Case Study: International Summer Research Programming Experiences Sponsored by TAMUS LSAMP

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With research interests rooted in engineering education, the learning styles of engineering students in particular, Shannon's tenure at Texas A&M is and has been rooted in the mentoring of both undergraduate and graduate students. Currently an advisor for the Texas A&M National Society of Black Engineers (NSBE) Chapter and an active member of Delta Sigma Theta Sorority, Incorporated, a service organization, Shannon is no stranger to mission and vision of the academic excellence and cultural responsibility.

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Abstract

The Texas A&M University System (TAMUS) Louis Stokes Alliance for Minority Participation (LSAMP) supported two forms of international research experiences for undergraduates in the summer of 2022. A total of 29 students, 82.3% of whom identified with underrepresented groups, participated in either a ten-day program in the Yucatan, Texas A&M University's College of Engineering Introduction to Research Abroad (IRAP), or a two-week intensive course in Belize, Texas A&M University – Corpus Christi's Ridges to Reefs program (R2R). The first offered an introduction to research in collaboration with universities in the Yucatan while the second considered ecology of river and coral reef systems in Belize with programming offered on land and at the Mesoamerican Coral Reef. Pre- and post-participation surveys regarding prior experience, research skills, a variety of potential impacts, graduate school, and learning were conducted with participants. Comparison of the pre- and post-participation submissions indicated participants found the offerings valuable for learning about concepts related to their major and specific topics in the sciences, learning about research, themselves, history and culture, refining education and career plans, developing confidence in personal ability, expanding conceptions of research, science and culture while increasing openness to employment outside the United States, and ability to relate to peers and professional scientists. These outcomes were present for both cohorts, IRAP and R2R, with some instances of statistically significant increases pre- to post-participation despite the small counts of participants (IRAP = 18, R2R = 11). Several of the outcomes parallel findings from prior support of international research experiences by TAMUS LSAMP (Preuss et al, 2020; Preuss, et al, 2021; Preuss et al, 2022). The survey findings from summer 2022 are presented as an initial data set that, while requiring verification through replication of programming in 2023 and beyond, point to the efficacy of short-term international research opportunities as learning, perspective altering, and motivating experiences for undergraduates who identify with underrepresented groups and for undergraduates in general.

1. Introduction

The impacts of short-term study abroad programs are considered in the literature [1, 2, 3, 4] but information regarding mentored undergraduate research in STEM disciplines completed through two-week international programs is limited as is material regarding impacts of such programming for students identifying with underrepresented groups. Outcomes from two short-term international programs in STEM, one offered in the Yucatan in collaboration with Mexican universities and the other in Belize, are considered herein. Student participation in these opportunities was funded by Texas A&M University System's (TAMUS) Louis Stokes Alliance for Minority Participation (LSAMP) with 82.3% of the 2022 participants identifying with historically underrepresented groups.

TAMUS' LSAMP project was funded by the National Science Foundation (NSF) in 1991 as one of the first six Louis Stokes Alliances for Minority Participation and has been continuously funded since. "The overall goal of the LSAMP program is to help diversify the nation's STEM

workforce by funding institutions of higher education to implement comprehensive, evidence-based, and sustained approaches to broadening the participation of students historically underrepresented in STEM (African Americans, Hispanic Americans, American Indians or Alaska Natives, Native Hawaiians or Other Pacific Islanders) primarily at the undergraduate…and post-baccalaureate levels" [5]. The five "program priorities [of LSAMP] are…(a) increase individual student engagement, retention and progression to baccalaureate degrees for underrepresented racial and ethnic groups, (b) enable successful transfer of underrepresented minority students from two-year to four-year institutions in STEM programs (c) increase access to high quality STEM mentoring and undergraduate and graduate research experiences, (d) facilitate seamless transition of underrepresented minority students into STEM graduate programs and degree completion and (e) stimulate new research and learning on broadening participation in STEM disciplines" [6, 7].

There are four institutional partners in the TAMUS LSAMP project: Prairie View A&M University (PVAMU), Texas A&M International University (TAMIU), Texas A&M University – Corpus Christi (TAMUCC), and Texas A&M University (TAMU). PVAMU is a Historically Black College/University (HBCU). TAMIU, TAMUCC, and TAMU are all designated as Hispanic-Serving Institutions (HSIs). TAMU is a recent HSI designee, having gained HSI standing in Fall 2021 [8], is a very high research activity institution [9], and is also the sixth largest university in the United States and the largest in Texas [10].

When crafting its application for renewed funding in 2018, TAMUS LSAMP elected to pursue international research opportunities for participants. This decision was taken as a means of addressing four of the five LSAMP program priorities listed above. The intention was to "increase…student engagement, retention and progression to baccalaureate degrees for underrepresented racial and ethnic groups…[by] increas[ing] access to high quality STEM mentoring and undergraduate…research experiences" [2] in international settings. This was seen as a means of facilitating "seamless transition of underrepresented minority students into STEM graduate programs and [toward] degree completion and…stimulat[ing] new research and learning on broadening participation in STEM disciplines" [6, 7]. Data from prior TAMUS LSAMP support of international research experiences [11, 12, 13, 14, 15] and evidence in the literature [16 ,17, 18] supported the efficacy of the approach.

TAMUS LSAMP's international programming commitments were nearing the point of participant recruitment when the COVID-19 pandemic began. Restrictions on in-person gatherings and travel put in place by TAMUS in response to the pandemic prevented implementation of international programming in the summers of 2020 and 2021. However, it was possible to enact the pattern in the summer of 2022 in collaboration with the Introduction to Research Abroad Program (IRAP) at TAMU and the Ridges to Reefs (R2R) project at TAMUCC. This paper presents the findings from pre- and post-participation surveys completed with participants in both undertakings in the summer of 2022.

2. Program Descriptions

Brief descriptions of the two international research programs follow. Similarities and differences between the two initiatives are noted.

2.1 Introduction to Research Abroad Program

TAMU's Introduction to Research Abroad Program is an extension of the Engineering Learning Community Introduction to Research (ELCIR) initiative. Funding student participation in ELCIR was one of the primary means by which TAMUS's LSAMP undertaking had engaged with international programming [13, 14, 15]. While offering ELCIR was prevented by the COVID-19 pandemic, the faculty associated with it continued to advance the programming. Part of that process was applying for a Global Engagement Grant at TAMU with the intention of offering ELCIR participation to more colleges within the University (TAMU faculty member, personal correspondence, January 31, 2023) [19]. The program name in that application was Introduction to Research Abroad Program (IRAP) and the grant was awarded in 2021. Thus, IRAP represents an expansion of the audience of ELCIR rather than a reconfiguration of the programming.

IRAP/ELCIR is a three-semester commitment for students involving preparatory activities in the spring of the year, an international research experience in the summer, and fall capstone activities [19, 20]. Students are recruited as freshmen and sophomores from TAMU's College of Engineering (CoE), College of Business, College of Geosciences, and College of Agriculture [20]. To be considered, applicants must be in "good academic standing with a 2.0 or better" grade point average [20]. The students supported by TAMUS LSAMP come from the CoE Regents' Scholars program. CoE Regents' Scholars are full-time Engineering students who are first-generation college students (neither parent completed college), whose families "have an adjusted gross income of less than $40,000 a year" [21] and who live in campus housing their entire first year at the university. Regents' Scholars receive a scholarship of $6,000 per year for four years if they meet program requirements [21]. As part of their scholarship award they are offered support programming and applicants for IRAP participation must meet the additional requirement of having completed the CoE Engineering Success Program [22] and Peer Mentor Program [20, 23].

