promoting societal sustainability. They discussed the importance of raising awareness about environmental issues and advocating for sustainable practices. Students highlighted the significance of collective action and community engagement in addressing global challenges such as climate change and resource depletion. They expressed a

commitment to positively changing their lifestyles and behaviors to contribute to a more sustainable future. **(K, B, A)**

(4) **Appreciation for Interdisciplinary Perspectives**: Some students appreciated the interdisciplinary nature of sustainability education, which integrates knowledge and perspectives from various fields such as science, economics, and sociology. They emphasized the value of understanding the interconnectedness of different disciplines in addressing complex sustainability challenges. Students expressed a desire to continue exploring interdisciplinary connections and applying their knowledge to real-world sustainability issues. **(K)**

Overall, these emergent themes highlighted the multifaceted nature of learning experiences within the program, encompassing environmental awareness, social responsibility, interdisciplinary learning, and the promotion of sustainable practices, and primarily correspond to model elements K, B, and A.

SQ2: What skills have you developed? (S)

From the responses provided by the students, several emergent themes regarding the skills they have developed can be identified:

(1) **Academic Skills Enhancement**: Many students highlighted improvements in their academic performance and study habits because they participated in the program. They reported developing reading comprehension, critical thinking, time management, and organization skills. Students mentioned strategies such as reading course materials in advance, allowing them to understand the subject matter better and effectively prepare for class discussions and assignments. Additionally, they emphasized the importance of maintaining a daily routine to balance academic responsibilities with extracurricular activities and social life. **(S)**

(2) **Interpersonal and Social Skills**: Students acknowledged the significance of interpersonal skills and teamwork in their personal and professional development. They described building relationships with peers from diverse backgrounds and majors, recognizing the value of collaboration and networking for future endeavors. Participation in team activities and group projects has enabled students to enhance their communication, teamwork, and empathy skills, which they believe will benefit them in future careers and interactions. **(S)**

(3) **Personal Growth and Awareness**: Several students emphasized personal growth and self-awareness as outcomes of participating in the program. They described adopting healthier and more sustainable lifestyles, demonstrating increased awareness of environmental issues, and exhibiting greater empathy and openness to diverse perspectives. Students were willing to engage in self-reflection and continuous improvement, striving to become more responsible, empathetic, and open-minded. **(S)**

(4) **Professional Development**: Some students highlighted acquiring professional skills and readiness for the job market. They mentioned improvements in interview skills, data analysis, and problem-solving abilities, which they attribute to program activities such as job fair assignments and project-based learning. Students recognized the importance of developing a

diverse skill set that aligns with their career aspirations and enhances their competitiveness in the workforce. **(S)**

Overall, these emergent themes reflect the multifaceted nature of skills development experienced by students participating in the program, encompassing academic, interpersonal, personal, and professional dimensions, and principally correspond to model element S.

SQ3: How have some of your behaviors, habits, or practices changed, and/or what are new ones that you have developed or adopted? (B)

Based on the responses provided by the students, several emergent themes regarding changes in behaviors, habits, or practices can be identified:

(1) **Improved Study Habits and Time Management**: Students mentioned developing new daily study strategies and achieving short-term goals. They emphasized the importance of using past experiences to enhance their development as college students and improve academic achievement. Many students discussed prioritizing their time effectively and allocating time for studying hobbies, and personal relationships. Changes in weekend routines were noted, focusing on self-care, relaxation, and maintaining productivity outside of class hours. **(S, B)**

(2) **Environmental Consciousness and Sustainable Practices**: Several students highlighted a reduction in the use of disposable utensils and a conscious effort to minimize waste. Increased awareness of environmental issues, such as recycling and reducing personal waste generation, was evident. Students mentioned setting goals to minimize waste and actively seeking alternative uses for disposable items to reduce environmental impact. **(B)**

(3) **Organization and Discipline**: Students reported establishing priorities and improving organizational skills. They mentioned developing better habits, such as exercising and maintaining discipline in daily routines. **(S, B)**

(4) **Increased Consciousness and Critical Thinking**: Many students expressed greater awareness of their actions and surroundings, including identifying greenwashing attempts by companies while shopping. There was a focus on conscious decision-making in personal habits and academic pursuits. Students mentioned actively connecting classroom learnings and real-life situations, demonstrating enhanced critical thinking skills. **(K, S, B)**

(5) **Efforts towards Self-Improvement and Awareness Spreading**: Students discussed efforts to care more about waste generation and spread awareness to others in their social circles. They emphasized the importance of creating better habits, such as efficient studying techniques, to improve personal growth and academic performance. **(S, B)**

These emergent themes highlight how students have adapted their behaviors, habits, and practices in response to their experiences and learnings, demonstrating a multifaceted approach to personal and academic development within sustainability education.