IRAP/ELCIR includes course credit. Each participant must register for a research elective which is conducted as an independent study course [14, 15, 20]. The elective can be taken for up to four hours of credit [20, 24], although one hour is the typical load for an IRAP participant [14, 15]. The course curriculum is adapted specifically to the IRAP process and spans three semesters, spring, summer and fall.

IRAP/ELCIR's spring activities are an "orientation and training workshop" [20]. These are followed in the summer by a "two-week trip to Yucatan in Mexico, where students take a class on introduction to research, visit research sites and tour cultural areas of Yucatan, including Uxmal, Chichen Itza, the cenotes and the Mundo Maya Museum" [20]. The time in Mexico includes living with host families and collaborating with students at Mexican universities in educational and research undertakings. Fall commitments for the participants are "an online learning community and writ[ing] a research proposal on the research problem identified while [the student was] in Yucatan" [20] and presenting their proposal as a research poster. These activities were offered through the ELCIR project from 2015 to 2019 with marked success for participants by exposing them to research and international contexts early in their academic careers [11, 12, 13, 14, 15, 20]. Therefore, outcomes for students similar to those reported in [11,

12, 13, 14, 15] were expected for the summer 2022 IRAP cohort.

2.2 Ridges to Reefs Program

TAMUCC's Ridges to Reefs program (R2R) has an extended history but it was not offered in the summers of 2020 and 2021 due to COVID-19. An extended description of it was published in 2022 [15] which can be consulted by interested parties for additional details. An overview of R2R activity follows. The summer of 2022 was also the first year in which the program's participants were funded by TAMUS LSAMP.

The Ridges to Reefs summer program at TAMUCC was included in TAMUS LSAMP's offerings as one of two international research experiences proposed to NSF [15]. "Its educational goals are for participants to: (1) learn 'the ecology of coral reef ecosystems including the diversity of fishes and corals,' (2) 'apply studies of hydrology, water resource management, and geospatial analysis to determine how water flow connects ecosystems and how the ecology of coral reefs are influenced by seagrass, mangrove, lagoon, and riverine systems, providing…a wholistic view of these ecosystems,' (3) 'gain marketable experience with methods used to study coral reef systems,' (4) 'analyze the heterogeneity and dynamics of hydrological functions and patterns,' (5) 'understand hydrological design and modeling under uncertainty,' (6) 'assess the impacts of hydrological controls on water quality and ecosystem services,' (7) 'explore how humans interact with and impact water resources and ecosystems,' and (8) 'learn how to design and execute field experiments in the tropics'" [13, 15].

R2R involves participation in a research-driven, field-based course which is part of the TAMUCC's College of Science and Engineering's Coral Reef Ecology program [13, 15]. The core of the R2R offering is onsite study of Mesoamerican coral reef ecosystems in southern Belize on the world's second largest reef system [13]. "Students study the diversity and ecology of the flora and fauna communities associated with the coral reefs and learn how the reefs are influenced by seagrass, mangrove, lagoon, and riverine systems. They receive hands-on experience in field research using numerous methods of sampling and parameter testing with particular emphasis on the integration of unmanned systems for data collection. Undergraduate and graduate students are supervised by faculty who are experts in coral reef ecology, coastal terrestrial ecology, and unmanned systems. In addition to the technical training, students work in teams on a class research project. The three-week program includes one week of pre-travel training and two weeks in the field" [15].

The Ridges to Reefs program occurs in Belize, a nation on the eastern coast of Central America with Caribbean Sea shorelines to the east and dense jungle to the west [14, 15]. "Ridges to Reefs students can take one or two courses specific to the summer undertaking, BIOL 4590/5590 Ridges to Reefs: Ecology of Coral Reef Ecosystem in Belize and/or MEEN 4396 Fundamentals and Applications of Hydrological Engineering for Coastal Studies in Belize…. The instructors for these courses serve as facilitators of the summer experience in Belize particularly by guiding students in defining, detailing, and implementing research projects (TAMUCC faculty member, personal correspondence, January 31, 2022)" [15].

The Ridges to Reefs programming emphasizes three learning patterns, on-campus training and planning, field surveys and data analysis, and synthesis and broader discussions [13]. The first of these involves extended preparation of required paperwork and documents and four days of on campus activity prior to departure (see details in [15]). Also, "prior to departure, students present a research proposal to ensure the research they have planned is feasible and that it aligns with the overall research program" [15]. Field surveys and data analysis are conducted in Belize where students: (1) are exposed to "a variety of habitats found in the lowland forest" [15], (2) explore the biota in the Sibun River, (3) "conduct stream surveys to quantify invertebrates, fishes, and riparian plants on Privassion Creek" [15], (4) visit a hydroelectric dam to understand the interaction between human infrastructure and river ecosystems, (5) visit the 1000 Foot Falls natural monument to learn about the effect of water in shaping landscapes and ecosystems, (6) visit Karst Caves to "facilitate discussion of how water flows through carbonate rock compared to granite rock and how the geology influences the ecosystems" [15], and (7) live and work from a marine station in the Mesoamerican Reef. At the Tabacco Caye marine station "students learn about fisheries, the marine-protected areas of Belize, and more about the Mesoamerican Barrier Reef System…assess the reef communities and collect data relevant to their independent research projects" [15]. Discussion and synthesis is a consistent element of project programming in individual and group settings to initiate, expand, or reinforce learning. It is started in the pre-departure programming and continues as an element of all programming from that point.

"A goal of the project is for students to learn the value of cross-disciplinary research and collaboration between civil engineering and marine ecology professionals. To that end, participants are guided by faculty experts while working in teams to accomplish data gathering and analysis for research projects. In these endeavors, the undergraduate researchers gain experience collaborating with peers specializing in biology and engineering" [15].

3. Participant Groups

As the descriptions of the two international opportunities make clear, they target different audiences. IRAP focuses on freshmen and sophomores seeking to impact their conception of research and international contexts early in their academic careers. R2R recruits upper classmen who have the background to conduct supervised hands-on data gathering in the jungle and on a coral reef. This results in differences in the demography for the two cohorts, predominantly underclassmen versus exclusively upperclassmen. Another distinction resulting from the recruitment patterns was a 100% Hispanic/Latinx cohort for IRAP, a product of the participant requirements for the TAMU CoE Regents' Scholars program (see above), versus one split between Hispanic/Latinx individuals and non-Hispanics for R2R. A final distinction is the academic backgrounds of the parties, with the R2R cohort composed of parties interested in marine biology and the environment while the IRAP cohort was made up almost exclusively of students studying engineering disciplines.

The 18 IRAP participants, 17 of whom were TAMU Regents' Scholars (one was recruited from TAMIU), were 12 freshmen, four sophomores, and two juniors. Five of them thought of themselves as male and 13 as female. All considered their ethnicity to be Hispanic/Latinx with 16 of 18 identifying racially as Hispanic/Latino (two identified as White). They were studying in

12 different degree programs (Table 1), ten of which, when Computer Science is included, are engineering programs.

The 11 R2R participants were all juniors and seniors. Each attended TAMUCC. Two thought of themselves as male, eight as female, and one elected not to submit a gender response. Six of the 11 identified their ethnicity as Hispanic/Latinx and five as non-Hispanic. All of non-Hispanics classified themselves as White while their Hispanic/Latinx peers considered their race to be Hispanic/Latino. The 11 participants studied four different majors (Table 1) with ten of the 11 pursuing degrees in natural science fields.

Table 1

Participant Degree Programs

Introduction to Research Abroad Program		**Ridges to Reefs**
- Architectural Eng. (*n* = 1)	- Electrical Eng. (*n* = 2)	- Biology (*n* = 1)
- Biology (*n* = 1)	- Electrical Systems Eng. Technology (*n* = 1)	- Environmental Science (*n* = 2)
- Biomedical Eng. (*n* = 1)	- General Eng. (*n* = 4)	- Mechanical Engineering (*n* = 2)
- Chemical Eng. (*n* = 1)	- General Studies (*n* = 1)	- Marine Biology (*n* = 6)
- Civil Eng. (*n* = 2)	- Mechanical Eng. (*n* = 2)	
- Computer Science (*n* = 1)	- Multidisciplinary Eng. (*n* = 1)	

The differences in background, ethnicity, and race were associated with other differences between the two cohorts. The proportion of participants who had prior experience with international travel was skewed slightly toward R2R, the cohort that was upperclassmen. Nine of 11 participants in R2R had prior experience with international travel while 12 of 18 did for IRAP. For both groups, the primary form of prior international travel was a family trip (61.1% for IRAP, 63.6% for R2R) although several students had lived outside the United States and/or traveled internationally on a service project. None of the students reported prior experience in a study abroad program. The difference in prior experience with research was strongly skewed toward R2R with 9 of 11 of the R2R students reporting prior experience while 15 of 18 IRAP students reported no prior research experience. Finally, the IRAP participants, 100% of whom identified as Hispanic/Latinx, were nearly twice as confident in their ability to speak Spanish as the R2R participants. Proficiency in Spanish, the primary language of the regions visited, had the potential to diminish culture shock and increase the depth of cultural experiences and learning. Each of these differences can be understood as logical extensions of other characteristics of the groups, identifying as Hispanic/Latinx and being upperclassmen with several more years of life experience.

The year in school, ethnicity, and race differences between the two groups limit the ability to make comparisons between them as did the difference in programming offered. That limitation should not, though, be seen as a shortcoming. It was still possible to assess impact of international research opportunities for students across the undergraduate spectrum and through two distinct programs. The breadth of majors represented also prevented assessment of outcomes by major as the count of informants in each major was small, one or two persons in all but one case, but the variety exhibited supports the intention of assessing across the undergraduate spectrum.

4. Outcomes for Summer 2022

The same pre- and post-participation surveys were administered to the two cohorts with the exception of an additional group of 11 questions about forms of learning specific to the R2R that were distributed to R2R participants. The surveys had questions in 37 topic areas and some of the information gathered, specifically demographics, prior experience with international travel, study abroad and research plus proficiency in Spanish, were discussed above when describing the two cohorts. Other lines of inquiry, like requests for suggestions about improving project logistics and research mentoring, additional information participants desired about graduate school and student plans regarding presentation of the research activity completed, had a formative intent and will not be discussed here. Topics to be discussed are grouped below as: (1) confidence traveling and interest in employment outside the United States, (2) commitment to an undergraduate degree in STEM, (3) orientation toward graduate school, (4) pattern and process assessments only possible post-participation, (5) ratings of personal skill in research- or discipline-relevant tasks, and (6) impacts on interest or understanding. The survey prompts, which were developed by the project evaluator with input from members of the project's leadership team, are listed verbatim in the discussion that follows unless otherwise noted.

The data for the two surveys can support statistical analysis even though the counts are under 20 persons as they are repeated measures. There were 18 LSAMP-sponsored participants in IRAP and all 18 completed both the pre- and post-participation surveys. Of the 11 R2R participants, 11 submitted pre-participation and 10 post-participation responses. The size of the samples decreases the potential for statistical significance but not, in this case, the possibility of analysis.

4.1 Confidence traveling outside the US and interest in international employment

Participants were asked, before and after participation, to rate their level of confidence in traveling outside the United States. They were also asked to rate their interest in employment outside the United States. The prompts used appear in Table 2. Ratings were submitted on a ten-point scale with the students instructed to use zero for strongly disagree and ten for strongly agree. Mean, mode, and standard deviation are listed in the table to provide a clearer representation of central tendency.

Table 2

Central Tendency Measures for Rating of Confidence in International Travel

Cohort	Period	Mean	Mode	SD	Sign.
I am confident in my ability to travel outside the United States.					
IRAP Summer 2022	Pre	7.22	10	2.42	0.016
	Post	8.94	10	1.54	
Ridges to Reefs Summer of 2022	Pre	9.0	10	1.13	-
	Post	9.20	10	1.08	
I would consider taking a job outside the United States.					
IRAP Summer 2022	Pre	6.89	10	2.58	-
	Post	7.56	7.0	2.36	
Ridges to Reefs Summer of 2022	Pre	9.09	9.0	0.90	-
	Post	9.50	10	1.02	

While there were increases in mean pre- to post-participation for both groups in respect to both questions, there was only one significant finding. IRAP participants experienced significant increases in personal confidence in their ability to travel outside the US. Since this occurred for the younger of the two cohorts and the one in which 33% of participants had no prior international travel experience, little explanation is required. The younger, less experienced group had a greater increase in personal confidence which is logical especially given the relatively high confidence level of the R2R cohort pre-participation, a mean of nine on a ten-point scale.

4.2 Commitment to an undergraduate degree in STEM

Students were asked to rate their level of commitment to completing an undergraduate degree in a STEM discipline. For this query the rating scale began at zero for "no commitment" and extended to ten for "100% commitment." A summary of pre- and post-participation responses appears in Table 3.

Table 3

Central Tendency Measures for Commitment to Completing an Undergraduate STEM Degree

Cohort	Period	Mean	Mode	SD	Sign.
IRAP Summer 2022	Pre	9.56	10	0.90	-
	Post	9.72	10	0.73	
Ridges to Reefs Summer of 2022	Pre	9.91	10	0.29	-
	Post	10.0	10	0.0	

Both programs recruited individuals who were strongly committed to completing an undergraduate degree in a STEM field. The difference in the extent to which that was the case for IRAP and R2R is associated with the academic level of the participants. Those in R2R were nearly all seniors and in the final year of their chosen field of study. They would be unlikely to abandon it in their final year, especially since they sought a summer research experience related to that field.

The summer programming produced no statistically significant increase in commitment to completing an undergraduate STEM degree although that would have been difficult to achieve. The initial means for IRAP and R2R were 9.56 and 9.91 respectively leaving very little room for improvement. Even with that being the case, the means increased post-participation and standard deviations decreased pre- to post-participation indicating greater certainty.