SQ4: How have some of your attitudes or beliefs changed, and/or what new ones have you developed or adopted? (A)

From the responses provided by the students, several emergent themes regarding changes in attitudes or beliefs can be identified:

(1) **Increased Environmental Awareness**: Many students expressed a shift in their attitudes toward environmental issues, particularly regarding climate change and sustainability. Some students admitted to previously underestimating the severity of climate change but have since developed a deeper understanding of its magnitude through their experiences in the program. They acknowledged the urgency of addressing environmental challenges and recognized the importance of taking action to mitigate their impact. **(A)**

(2) **Adoption of Sustainable Practices**: Several students mentioned adopting new habits and practices that align with sustainability principles. These changes include reducing the use of disposable plastic products, increasing recycling efforts, and prioritizing eco-friendly alternatives. Students demonstrated a heightened awareness of their environmental footprint and were committed to adopting more sustainable behaviors in their daily lives. **(B, A)**

(3) **Improved Personal Organization and Prioritization**: Some students highlighted personal organization and time management improvements because they participated in the program. They discussed establishing priorities, developing better habits, and enhancing discipline to balance academic responsibilities with personal interests and well-being. These changes reflected greater self-awareness and proactive planning to optimize productivity and overall success. **(S, B)**

(4) **Enhanced Social and Networking Skills**: A few students attributed their improved social and networking skills to their involvement in the program. They noted that interacting with individuals from diverse backgrounds and ages has helped them become more outgoing and sociable. Students valued the opportunity to build connections with like-minded peers and professionals, recognizing the importance of networking for personal and professional growth. **(B, A)**

(5) **Critical Thinking and Open-Mindedness**: Some students mentioned developing essential thinking skills and adopting a more open-minded approach toward sustainability-related issues. They were willing to explore diverse perspectives and solutions, moving beyond rigid beliefs to embrace innovative ideas and practices. Students acknowledged the complexity of sustainability challenges and emphasized the importance of flexibility and collaboration in addressing them effectively. **(A)**

These emergent themes reflect the program's transformative impact on students' attitudes, beliefs, and behaviors, leading to greater environmental awareness, adoption of sustainable practices, improved personal organization, enhanced social skills, and a more open-minded approach to sustainability issues.

SQ5: Based on what you now know and have studied, how do you understand the idea of Sustainability? (K)

Based on the responses provided by the students, several emergent themes regarding their understanding of sustainability can be identified:

(1) **Comprehensive Perspective**: Students perceived sustainability as encompassing a broad spectrum of interconnected topics, extending beyond environmental considerations to include social, economic, and cultural dimensions. They recognized sustainability as a holistic concept that addresses the complex interplay between human activities, natural systems, and societal well-being. Sustainability is viewed as a multifaceted endeavor that requires understanding Earth's systems, including chemical processes and ecological dynamics, and the need to mitigate damaging behaviors to foster resilience and adaptation. **(K)**

(2) **Interdisciplinary Relevance**: Many students emphasized the interdisciplinary nature of sustainability, highlighting its applicability across various academic disciplines and facets of human life. They recognized sustainability as a flexible framework that can be integrated into diverse fields, including science, technology, economics, and sociology. Students perceived sustainability as essential for environmental conservation and a tool for addressing global crises and promoting human development and well-being. **(K)**

(3) **Long-Term Vision and Action**: Sustainability is perceived as a long-term commitment to ensure the well-being of present and future generations. Students emphasized the importance of addressing immediate needs while safeguarding resources and systems for future use. They viewed sustainability as a proactive approach to balancing environmental preservation, social equity, and economic prosperity. Moreover, students emphasized the need for transformative change in lifestyle and consumption patterns to achieve sustainable development goals effectively. **(K, B)**

(4) **Continuous Learning and Adaptation**: While students expressed a solid understanding of sustainability concepts, they also acknowledged the ongoing learning process and the need for continuous improvement. They recognized that sustainability is a dynamic field that requires ongoing education, innovation, and adaptation to address evolving challenges and opportunities. Students expressed a willingness to deepen their understanding of sustainability and engage in meaningful actions to contribute to a more sustainable future. **(K)**

These emergent themes reflect students' nuanced understanding of sustainability as a multifaceted concept that requires interdisciplinary collaboration, long-term vision, and continuous learning and adaptation to address complex global challenges.

SQ6: What are some connections that you have made, or that you see, between your general coursework (Math, Chemistry, English, Spanish, Graphics, Creative Design, etc.), and the topic of sustainability? (K, S, B, A)

We note that this question was designed and deployed as a means to respond to the repeated presence of “systems thinking” in various frameworks for sustainability competencies. Based on

the responses provided by the students, several emergent themes regarding connections between their general coursework and the topic of sustainability can be identified:

(1) **Interdisciplinary Integration**: Students recognized the interdisciplinary nature of sustainability, drawing parallels between concepts from various disciplines and sustainability principles. They highlighted how subjects such as Engineering Graphics, Chemistry, English, and Spanish intersect with sustainability through diverse applications. For instance, in Engineering Graphics, the concept of concurrent engineering was likened to the collaborative efforts required in sustainability initiatives, emphasizing the importance of cross-disciplinary communication and diversity. Chemistry was viewed as directly relevant to sustainability, with students applying chemical equations and principles to understand environmental processes and calculate emissions. Additionally, languages like English and Spanish were seen as facilitating communication and collaboration essential for global sustainability efforts. **(K)**