4.3 Orientation toward graduate school

As noted above, one of the primary goals of LSAMP programming is to encourage students who identify with underrepresented groups to enroll in graduate school. Thus, eight questions were included on the surveys about graduate school. These addressed knowledge of, interest in, and commitment to attend graduate school, perception of the affordability of graduate study, whether the student's family will be supportive of graduate study, and when the student might attend graduate school. There was also a related query about the highest degree the student planned to

obtain. Six of the queries employed a ten-point rating scale while the other two were multiple-choice questions from which one response was to be selected. Summaries of the responses in each topic area follow.

The differences between the IRAP and R2R cohorts are clearly reflected in the ratings submitted for the queries that used ten-point scales (Table 4). The R2R group submitted higher ratings for every query which reflects their status as upperclassmen and proximity to graduate study.

While increases in means existed from pre- to post-participation for every measure, there was a statistically significant finding in only one topic area. That was for an increase in knowledge regarding graduate school and only for the IRAP cohort.

Table 4

Central Tendency and Significance Measures for Orientation toward Graduate School

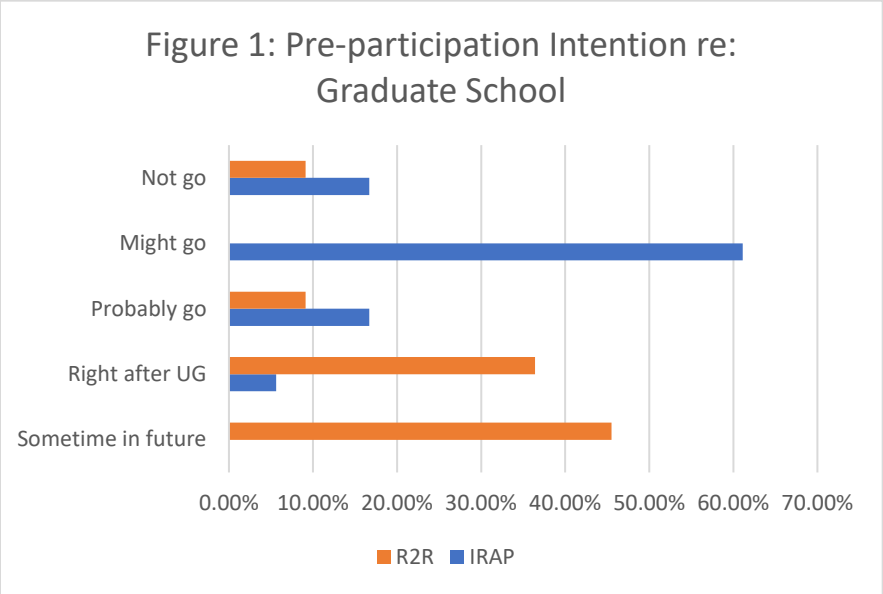
Prompt	Cohort	Period	Mean	Mode	SD	Sign.
Rate your current knowledge of graduate school.	IRAP	Pre	4.44	2.0	2.26	0.03
		Post	5.94	7.0	1.75	
	R2R	Pre	5.36	7.0	2.77	-
		Post	7.10	7.0	1.58	
Rate your current interest in graduate school.	IRAP	Pre	5.06	5.0	3.01	-
		Post	5.22	6.0	2.89	
	R2R	Pre	7.73	10	2.30	-
		Post	9.2	10	1.25	
Rate your current level of commitment to attending graduate school.	IRAP	Pre	3.83	4.0	2.77	-
		Post	4.11	5.0	2.75	
	R2R	Pre	7.45	10	2.68	-
		Post	8.80	10	1.89	
Rate your level of commitment to completing a graduate degree in a STEM discipline.	IRAP	Pre	4.21	10	2.91	-
		Post	4.94	5.0	3.29	
	R2R	Pre	8.17	10	2.31	-
		Post	9.20	10	1.25	
I don't see how I can afford graduate school.	IRAP	Pre	5.72	7.0	3.35	-
		Post	6.56	8.0	2.39	
	R2R	Pre	5.55	10	3.39	-
		Post	6.0	8.0	2.83	
My family would be supportive of my going to graduate school.	IRAP	Pre	7.94	10	2.34	-
		Post	8.56	10	2.39	
	R2R	Pre	8.73	10	1.66	-
		Post	8.60	10	2.73	

An increased mean is not the desired pattern for the query about ability to afford graduate school. It was worded in the negative. The outcome desired would be a decrease in mean indicating greater confidence in ability to afford graduate school. Participants in both programs are offered information about ways of funding graduate school, at a minimum as information sheets of

online resources and informal conversations (TAMUCC faculty member, personal correspondence, January 31, 2023), making this outcome counterintuitive.

Past considerations of international research programming included the query about whether the student's family would be supportive of him/her pursuing a graduate degree. Those data indicated that students felt this was the case [13, 14, 15]. The data for 2022 is, though, inconclusive which may be a function of the cohorts recruited for 2022, the small size of the cohorts, or some unknown factor.

A separate question about graduate school highlights the difference between the IRAP and R2R cohorts. The informants were asked to select one of five statements about their plans for attending graduate school. Figure 1 illustrates the responses from the two cohorts, 17 of 18 IRAP participants chose the three lowest levels of likelihood while 10 of 11 R2R participants chose the three options at the higher end of the scale.



The count of submissions for intent to attend graduate school, the data employed to produce Figure 1, are included in Table 5. These data cannot be assessed using statistical analysis as the ratings employ a nominal scale. The most that can be done is calculate percentages for each category so that the information for the two programs is comparable. Simple comparisons show that there was change in the IRAP and R2R groups pre- to post-participation with several students determining they would attend graduate school in the future (Table 5; see also Table 6 which shows a post-participation increase in IRAP cohort members who wish to obtain a master's degree). While a positive outcome, this is not conclusive. It would

Table 5

Response Patterns for Intent to Attend Graduate School as Percentages

Project	Period	Not Go	Might Go	Probably	After UG	In Future
IRAP	Pre	16.7%	61.1%	16.7%	5.6%	-
	Post	16.7%	50.0%	16.7%	5.6%	16.7%
R2R	Pre	9.1%	-	9.1%	36.4%	45.5%
	Post			10.0%	30.0%	60.0%

appear that the programming was associated with these changes but statistical analysis cannot be completed and the students were not asked whether any changes in plans were a direct result of their summer experience.

The informants were asked to select the highest degree they intended to obtain on a multiple-choice question for which they were limited to one answer. The response options were bachelor's degree, master's degree, PhD, and other professional degree (e.g., MD, JD, EdD). Table 6 contains a summary of the responses. There is no presentation of the combined ratings as sufficient differences existing in audiences and programming make combining the scores suspect.

Table 6

Intentions Regarding the Highest Degree Participants to Obtain as Percentages

Cohort	Period	Bacc.	Mstrs	PhD	Other
IRAP Summer 2022	Pre	72.2%	16.7%	5.6%	5.6%
	Post	55.6%	33.3%	5.6%	5.6%
Ridges to Reefs Summer of 2022	Pre	9.1%	18.2%	72.8%	-
	Post	-	50.0%	50.0%	-

Trends pre- to post-participation for highest degree desired (Table 6) parallel those in Tables 4 and 5 for intention to attend graduate school. Thus, this data elucidates those findings by indicating the shifts in intention were, for both groups, an increase in the number of persons who intended a master's degree to be the culminating point of their education.