(2) **Mathematical and Analytical Approaches**: Mathematics emerged as a foundational tool for understanding sustainability, with students emphasizing its role in calculations, conversions, and statistical analysis. They recognized the importance of mathematical concepts in assessing project costs, analyzing data related to sustainability issues, and understanding statistical information relevant to sustainability solutions. Students highlighted the indispensable nature of mathematical thinking in quantifying sustainability metrics and evaluating environmental impacts. **(K)**

(3) **Practical Application and Problem-Solving**: Students identified practical applications of their coursework in addressing sustainability challenges. They discussed how skills learned in courses such as Chemistry and Creative Design were directly applicable to understanding materials, chemical reactions, and design principles essential for sustainable technologies and solutions. Problem-solving methodologies learned in Mathematics and Chemistry were seen as valuable assets in devising sustainable strategies and implementing eco-friendly practices. **(K, B)**

(4) **Social and Cultural Considerations**: Some students recognized sustainability's social and cultural dimensions, highlighting the importance of sociological perspectives in complementing scientific and mathematical analyses. They emphasized the need for interdisciplinary approaches incorporating sociological insights to address sustainability challenges effectively. Students acknowledged the role of languages and social sciences in facilitating global cooperation and understanding for sustainable development. **(K)**

These emergent themes underscore the multifaceted nature of sustainability education, highlighting the diverse ways students integrate concepts from their general coursework with sustainability principles to develop a holistic understanding of environmental stewardship and societal responsibility.

SQ7: Considering your previous answers, emphasize or summarize how participation in the ISOS program has supported or motivated your academic and personal growth and development? (K, S, B, A)

Question 7 of the survey focused on understanding how participation in the ISOS program supported or motivated students' academic and personal growth and development. The responses revealed several key themes:

(1) **Teamwork and Networking**: Many participants emphasized the value of teamwork skills gained through ISOS activities, highlighting the importance of collaborating with classmates and professionals. Networking opportunities provided by the program were also appreciated for connecting with like-minded individuals and associations dedicated to sustainability. **(S, B)**

(2) **Motivation and Inspiration**: Several students expressed how participation in ISOS motivated them to learn more about sustainability and inspired them to explore new opportunities in the field. The program served as a catalyst for their interest in sustainability, encouraging them to delve deeper into related topics and pursue sustainable career paths. **(K, A)**

(3) **Appreciation and Establishment of Goals**: Participants expressed gratitude for the opportunity provided by ISOS, recognizing the program's role in helping them appreciate the value of sustainability and establish professional goals aligned with their newfound interests. ISOS was credited with broadening their perspectives and guiding them toward meaningful academic and personal endeavors. **(A)**

(4) **Personal Growth and Development**: ISOS was acknowledged for facilitating personal growth and development, with participants highlighting how the program enhanced their understanding of societal, environmental, and economic processes. Through ISOS, students gained insights into their values and interests, developed key skills, and explored potential career paths with a sustainability focus. **(K, S)**

Clearly, participation in the ISOS program emerged as a transformative experience for students, shaping their academic trajectories and fostering personal growth in many ways. ISOS played a pivotal role in shaping participants' academic and personal journeys, from building teamwork skills to sparking motivation and inspiring sustainable career aspirations.

V. Conclusions and Implications

The synthesis of the literature review and the findings from the survey analysis provide valuable insights into the intersection of sustainability education and student development. Through an exploration of existing research and firsthand accounts from participants in the ISOS program, several key conclusions can be drawn:

Comprehensive Understanding of Sustainability: The literature review highlights the broad scope of sustainability competencies and the related notion of a sustainability mindset, justifying the framework of Knowledge, Skills, Behaviors, and Attitudes to capture the full range of student growth and development. The importance of sustainability education in fostering a

comprehensive understanding of environmental, social, and economic issues among students is also demonstrated. Similarly, the survey results demonstrate that participation in the ISOS program enhances students' knowledge of sustainability concepts, including the interconnectedness of environmental systems, the significance of societal responsibilities, and the relevance of interdisciplinary perspectives. This holistic understanding equips students with the awareness and insights needed to address complex sustainability challenges effectively.

Skills Development and Application: Both the literature review and the survey findings underscore the role of sustainability education in developing critical skills and competencies essential for sustainable development. Students participating in the ISOS program report significant improvements in various areas, from academic skills enhancement to interpersonal and problem-solving abilities. These skills are applicable within educational settings and extend to real-world contexts, enabling students to analyze sustainability issues, collaborate with diverse stakeholders, and implement sustainable practices in their personal and professional lives.

Behavioral Changes and Attitude Shifts: A notable outcome highlighted in the literature and the survey is the potential for sustainability education to instigate behavioral changes and foster positive attitude shifts among students. The survey results reveal that participation in the ISOS program leads to increased environmental consciousness, adoption of sustainable practices, and a heightened sense of social responsibility among students. Moreover, students demonstrate a greater openness to diverse perspectives and a willingness to engage in continuous learning and adaptation, reflecting a deeper commitment to sustainability principles and values.

The conclusions drawn from the synthesis of the literature review and survey findings have several implications for sustainability education and student development:

Curriculum Design and Implementation: Educators and curriculum developers can leverage the insights gained from this study to design and implement sustainability education programs that foster holistic understanding, skills development, and attitude change among students. By incorporating interdisciplinary perspectives, hands-on learning experiences, and opportunities for reflection and action, curriculum designers can enhance the effectiveness of sustainability education initiatives in preparing students for future challenges.