4.4 Patterns and Processes Measured Post-Participation

The students were asked a series of six questions on the post-participation survey about direct impacts of participating in the summer programming. These queries only appeared on the second

Table 7

Central Tendency Measures for Ratings Regarding General Impacts Reported

Cohort	Cohort	Mean	Mode	SD
…increased understanding of concepts in my major field.	IRAP	7.28	8.0	2.21
	R2R	8.90	10	2.07
...made me want to continue my involvement with research.	IRAP	8.17	8.0	1.38
	R2R	9.0	10	1.26
...showed me the field is not for me.	IRAP	2.11	0	2.45
	R2R	1.43	0	2.32
…reinforced my commitment to my field of study.	IRAP	8.17	10	1.71
	R2R	9.10	10	1.14
...caused me to be open to participating in another international research experience.	IRAP	9.33	10	0.94
	R2R	9.5	10	1.20
...reinforced my career plans.	IRAP	8.28	10	1.73
	R2R	8.90	10	2.02

instrument because they sought information about outcomes. The table lists the second clause of each prompt. The initial clause for each was “My LSAMP-supported international research experience….” The data (Table 7) represents the opinions of the informants, perspectives regarding their own learning and preferences, and, as post-participation only measures, cannot support statistical analysis.

Movement in the desired direction occurred in each topic area. Students reported:

1. Increased understanding of concepts related to their major.
2. Increased interest in continued involvement with research.
3. Increased certainty that the “field” was “for them.”
4. Reinforcement of their commitment to their field of study.
5. Reinforcement of their career plans.
6. Openness to another international research experience.

These findings parallel those from prior investigations of international research programs for undergraduates that were supported with TAMUS LSAMP funds [13, 14, 15]. The findings for 2022, especially given the parallel to prior indications of the same pattern, can be understood to be verified impacts.

It should be noted that the data for IRAP regarding student sense that the “field is not for me” appeared to contain a submission error. One party entered a rating of nine which would indicate determination of a mismatch. However, that same party indicated just the opposite on other questions including the next one about the programming reinforcing commitment to the field. Since questions in the negative were rare on the survey, it seems likely the student misread the prompt. If that is the case, the true rating and standard deviation for “field is not for me” for IRAP in 2022 would be lower.

4.5 Personal skill in research- or discipline-relevant tasks

The students were asked to provide ratings of their level of capability in respect to 20 research-related skills. The general prompt was “Please rate your skill in respect to each of the following research activities.” Table 8 contains the research activities and a summary of the responses. Like with other measures described above, the R2R cohort submitted consistently higher ratings of themselves than the IRAP students. The simplest explanation for this is their being more advanced in their studies and, as a result, having been provided opportunity to develop research relevant skills.

Pre- to post-participation ratings of skill increased in each topic area for IRAP participants. R2R participants showed increases in 13 of the 20 topic areas. This is likely related to their having rated their skill at reasonably high levels prior to their summer experience and encountering new and challenging circumstances that caused them to understand they had more room to grow.

Significant differences between pre- and post-participation ratings existed for five of the 40 comparisons (20 comparisons each for IRAP and R2R). Those are for IRAP in respect to "gathering data and handling samples," "writing a research plan/proposal," "writing a research abstract," and "writing summaries for professional publication." For R2R, there was only one significant finding which was for "writing a research abstract." That these detailed and technical skills would be the items in which significant change occurred is not surprising as undergraduate students rarely have opportunity to engage in these practices. Providing sufficient opportunities to elicit such a change in one summer experience is, though, a notable and positive outcome.

Table 8

Central Tendency and Significance Measures for Research Skills

Prompt	Cohort	Period	Mean	Mode	SD	Sign.
General planning skill.	IRAP	Pre	8.0	8.0	2.03	-
		Post	7.78	8.0	1.27	
	R2R	Pre	8.73	10	1.35	-
		Post	8.50	8.0	1.02	
Interpersonal communication skill.	IRAP	Pre	7.56	8.0	2.11	-
		Post	8.17	9.0	1.01	
	R2R	Pre	8.55	9.0	0.78	-
		Post	8.70	10	1.19	
Leading a group of collaborators.	IRAP	Pre	7.28	6.0	2.02	-
		Post	7.56	8.0	1.30	
	R2R	Pre	8.18	8.0	1.34	-
		Post	8.60	10	1.36	
Time management.	IRAP	Pre	7.17	7.0	1.89	-
		Post	7.11	6.0	1.82	
	R2R	Pre	8.45	10	1.23	-
		Post	8.20	8.0	1.33	
Collaborating with others.	IRAP	Pre	8.22	9.0	1.51	-
		Post	8.44	8.0	1.07	
	R2R	Pre	9.0	10	1.21	-
		Post	8.70	10	1.55	
Problem solving.	IRAP	Pre	7.89	9.0	1.91	-
		Post	8.33	9.0	1.11	
	R2R	Pre	9.09	9.0	0.90	-
		Post	8.80	10	1.33	
Forming a hypothesis and devising a research question.	IRAP	Pre	6.65	7.0	2.06	-
		Post	7.33	8.0	1.20	
	R2R	Pre	8.0	7.0	1.28	-
		Post	8.30	10	1.55	
Designing a research methodology.	IRAP	Pre	6.41	8.0	2.03	-
		Post	7.39	8.0	1.30	
	R2R	Pre	7.64	8.0	2.14	-
		Post	8.40	10	1.36	

Gathering data and handling samples (even as information provided by people).	IRAP	Pre	6.41	5.0	2.22	0.02
		Post	7.83	8.0	1.17	
	R2R	Pre	8.45	10	1.88	-
		Post	8.9	10	1.14	
Data analysis (quantitative or qualitative as applicable).	IRAP	Pre	6.94	9.0	2.21	-
		Post	7.78	8.0	1.23	
	R2R	Pre	8.0	9.0	1.54	-
		Post	7.90	8.0	1.37	
Interpreting results of data analysis.	IRAP	Pre	6.78	8.0	2.22	-
		Post	7.83	8.0	1.21	
	R2R	Pre	7.82	8.0	1.40	-
		Post	8.10	9.0	1.30	
Project/process management.	IRAP	Pre	6.59	9.0	2.66	-
		Post	7.94	7.0	1.08	
	R2R	Pre	8.36	9.0	1.55	-
		Post	8.30	9.0	1.68	
Recordkeeping.	IRAP	Pre	7.83	10	2.22	-
		Post	8.50	9.0	1.70	
	R2R	Pre	8.82	10	1.34	-
		Post	8.60	10	1.74	
Project budget planning and fiscal management.	IRAP	Pre	6.65	7.0	2.45	-
		Post	7.28	9.0	1.45	
	R2R	Pre	7.0	8.0	1.04	-
		Post	7.1	8.0	1.51	
Preparing presentation materials (graphics, posters, PPT slides).	IRAP	Pre	7.78	10	2.51	-
		Post	8.50	8.0	1.07	
	R2R	Pre	8.73	9.0	1.14	-
		Post	9.0	10	1.10	
Communicating technical information to people in your field.	IRAP	Pre	7.33	10	2.60	-
		Post	8.06	8.0	0.85	
	R2R	Pre	8.0	10	2.04	-
		Post	8.90	8.0	0.94	
Communicating technical information to people outside your field.	IRAP	Pre	6.89	7.0	2.23	-
		Post	7.33	7.0	1.05	
	R2R	Pre	8.09	8.0	1.38	-
		Post	8.40	10	1.91	
Writing a research plan/proposal.	IRAP	Pre	5.41	3.0	2.52	.001
		Post	7.72	8.0	1.10	
	R2R	Pre	6.82	7.0	2.04	-
		Post	8.20	6.0	1.60	
Writing a research abstract.	IRAP	Pre	5.56	3.0	2.71	.009
		Post	7.50	8.0	1.17	
	R2R	Pre	6.64	8.0	1.87	.04
		Post	8.30	10	1.49	
	IRAP	Pre	5.12	8.0	2.63	.009