Pedagogical Approaches and Teaching Strategies: The findings suggest the importance of adopting pedagogical approaches and teaching strategies that promote active engagement, critical thinking, and experiential learning in sustainability education. Educators can employ innovative methods such as project-based learning, case studies, field trips, and collaborative activities to enhance student learning outcomes and facilitate meaningful connections between classroom concepts and real-world sustainability issues.

Institutional Support and Community Engagement: Institutions of higher education play a critical role in supporting sustainability education initiatives and fostering a culture of sustainability on campus. By providing resources, infrastructure, and institutional support for sustainability education programs like the ISOS program, universities can empower students to become catalysts for positive change within their communities. Additionally, fostering partnerships with local organizations, businesses, and government agencies can create opportunities for students to

apply their knowledge and skills in addressing sustainability challenges at the regional and global levels.

In summary, the conclusions and implications drawn from this study underscore the transformative potential of sustainability education in promoting holistic student development and empowering future generations to address pressing sustainability challenges. By leveraging the insights gained from this research, educators, policymakers, and stakeholders can work collaboratively to advance sustainability education initiatives and cultivate a more sustainable and equitable world for all.

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Appendix. Excerpts of Student Responses

In this Appendix, we provide examples of student responses for each question and explain how the responses were coded and categorized. The explanations of each code are repeated in Section IV. The authors translated some responses from Spanish to English. After each comment, a parenthetical note summarizes a key point, which will be used in future analysis.

SQ1: What ideas, concepts, knowledge, or facts have you learned?		
Understanding Sustainability Concepts (K): Students participating in the program demonstrated a deeper understanding of sustainability concepts, including topics like the carbon cycle, planetary boundaries, sustainable practices, energy sources, and environmental conservation, while also stressing the interconnectedness of environmental, social, and economic aspects, underscoring the necessity of holistic approaches to achieve enduring sustainability objectives.	*ISOS 2301:*	*I learned the differences between the types of systems, how important the carbon cycle is for the ocean and for nature in Creating a Sustainable World.* ***(Environmental Knowledge)***
	ISOS2308:	*From my experiences so far with the ISOS program, I have learned about all of the aspects that make up the study of sustainability. I have learned that this term does not only refer to the environmental protection of the planet, but also about the economic and social effects this entails. I have also learned about the measures that are being taken internationally to aid in the journey of sustainability, like the Sustainable Development Goals. We were also taught about the energy crisis, and how the rise of population and the advancement of technology have increased energy consumption to a dangerous point. Finally, I learned about how certain materials can be used in a more efficient manner in order to reduce environmental impacts.* ***(knowledge of the 3 pillars of sustainable development)***
Awareness of Environmental Impact (A): Many students demonstrated increased awareness of their environmental impact, learning about the importance of conservation, waste reduction, and resource management, and recognizing the need for individual and collective action to mitigate environmental degradation and promote sustainability.	*ISOS2304:*	*I learned the importance of raising awareness about what is now happening in the world. We are so focused on ourselves and the things that we do that we cannot stop to look as the consequences of our actions on the environment. For example, not recycling, that is, everything goes to the trash and not in recycling. Creating awareness is super important so that this can change the way in which we perceive things. I learned that there is a lot of movement and unity in the organizations that are trying to improve the environment. Taking the initiative of ISOS, for example. I also learned that if we do not make a change in the way that we do things, we are not going to last much longer.*
	ISOS2310:	*There have been many things but the one that has sanded out the most for me is the different ways in which we trash our planet and how we can become more aware of this and make changes to our lifestyle.* ***(Attitudes of social and environmental changes)***
Recognition of Societal Responsibilities (K, B, A): Students acknowledged their role in promoting societal sustainability by emphasizing the importance of raising awareness about environmental issues, advocating for sustainable practices, engaging in collective action, and committing to changing their behaviors for a more sustainable future.	*ISOS2305:*	*Also, I have learned much about what materials that we don't require and the ones that we require in our daily life that are being scarce due to high demand of them.* ***(Environmental Knowledge, Economic Knowledge)***
	ISOS2308:	*Finally, I learned about how certain materials can be used in a more efficient manner in order to reduce environmental impacts.* ***(Environmental Knowledge)***
	ISOS2310:	*There have been many things but the one that has standed out the most for me is the different ways in which we trash our planet. how we can become more aware of this and make changes to our lifestyle.* ***(Social Behavior, Environmental l and social Knowledge)***
Appreciation for Interdisciplinary Perspectives (K): Some students appreciated the interdisciplinary nature of sustainability education, emphasizing its integration of knowledge from various fields like science, economics, and sociology, and expressing a	*ISOS2308:*	*From my experiences so far with the ISOS program, I have learned about all of the aspects that make up the study of sustainability. I have learned that this term does not only refer to the environmental protection of the planet, but also about the economic and social effects this entails. I have also learned about the measures that are being taken internationally to aid in the journey of sustainability, like the Sustainable*