Writing research summaries for professional publication.		Post	7.11	8.0	1.49	
	R2R	Pre	6.64	8.0	2.06	-
		Post	8.0	6.0	1.41	

4.5.1 Learning queries specific to Ridges to Reefs programming

The informants were asked, at the end of the surveys, to which of the two international opportunities they were committed. The response was used to sort respondents. Those participating in IRAP were presented with no other multiple-choice questions and were taken directly to the last qualitative query. Parties involved with R2R were presented with an eleven-part question specific to content covered in the R2R program. The question stem was "Please rate your level of understanding in each of the following areas." Table 9 lists the eleven topics for which the students were asked to submit ratings. They were selected from educational

Table 9

Central Tendency and Significance Measures for R2R-Specific Questions

Prompt	Period	Mean	Mode	SD	Sign.
Variety of influences on coral reef ecosystems.	Pre	8.0	10	2.09	-
	Post	9.2	10	1.78	
Forms of human impact on ecosystems.	Pre	8.36	10	2.10	-
	Post	9.40	10	1.50	
Methods used to study coral reef systems.	Pre	7.64	10	2.19	-
	Post	9.10	10	1.22	
Relationship of water sources to nature/health of ecosystems.	Pre	7.91	10	2.15	-
	Post	9.40	10	0.92	
Hydrological design and modeling.	Pre	4.50	6.0	2.01	= .005
	Post	7.40	10	2.20	
Assessing water quality.	Pre	6.45	10	2.74	= .01
	Post	9.20	10	1.40	
Conducting field experiments in the tropics.	Pre	5.30	3.0	2.41	> .001
	Post	9.70	10	0.64	
Identification of corals, fishes, and invertebrates.	Pre	5.91	5.0	2.11	= .02
	Post	8.30	10	2.33	
Basic biology and ecology of coral reefs.	Pre	8.18	10	2.52	-
	Post	9.0	10	2.37	
Coral bleaching and disease.	Pre	8.18	10	1.99	-
	Post	8.70	10	1.73	
Coral reef habitat assessment techniques.	Pre	7.09	9.0	2.71	-
	Post	9.0	10	2.05	
Major threats to coral reefs.	Pre	8.54	10	2.14	-
	Post	9.1	10	0.90	

objectives developed by the R2R project leaders and approved by them for inclusion in the survey. The table summarizes responses received for these queries on both the pre- and post-participation surveys.

As upperclassmen, the R2R students were generally confident in their knowledge prior to the summer program. The areas in which they showed the least confidence, were the technical and research technique topics which were unlikely to have been addressed in detail in their prior coursework. Even with an overall sense of having good understanding entering the program, there was learning reported in each of the eleven topic areas. In some cases, like conducting field experiments in the tropics, large increases in learning were reported. In fact, the four pre- to post-participation comparisons that proved to be statistically significant were also the technical topic or technique areas in which the participants noted the lowest levels of knowledge pre-participation.

The size of the cohort had substantial influence on the statistical significance of the learning reported. With 11 pre-participation and 10 post-participation informants, even with the one-to-one pairing of responses for 10 parties, the potential for the result to be a random occurrence was high. Combining 2022 data with that for subsequent years, which are also likely to include small cohorts, should overcome this limitation. That will, though, only be possible if substantial change does not occur within the program. Change to that degree is, however, unlikely as the R2R project has been in operation for over a decade.

4.6 Impacts on interest or understanding

Participants were asked five short-answer questions as part of their post-participation surveys. These addressed: (1) the most valuable element of their summer experience, (2) the program's impact on their understanding of science, (3) the program's impact on their understanding of scientific research, (4) the program's impact on the student's understanding of him/herself, and (5) the program's impact on their understanding of culture. Submissions from the two programs were treated separately since they involved different forms of programming and, as demonstrated above, had different audiences. Response rates were high, with all 18 IRAP students replying to each question and eight (second and third topic), nine (fourth topic) or ten R2R responses (first and fifth topics). The summary statements will be presented herein but full lists of the submissions and the categorical sorting are available from the lead author.

The responses submitted were assessed using the constant comparative method [25]. Coding was completed manually as there were no more than 18 submissions per question. The written responses, which consisted of two or three words up to several sentences, were read repeatedly to identify "different categories, properties, and dimensions" [25]. Those were noted by compiling a running list of quotes from the submissions. The elements of this list were assessed seeking to identify and relate "subcategories" [25] and create a catalog of concepts addressed in the submissions. This process involved refining summary statements for the themes addressed and considering how they were connected to other categories. Words and phrases used by the students in their submissions were employed as summaries of the themes whenever possible to

maintain fidelity with the original content. All topics addressed by informants were included without weighting to prevent bias. This process of "weaving and refining" [25] resulted in outlines for each set of responses with supporting quotations associated with each of the categorical labels. The supporting data made recognizing major themes, those most frequently addressed, a simple matter. The entire process was completed by the project's external evaluator.

4.6.1 Most valuable element of the summer experience

When asked what the most valuable element of their summer experience had been, IRAP participants noted learning about culture, learning about research, growth in knowledge/understanding, relationships they developed, the diversity among/multi-national nature of active parties/stakeholders, international travel, and the financial support from LSAMP. R2R responses were similar although worded in ways that align with that project's programming. R2R participants noted the following as valuable elements; the learning opportunity, field experience gained, learning about culture, working on collaborative teams, interdisciplinary activity, personal choice in research topic, and their summer experience confirming their commitment to STEM. Two of the elements, learning about culture and developing relationships with program and Mexican peers and project and international faculty, were the predominant themes for IRAP participants. Each was noted by eight of 18 while all other items in the IRAP list were noted by one or two parties. The field experience opportunity was the project element R2R participants felt was most valuable, six of ten informants, with learning about culture a step below, and all other items listed mentioned on one or two submissions. Cultural learning occurring as the predominant theme for IRAP and a major theme for R2R underscores the importance of this topic area which will be discussed in detail below (see Section 4.6.5). The points shared in common, perception of personal growth and learning about culture, as well as the headings unique to each of the undertakings represent participant verification that a number of the organizers' project objectives were realized, an indication that the programming is effective in achieving its intended purposes.