desire to continue exploring and applying interdisciplinary connections to real-world sustainability issues.		*Development Goals. We were also taught about the energy crisis, and how the rise of population and the advancement of technology have increased energy consumption to a dangerous point. Finally, I learned about how certain materials can be used in a more efficient manner in order to reduce environmental impacts.* ***(Social, Environmental and Economic Knowledge)***
	ISOS2309:	*I learned about Mass Timber and CO2 harvesting through bamboo. For some reason sustainability is seen as quite related to socialism.* ***(Social and Environmental Knowledge)***
SQ2: What skills have you developed? (S)		
Academic Skills Enhancement (S): Participation in the program led to significant improvements in academic performance and study habits, highlighting the development of skills such as reading comprehension, critical thinking, time management, and organization. Students emphasized strategies such as pre-reading course materials and maintaining a daily routine to balance academic responsibilities with extracurricular activities and social life.	*ISOS2301:*	*I started reading course textbooks before the chapter is covered in class which has given me an advantage in my academic performance. One time we had to read the first chapter of Technical Drawing with Engineering Graphics and then answer review questions. Since I had already read the chapter, I only had to answer the questions without rushing and then using the time I had left, for other courses or extracurricular activities [...] So far, I have been able to feed my reading comprehension.* ***(Personal Skills)***
	ISOS2308:	*From my time in the program, I feel like I have developed my ability to analyze complex texts and mathematical processes. An example that comes to mind is the article about the Earth-space battery, in which, in addition to the written content, the author employed heavily the use of data and graphs the carry their argument.* ***(Personal Skills)***
	ISOS2310:	*I have been able to become a better student and create better studying habits.* ***(Personal Skills)***
Interpersonal and Social Skills (S): Students recognized the importance of interpersonal skills and teamwork for personal and professional growth, emphasizing the value of collaborating with peers from diverse backgrounds. Engaging in team activities and group projects has allowed them to develop communication, teamwork, and empathy skills, which they anticipate will be advantageous in their future careers and interactions.	*ISOS2301:*	*I have also begun to get to know other people. I am aware that teamwork is very important through my journey as a student, and I think by hanging out and meeting people with different majors or even backgrounds will benefit me in the future in case I find myself needing something or someone and even meeting my future co-workers and team partners.* ***(Interpersonal Skills)***
	ISOS2307:	*To some extent I have developed the ability to manage my time more efficiently. Maintaining a balance of classes, extracurricular activities and a social life although it has been difficult I have made progress.* ***(Interpersonal and Social Skills)***
Personal Growth and Awareness (S): Students noted personal growth from the program, adopting healthier lifestyles, raising awareness of environmental issues, and showing empathy for diverse perspectives. They engage in self-reflection and aim for continuous improvement, aspiring to be responsible, empathetic, and open-minded individuals.	*ISOS2302:*	*I have developed personal skills, such as leading a healthier and more environmentally conscious lifestyle.* ***(Personal Growth Skills)***
	ISOS2309:	*I understand that I am now more willing and open to diverse opinions and points of views on sustainability and how to achieve it.* ***(Awareness Skills)***

Professional Development (S): Students noted gaining professional skills for the job market, citing improvements in interview skills, data analysis, and problem-solving, attributed to program activities like job fair assignments and project-based learning. They emphasized the importance of developing a diverse skill set aligned with career goals to enhance competitiveness in the workforce.	*ISOS2305:* *ISOS2308:*	*I have developed a better way of understanding themes, having more patience with what's not in my control and how to organize myself better.* ***(Development of professional skills)*** *In addition to this, I have improved my skill when it comes to managing job interviews, thanks to the company assignment for the job fair.* ***(Development of professional skills)***
SQ3: How have some of your behaviors, habits, or practices changed, and/or what are new ones that you have developed or adopted? (B)		
Improved Study Habits and Time Management (S, B): Students described adopting new daily study strategies and reaching short-term goals, stressing the use of past experiences to enhance their development as college students and academic success. They discussed prioritizing time effectively for studying, hobbies, and personal relationships, noting changes in weekend routines to focus on self-care, relaxation, and productivity.	*ISOS2301:*	*I have developed new strategies to study daily and to reach my short-term goals. Since last semester was my first semester in UPRM, Iâ€™m using the experience I already gained to improve my development as a college student and my academic achievement and therefore obtain better grades. I am taking advantage of the time I have now so I can be better prepared for exams and assignments that come my way and also sparing some time for my hobbies, being with my loved ones and having fun.* ***(Personal skills and Development of study habits (B))***
Environmental Consciousness and Sustainable Practices (B): Students emphasized reducing disposable utensil use and minimizing waste, showing heightened awareness of environmental issues like recycling and waste reduction. They set goals to minimize waste, actively seeking alternative uses for disposable items to lessen environmental impact.	*ISOS2302:* *ISOS2305:*	*The main change in my daily life has been the reduction of disposable cutlery, which I used to use because of its easy disposal.* ***(Social and Environmental Behavior)*** *I am more conscious about the actions that I take, from knowing how to recycle more effectively to knowing which decisions to make in my daily.* ***(Social and Environmental Behavior)***
Organization and Discipline (S, B): Students discussed prioritization and enhanced organizational skills, noting the development of better habits like regular exercise and disciplined daily routines.	*ISOS2304:* *ISOS2305:*	*A major change was to establish priorities. Another was to be more organized and to create better habits such as exercise, discipline, among others.****(Personal Skills and Behavior)*** *Last semester it took me until the last two weeks of November to know how to organize myself properly with all my homeworks and exams, for which in this semester I'm starting to organize my week as fast as I can to balance all the things that I need to do with my personal life as well.* ***Personal Skills and Behavior)***
Increased Consciousness and Critical Thinking (K, S, B): Students demonstrated increased awareness of their actions and surroundings, recognizing greenwashing attempts by companies and prioritizing conscious decision-making in personal habits and academic pursuits. They actively connected classroom	*ISOS2305:* *ISOS2310:*	*I am more conscious about the actions that I take, from knowing how to recycle more effectively to knowing which decisions to make in my daily. (****Environmental and social skills)*** *There have been many things but the one that has sanded out the most for me is the different ways in which we trash our planet and how we can become more aware of this and make changes to our lifestyle.* ***(Environmental skills, behaviors and actitudes)***

learnings with real-life situations, showcasing improved critical thinking skills.		
Efforts towards Self-Improvement and Awareness Spreading (S, B): Students discussed promoting waste reduction awareness within their social circles and emphasized cultivating better habits, like adopting efficient studying techniques, to enhance personal growth and academic performance.	*ISOS2301:* *ISOS2307:*	*I am taking good care of myself by sleeping enough hours, relaxing, using the help of professionals. And I also feel very focused to keep taking my courses without letting my personal life weaken.* *A behavior change of mine is to not limit my tendency to actively make connections to my classes. I purposely try to practice it in my everyday life to try and do it subconsciously.*
SQ4: How have some of your attitudes or beliefs changed, and/or what new ones have you developed or adopted? (A)		
Increased Environmental Awareness (A): Students recognized a shift in their attitudes toward environmental issues, particularly climate change and sustainability, after underestimating their severity. Through the program, they gained a deeper understanding of the urgency to address these challenges and the importance of taking action.	*ISOS2302:* *ISOS2308:*	*Honestly, I thought that the climate change situation was being exaggerated. However, this is not the case, this experience with the camp has helped me to understand that everything goes beyond that, and that nothing is being exaggerated, on the contrary, everything is being minimized.* ***(Personal Attitudes)*** *I am now much more mindful of the products that I constantly use, which has led me to decrease my use of single-use plastics, as well as my trash output altogether.* ***(Social Attitudes)***
Adoption of Sustainable Practices (B, A): Students adopted sustainable habits like reducing disposable plastic use, increasing recycling, and favoring eco-friendly alternatives. They showed heightened environmental awareness and committed to sustainable behaviors in daily life.	*ISOS2308:* *ISOS2310:*	*As someone who used to utilize somewhat heavily disposable plastic products, I would say that this attitude has changed since forming part of this class. I am now much more mindful of the products that I constantly use, which has led me to decrease my use of single-use plastics, as well as my trash output altogether.* ***(Social Attitudes)*** *My belief in how we should look at things whenever purchasing something.* ***(Social and Economic Attitudes)***
Improved Personal Organization and Prioritization (S, B): Students noted improved personal organization and time management skills through program participation, focusing on priorities, better habits, and discipline to balance academics with personal interests. These changes reflect increased self-awareness and proactive planning for productivity and success.	*ISOS2301:*	*I have developed new strategies to study daily and to reach my short-term goals. Since last semester was my first semester in UPRM, Iâ€™m using the experience I already gained to improve my development as a college student and my academic achievement and therefore obtain better grades. I am taking advantage of the time I have now so I can be better prepared for exams and assignments that come my way (**Personal skills and Development of study habits (B))***
Enhanced Social and Networking Skills (B, A): Some students credited their enhanced social and networking skills to program involvement, citing interactions with diverse individuals that boosted their outgoingness. They valued connecting with peers and	*ISOS2305:* *ISOS2307:*	*I have improved the way I approach people, also being able to live with a diverse society since at the beginning of class I could see someone quite different from me and somehow, I felt strange, but now it feels good to accept diversity and to judge less.* ***(Social Skills and Behavior)*** *ISOS, it did help me develop it is my social and networking ability. Meeting people of various ages and backgrounds has helped me be more social.* ***(Social Skills)***