4.6.2 Impact on understanding of science

Post-participation surveys included an open-ended query about the impact the summer research program had on the student's understanding of science. One IRAP participant submitted a general response, "This experience helped me acquire a more in-depth understanding of science." The remainder of IRAP responses mentioned introduction to new fields of study, learning about variety in approaches to address problems/research questions, learning about methods and techniques, improving understanding of research, learning about research labs, field research and the interdisciplinary nature of science, reinforcement of prior learning, and learning about presenting research results. R2R participants mentioned learning about challenges facing STEM fields and in "doing" science, the variety of discipline-specific conceptions that exist, how rewarding scientific investigation can be, expanding experience with science investigations and field work, and expanding understanding related to the R2R topics. There were two primary themes in the IRAP responses (stated by six or seven of the 18 informants) with all others

mentioned by between one and three individuals. The primary themes were learning about variety in approaches to address problems/research questions and learning about scientific methods and techniques. For R2R there was not a predominant theme as all topics were mentioned by one or two informants. As was the case with the most valuable element of programming, the full list of statements reads like a review of program goals showing that the programming enacted is effective in reaching its intended outcomes and is sufficiently broad and deep to facilitate valuable learning in a variety of topic areas.

4.6.3 Impact on understanding of scientific research

Post-participation surveys asked about the impact the summer research program had on the student's understanding of scientific research. Like with the other qualitative responses, the differences in academic standing and background of the two cohorts and between the programming offered made it necessary to consider the responses for each initiative separately.

Two IRAP participants submitted general responses, "Great intro course" and "Strengthened my knowledge." The 16 others mentioned learning about the breadth of research occurring, being more prepared to participate in research and being more interested in that prospect, learning that there are a variety of research approaches and how to enact some methodologies, learning that research could be enjoyable, and increasing understanding of the environment although the last comment has an unclear referent. It is unknown whether the student was referring to the research environment or climate and ecology. Three of the four IRAP themes, breadth of research, increased preparation for and interest in research and the variety of approaches to research, were mentioned frequently (eight, eight, and five times respectively). Increased perception of research as enjoyable was mentioned by two parties. The R2R students reported learning how to structure and conduct investigations, how to do field research, the importance of subject matter knowledge, perceiving the value of collaborative teams and adaptability, and expanding personal understanding. Three of those, how to structure and conduct investigations, how to do field research, and perceiving the value of collaborative teams and adaptability, were the most common themes with five, five, and three mentions respectively. The other two were mentioned by one student each.

The outcomes just noted related to most valuable element, impact on understanding of science and impact on understanding of scientific research read like a review of program goals. Since the intention was to provide this type of learning and these types of perspective changing experiences, these submissions are strong indication that was accomplished, a conclusion supported by the learning reported on questions soliciting ratings in respect to research skills and content specific to R2R programming.

4.6.4 Impact on understanding of self

On the post-participation survey, project participants were asked how the summer research program had impacted their understanding of themselves. Several students, one in IRAP and one

in R2R, addressed a different but related topic in their response. They indicated that they had developed relationships they valued as part of the international experience: (1) “Connected with a lot of people and found great friends” and (2) “I made life-long friends and potential colleagues on this trip.” Other general comments, from IRAP participants were “I got to live new experience [sic] and it opened me up also to talk to new people” and “Realized it can be hard to live in another country.” While these did not address the question asked, they speak to the ability of the participants to relate to each other and project facilitators, participants recognizing the potential future value of relationships established, and achieving personal revelations or change.

As regards impact on understanding of self, IRAP participants noted increased confidence, identifying areas for investment or personal growth, an expanded view of educational options, refining of career preferences, expanding cultural awareness/understanding, achieving a change in personal perspective, and increased confidence and interest in international travel. Of these, increased confidence and achieving a change in personal perspective were the most common responses (counts of five and six respectively) with all other ideas stated by two or three persons. R2R participants stated that they learned about themselves and experienced personal growth, and that they increased personal confidence in their own ability, identified personal strengths and weaknesses, recognized ways they could advance/grow, and had career choices affirmed. There was one primary response as six informants noted increased confidence in their own ability and all other topics were mentioned by three or fewer parties. The responses to this query continue the pattern with the other short-answer questions. The student responses parallel project goals and thus confirm that the goals were realized by the programming enacted. They also illustrate the programming had appropriate breadth and depth through the variety of responses received.

4.6.5 Historical and cultural understanding

Both IRAP/ELCIR and R2R include cultural experiences intended to enhance the participants’ exposure to and understanding of the culture of the region visited. IRAP/ELCIR participants tour “cultural areas of Yucatan, including Uxmal, Chichen Itza, the cenotes and the Mundo Maya Museum” [20]. They also live with Mexican host families, attend lectures presented by faculty from Mexican universities, and complete studies alongside and collaborative research activities with students from the participating Mexican universities. The R2R programming includes general cultural experiences (i.e., visits to Belize’s capital city, Belmopan, Mayan archeological sites, and other historic and relevant locations, exposure to Belizean food), discussions with local tour guides about Belizean culture, “discussions of fishery practices, introduction to uses local populations make of indigenous plants” [15], discussion of government procedures (TAMUCC faculty member, personal correspondence, January 31, 2023) and “local management strategies to protect the Mesoamerican Barrier Reef system. These opportunities facilitate discussion of the human history of the region and how past and current cultures interacted with the environment” [15].

To assess the impact of these offerings, the informants were also asked, pre- and post-participation, to rate their understanding of the history of the region their program visited and of the region’s culture. IRAP participants, likely due to the all parties having Hispanic/Latinx

backgrounds, rated themselves higher in understanding of the history and culture of the region to be visited on the pre-participation survey than their R2R peers. IRAP cohort members were also more than twice as likely to speak Spanish well as their R2R peers. This had the potential to impact project outcomes as Spanish speakers with an understanding of the regional culture would be less likely to encounter marked culture shock and would be able to concentrate their efforts on comprehending and advancing understanding rather than recognizing reactions and characterizing causes. Due to this pronounced difference in the two cohorts, others noted above, and the different patterns of programming, Table 10 does not include lines for combined data for the two cohorts.

Pre- to post-participation surveys included a question with the stem "Please rate your understanding of the part of the world you visited during your summer research experience in the following areas." A ten-point scale was employed with informants instructed to provide a rating of zero for "no understanding" and a rating of ten for "substantial and detailed understanding." The prompts in Table 10 are the two "areas" in which the students were to submit ratings. Comparisons of pre- and post-participation submissions resulted in statistically significant findings for both topics for the two cohorts. Both the IRAP and R2R cohorts experienced strongly significant increases in understanding of the history of the region they visited. They also reported significant increases in understanding of the culture of the regions they visited. This represents realization of project goals established by both the IRAP and R2R project leaders.