professionals, acknowledging networking's role in personal and professional development.	
Critical Thinking and Open-Mindedness (A): Students described developing critical thinking skills and an open-minded approach to sustainability issues, exploring diverse perspectives and innovative solutions. They recognized the complexity of these challenges and emphasized flexibility and collaboration for effective solutions.	*ISOS2304:* *Believing more in God. I have been in a Catholic family since I was a child, but now I realize that God is great.* ***(Personal Attitudes)*** *ISOS2302:* *This experience with the camp has helped me to understand that everything goes beyond that, and that nothing is being exaggerated, on the contrary, everything is being minimized.* ***(Personal attitudes)***
SQ5: Based on what you now know and have studied, how do you understand the idea of Sustainability? (K)	
Comprehensive Perspective (K): Students viewed sustainability holistically, acknowledging its intersection with environmental, social, economic, and cultural aspects. They recognized it as a multifaceted concept, involving the complex interplay between human activities, natural systems, and societal well-being. This perspective emphasizes the need for understanding Earth's systems, mitigating harmful behaviors, and fostering resilience and adaptation for sustainability.	*ISOS2301:* *Sustainability is much more than just the practice of sustainable principles. It covers a wide range of topics that interfere with communities, politics, structures, the planet itself and other subjects related to social, economic and sustainable skills. It requires the understanding of how the Earth works including chemical processes like the carbon and phosphorus cycles and how it tries to live and adapt with the damaging behaviors people are used to do.* ***(Social, economic and environmental knowledge)*** *ISOS2302:* *With what I have studied and understood, I take the term sustainability as the action of solving the current needs, meaning energy, food, health, etc. without subjecting the needs of the coming generations. With this term we tend to limit the world thinking that it only refers to the environment and basic needs. However, this is not so, this goes beyond, it includes needs from comfort as a person, acceptance to society, identity of each human being, interpersonal relationships, technological development, among many others.* ***(Social, economic and environmental knowledge)*** *ISOS2308:* *Based on what I learned during the summer camp and the class, I would define sustainability as the act of achieving environmental, social, and economic progress and prosperity within our society without hindering future generations and their respective prosperity.* ***(Social, economic and environmental knowledge)***
Interdisciplinary Relevance (K): Students stressed sustainability's interdisciplinary nature, applicable across academic disciplines and human life facets. They viewed it as a flexible framework integrating fields like science, technology, economics, and sociology, essential for environmental conservation and addressing global crises while promoting human development and well-being.	*ISOS2301:* *It requires the understanding of how the Earth works including chemical processes like the carbon and phosphorus cycles and how it tries to live.* ***(Knowledge)*** *ISOS2303:* *Sustainability is a flexible area that can be adapted to any discipline, not only is the fact that it is a fundamental pillar in the planet but also in our lives.* ***(Knowledge)***
Long-Term Vision and Action (K, B): Students view sustainability as a commitment to present and future well-being, emphasizing balancing immediate needs with resource preservation. They	*ISOS2305:* *These pillars lead to a natural balance along with the certain and necessary action taken by humans to be able to maintain natural resources and, therefore, the Earth, in conditions suitable for living in the present as well as for future generations.* ***(Environmental Knowledge)***

advocate for transformative lifestyle changes to achieve sustainable development goals, recognizing it as proactive action balancing environmental, social, and economic concerns.	*ISOS2309:* *This is because sustainability is not a short- or long-term solution, but rather a search for solutions that can remain stable forever or until they are no longer needed. For example, recycling, which is what one thinks of as sustainability, is a long-term solution and what is not currently sustainable is what to do with what we already have.* ***(Long-term behaviors)***
Continuous Learning and Adaptation (K): Students demonstrated a solid grasp of sustainability concepts but acknowledged the need for continuous learning and improvement in the dynamic field. They expressed readiness to deepen their understanding and engage in meaningful actions to address evolving challenges for a more sustainable future.	*ISOS2301:* *Adapt with the damaging behaviors people are used to do* ***(Knowledge)*** *ISOS2307:* *From what i have studied is that sustainability is very similar to a healthy lifestyle.to elaborate most of the solutions for the various problems that being sustainable have to fix are like a diet temporary. That being said to truly fix the problem our way of living has to change permanently like having a healthy lifestyle just not limit it four our body but include our world.* ***(Social Knowledge)***
SQ6: What are some connections that you have made, or that you see, between your general coursework (Math, Chemistry, English, Spanish, Graphics, Creative Design, etc.), and the topic of sustainability? (K, S, B, A)	
Interdisciplinary Integration (K): Students acknowledged the interdisciplinary aspect of sustainability, linking concepts from diverse fields like Engineering Graphics, Chemistry, English, and Spanish to sustainability principles. For example, they likened concurrent engineering in Engineering Graphics to collaborative efforts in sustainability, applied chemical equations in Chemistry to understand environmental processes, and recognized languages' role in facilitating global sustainability communication.	*ISOS2301:* *When reading the first chapter of Engineering Graphics textbook, I acknowledged concurrent engineering exists. It optimizes elements involved in a design simultaneously to be worked at the same time, rather than going through a sequential order, just like in sustainability, many disciplines come together to achieve their economic, societal, and sustainable goals. Also, the concept of sketching was discussed. It's very important since the idea of a new product, machine or structure must be forwarded to people with different disciplines who may or may not speak the same language. I found it related to diversity since professionals and personnel from various fields of study come together to make a model a reality, but they won't always understand each other for geographic or cultural reasons. There is also cross-disciplinary communication, which helps saving materials and costs. (****Knowledge)*** *ISOS2303:* *The course in which I see sustainability reflected the most is chemistry, since in my semester thanks to chemistry I was able to understand several chemical reactions that generally occur naturally in the environment. (****Knowledge)***
Mathematical and Analytical Approaches (K): Students highlighted mathematics as essential for sustainability, noting its role in calculations, statistical analysis, and cost assessment for projects. They emphasized its importance in quantifying sustainability metrics, analyzing data, and evaluating environmental impacts, showcasing mathematical thinking's indispensability in sustainability efforts.	*ISOS2302:* *To be honest, the topic of sustainability has been connected to all general courses, using mathematics to explain everything, such as conversions of energy units. Chemistry, in explaining the process of photosynthesis, cycles of the elements, etc. English, I connect it indirectly with sustainability, because the way I learned about the term was nurturing my brain mostly in English, which I think has helped me to develop myself a little more, regarding Graphics, I was able to use the skills learned to understand plans that some companies have proposed presenting their models to contribute to a sustainable world* ***(Course Knowledge)*** *ISOS2308: I would say that the biggest connection that I was able to establish was with Chemistry. More than the fact that the topics of energy and power were part of both classes, I would say that many of the mathematical process being utilized during the Chemistry*