Table 10

Central Tendency Measures for Ratings Regarding Understanding of History and Culture

Prompt	Cohort	Period	Mean	Mode	SD	Sign
Understanding of the history of the region.	IRAP	Pre	6.06	5.0	1.87	> .001
		Post	8.17	9.0	1.21	
	R2R	Pre	3.80	2.0	2.23	> .001
		Post	7.90	8.0	1.45	
Understanding of regional culture.	IRAP	Pre	7.61	8.0	1.46	0.03
		Post	8.61	9.0	1.11	
	R2R	Pre	4.27	3.0	2.60	.001
		Post	8.10	10	1.76	

A related short-answer question was asked. It was "How did the international research experience impact your understanding of culture?" The replies can be summarized for IRAP as realization that "there is always something new you can learn," increased understanding of culture and the variety of cultures, forming connections to personal background, achieving a broader perspective of how people live their lives, and aroused interest in knowing more about other cultures. R2R participants noted forming new understandings related to culture, achieving a broader perspective of people's life circumstances, recognizing values that exist across cultures, making connections to historical events, and connections made to personal background. Collectively, the student comments represent increasing personal understanding, learning about a different culture and cultural variation, broadening perspectives regarding cultures and people groups, and arousing curiosity, which are all goals of the programming. That students would

state these as areas of personal learning following a two-week summer program indicates that the organizers' goals for the programs were realized and that even short-term immersive initiatives can have strong impacts.
Developing an increased understanding of culture and its varieties was the most prominent theme for both groups (also was noted as a most valuable project element; see Section 4.6.1 above), mentioned by half of R2R and all but one of IRAP participants. Each of the other themes listed above for impact on understanding of culture was mentioned by a couple of parties. There were also no notable differences based in gender or ethnicity/race for the students stating their understanding of culture increased. These findings align with, confirm, and provide elucidation of those from the quantitative questions as the statistically significant increases in understanding occurred primarily through the learning just noted.

While forming a broader understanding of culture and variation across cultures may seem like a mundane outcome, it represents a valuable form of learning and one targeted by the project programming. A sense that differences exist in how people groups choose to address and understand the world and the openness to learn about that is basic to and essential for further learning regarding culture. One R2R participant described this as her eyes being opened "to how other people live and what they experience." A basic understanding of what culture is, that it varies between people groups, and an interest in understanding how others view the world is also an important precursor for successful interactions with parties from other cultures, an increasingly important component of engineering practice. Overall, a simple but profound shift in orientation occurred for the IRAP and R2R participants.

A second form of cultural learning that occurred for at least some of the Hispanic/Latinx participants was making important personal connections. Several students noted making connections to "stories" their parents told them or family heritage. One shared a poignant account. Her family was from a country bordering Belize and they are proud of their national heritage. She noted that after her summer experience "my knowledge, understanding and appreciation for Belize has expanded. It is amazing to see and understand the difference between the neighboring countries. Seeing how a country I adore has negatively impacted a country I was researching in was eye opening and was a call to action to me. Thanks…to the [R2R experience] I am now even more knowledgeable about my own history and culture as the countries share that Mayan heritage." That students could form meaningful associations with family lore and heritage up to the more nuanced and balanced perspective achieved by the student quoted above is substantial contribution to student formation as self-knowledge is important in decision-making and can contribute to personal "health and wellbeing" [26].

5. Limitations

There are a number of limitations for this study. The questions deployed in the surveys, while adapted from other surveys the evaluator has employed or developed in collaboration with IRAP and R2R program faculty based on educational goals, only have face and content validity. They have not been tested to verify their reliability although repeated use has produced similar responses from different cohorts. The cohort sizes were small, limiting analytical power, and

restricted to one year so the data may include patterns reflecting idiosyncrasies of the cohorts rather than impacts of the programming. The two summer opportunities also have different programming and audiences so the survey responses, while to the same questions, cannot be combined and considered as one set.

6. Results Summary and Conclusion

The survey results included positive trends and statistically significant outcomes for both programs. Notable outcomes from the summer of 2022 were as follows with each paralleling findings for similar programming previously reported by parties engaged with the TAMUS LSAMP project [11, 12, 13, 14, 15].

- Participants in IRAP and R2R reported increased confidence in their ability to travel outside the United States with the change proving statistically significant for the IRAP cohort.
- IRAP and R2R participants increased their interest in employment outside the United States.
- Students in both programs reported increased commitment to completing STEM degrees.
- All measures related to graduate school increased, knowledge of, interest in, intent to attend, and intent to complete a graduate degree in a STEM field, with the increase in knowledge about graduate school proving to be statistically significant for the IRAP cohort.
- Participant plans regarding their futures included more participants wishing to complete a master's degree.
- IRAP participants, 100% of whom identified with underrepresented groups and were first-generation college students, and their R2R peers, 54% of whom identified with underrepresented groups, felt strongly that their families would support the intention to pursue a graduate degree.
- Participants in both programs felt the experience increased their understanding of topics relevant to their major area of study, reinforced their commitment to their field of study and career plans, increased their interest in continued involvement with research, and increased willingness to undertake another international study abroad project.
- IRAP participants rated their level of ability higher in all 20 research-relevant skills post-participation while R2R students rated theirs higher in 13 of the 20. Four of the increased ratings were statistically significant for IRAP with one proving so for R2R.
- R2R participants reported greater understanding in 12 project-specific topic areas post-participation, four at statistically significant levels.
- Participants' written responses to queries regarding the most valuable element of programming, impact on understanding of science, scientific research and understanding of self, and understanding of history and culture of the region visited indicated substantial learning and growth reading like restatements of the programming's educational goals and objectives indicating the programming was appropriately scaled and that as enacted, it was effective in achieving those purposes.
- Increases in understanding of history and culture, statistically significant with supporting and elucidating qualitative evidence, are a valuable form of student formation and

through contribution to self-concept can influence important decision-making and contribute to personal "health and well-being" [26].

Participants did, though, register a slight increase in concern regarding their ability to afford graduate school. The pre- to post-participation increase in rating was moderate, 0.84 points for IRAP and 0.45 points for R2R, with large standard deviations (above 2.25 on a ten-point scale) indicating variety in the response set. This pattern suggests that emphasis on how students can fund graduate study might need to be increased, although the pattern would need to be verified with data from future summer programs to warrant the change.

The presence of consistently positive trends with statistically significant findings in some cases even given the small groups, especially as there were similar findings in past international program offerings [12, 13, 14, 15], suggests efficacy. "Significant change in participant understanding, skill, and orientation toward continued involvement with research and pursuit of advanced degrees" [15] with corroborating evidence in short-answer responses suggests both programs have substantial impact. That "these results were achieved with students from universities of different size and Carnegie classification who were drawn from programming for parties from underrepresented groups and first-generation college students" [15], like in prior years [11, 12, 13, 14, 15], makes them especially important as does their having been achieved with short-term immersive initiatives. The outcomes achieved suggest that IRAP and R2R can be valuable contributors toward preparing a well-trained and engaged STEM work force and that "other institutions and their students could benefit from similar processes being enacted" [15].

7. Recommendations and Generalization

The processes reported in this paper will be replicated through the TAMUS LSAMP project. It is, though, possible to replicate them, at least in part, at other institutions given detailed descriptions that already exist [11, 12, 13, 14, 15] and the addition of this paper. As has been suggested in prior considerations, institutions near a US border with Mexico or Canada or that have existing, strong international partnerships are well-positioned to establish similar two-week programming with immersive experiences "although identifying [willing] international partners and [meeting] administrative cost are potential limitations" [15].

It is possible to generalize from the findings, at least for institutions in the southwest United States, where TAMUS is located, and especially for those who are collaborating with partners in Central America. Multiple years of programming [11, 12, 13, 14, 15] with consistent results that also reflect findings of other parties [1, 2, 3, 4, 16, 17, 18] suggests that the patterns described are not isolated occurrences and the programming described is effective with students who identify with underrepresented groups and are first-generation college students, a common set of characteristics for students in the southwest United States where two-thirds of Hispanic-Serving Institutions are located. Offering these students opportunities like those described herein with the potential to see similar impacts could bolster student education and training at many of these institutions of higher education.

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