		class were also applicable to the Sustainability class. Look no further than the energy assignments as an example. During said exercises, I was able to use mathematical processes similar to stoichiometry for Chemistry in order to stoichiometry and unit conversion in order to achieve the desired results. ***(Course Knowledge)***
Practical Application and Problem-Solving (K, B): Students recognized the direct applicability of coursework in Chemistry and Creative Design to understanding materials and design principles crucial for sustainability. They emphasized problem-solving skills gained in Mathematics and Chemistry as valuable for devising sustainable strategies and implementing eco-friendly practices.	*ISOS2303:*	*The course in which I see sustainability reflected the most is chemistry, since in my semester thanks to chemistry I was able to understand several chemical reactions that generally occur naturally in the environment.* ***(Course Knowledge)****.*
Social and Cultural Considerations (K): Students noted sustainability's social and cultural dimensions, advocating for sociological perspectives to complement scientific analyses and interdisciplinary approaches. They recognized languages and social sciences' role in fostering global cooperation and understanding for sustainable development.	*ISOS2305:* *ISOS2309:*	*… and in English on how to express my thoughts more concretely while letting people know of how new technologies can also be adapted to have a better life.* ***(Social and Cultural Skills*** *In terms of languages, they are completely necessary because sustainability will not be achieved without the support and teamwork among the various nations. On the other hand, this semester I decided to take sociology of climate change because I understand that sustainability cannot be achieved if it is only visualized in a mathematical and scientific way, since socially not everyone has the ability to adapt to both the effects of not being sustainable, as well as sustainable practices.* ***(Social and Cultural Skills)***
SQ7: Considering your previous answers, emphasize or summarize how participation in the ISOS program has supported or motivated your academic and personal growth and development? (K, S, B, A)		
Teamwork and Networking (S, K): Participants emphasized the value of teamwork skills acquired through ISOS activities, underscoring collaboration with peers and professionals. They also appreciated networking opportunities for connecting with like-minded individuals and sustainability-focused associations.	*ISOS2301:* *ISOS2308:*	*Being a part of the ISOS program has helped me appreciate the value of teamwork required for not only class activities, but for the work environment in a future. As I got to know my classmates from ISOS, some of us had to work together and learn to cooperate with each other's different mindsets, thoughts and even habits and it's part of coming all together, growing, and learning from other people. I had the opportunity to meet and reunite with professionals and students that every day look forward to the same goal: saving our planet.* ***(Social Skills)*** *Leaning towards the personal aspect, my time in this program have allowed me to join student associations that align with my values. (****Social Skills)***
Motivation and Inspiration (K, A): Several students credited ISOS participation for motivating them to delve deeper into sustainability and pursue related opportunities. The program served as a catalyst for their interest in sustainability, inspiring exploration of new topics and career paths aligned with sustainability principles.	*ISOS2302:* *ISOS2305:*	*The presence of ISOS in this academic year was what provoked this intrigue in wanting to know more about the subject. It motivated me to learn more because they didn't just leave you with the literature, they took us to get to know and observe up close how we can be affected (house, village, forest, school).* ***(Attitudes)*** *By another part, the program has shown me the good impact of those who share the same interests and not to give up because great things are always coming ahead.* ***(Attitudes)***

Appreciation and Establishment of Goals (A): Participants expressed gratitude for ISOS, acknowledging its role in fostering an appreciation for sustainability and shaping professional goals. The program broadened their perspectives and guided them toward meaningful academic and personal pursuits.	*ISOS2303:*	*The ISOS program has been a great help to show me a branch that was unknown to me, with some time I started to realize that I want to be a sustainable development engineer.* ***(Attitudes)***
	ISOS2304:	*Without being in ISOS I would not have the opportunities that I have today to belong to an organization for the future of the global world. I wouldn't have the knowledge of the things I do wrong. That's why I'm grateful that they caught me. My mentor has helped me a lot to grow and advise me.* ***(Attitudes)***
Personal Growth and Development (K, S): Participants recognized ISOS for fostering personal growth, enhancing understanding of societal, environmental, and economic processes. The program provided insights into values and interests, developed key skills, and explored potential sustainability-focused career paths.	*ISOS2308:*	*My participation in the ISOS program has definitely supported my academic and personal growth. Thanks to it, I have reached a better understanding of the day-to-day processes that surround me, whether they are social, environmental, or economic. [...] I have been able to develop key skills that will help me during my future endeavors, like my interview skills.* ***(Social, environmental, and personal skills)***
	ISOS2310:	*My participation on the ISOS program has lead me to grow in many ways specially mentally and as a person. Academically it has been a big positive impact and growth.* ***(Social and personal skills)***