

International Research Exposure: Impact on Early-Career, Undergraduate Engineering Students

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Abstract: The Texas A&M University (TAMU) Louis Stokes Alliance for Minority Participation (TAMUS LSAMP) office provided funding to the Texas A&M University College of Engineering to support student participation in the Engineering Learning Community Introduction to Research (ELCIR) program. ELCIR is a two-week, study abroad, research program implemented in a learning community pattern. ELCIR has three purposes: (1) to expose sophomores to research, (2) to introduce students to cultural differences and global challenges, and (3) to provide students with the basic tools to prepare them for future research involvement. Participation is limited to first-generation college students and/or students from underrepresented populations. The external evaluator for the TAMU System LSAMP developed a survey for students to complete following their participation in the ELCIR international experience. Survey questions were designed to identify the impact of participation in ELCIR on students and gather participant suggestions for improvement of future LSAMP-supported international research experiences. The evaluator compiled information gathered from 91 LSAMP-supported participants during five years of ELCIR programming. This paper describes the participants' self-reports of experience with and continued interest in study abroad programming, interest in another similar experience, subsequent involvement with undergraduate research, and ELCIR's impact on their confidence regarding international travel, their awareness of, interest in, and plans regarding graduate school, their education and career plans, and interest in employment outside the United States. Increases in confidence regarding international travel and increases in interest in study abroad programming, in continued involvement with research, awareness and interest in graduate school, and willingness to consider employment outside the United States were found. Less than half of participants felt their ELCIR experience impacted their career plans and programming did not appear to have a pronounced immediate impact on student involvement with undergraduate research. The respondents reported concern about their ability to afford graduate study but that they felt their families would be supportive of plans to attend graduate school. No significant differences were found by gender, ethnicity, or race for any of the queries. These findings can inform engineering education programming for first-generation and minority students, an area of national need, at institutions across the United States.

Keywords: engineering, first-generation students, underrepresented minorities, study abroad, STEM

Introduction

The Texas A&M University System (TAMUS) received funding in fiscal year 2013 from the National Science Foundation (NSF) for the continuation of a Louis Stokes Alliance for Minority Participation (LSAMP) project entitled "Sustaining the Progress." The institutions participating in TAMUS LSAMP during the period under

consideration were Texas A&M University, Prairie View A&M University, and Texas A&M University – Corpus Christi. As part of LSAMP activities, the Texas A&M University project office provided funding to the Texas A&M University (TAMU) College of Engineering (COE) to support student participation in the Engineering Learning Community Introduction to Research (ELCIR) program. ELCIR is a two-week, study-abroad research program implemented in a learning community pattern. Ten days of international instruction are completed at the Anahuac Mayab University in Merida, Yucatan; a university that has a partnership with the TAMU COE and the Texas A&M Engineering Experiment Station. ELCIR has three purposes: (1) to expose students to research early in their academic careers, (2) to introduce students to cultural differences and global challenges, and (3) to provide students with the basic tools to prepare them for future research opportunities within TAMU’s College of Engineering research internship programs, especially study abroad internships. Participation is limited to first generation college students and/or students from underrepresented populations who are associated with the Access and Inclusion program in the College of Engineering. There have been 150 students, or more, who fit these qualifications in each year of the project.

The ELCIR Program engages students at the beginning of their engineering education in four sets of experiences: (1) a hands-on research class, allowing students to identify their own research problem with the support of faculty and researchers, (2) international travel and two-week residence outside the United States, (3) engagement with highly experienced researchers and well-known research centers, and (4) a poster presentation of their research proposal results to peers, faculty, and administrators. This combination includes six high impact practices: common intellectual pursuits, a learning community, collaborative assignments, undergraduate research, plus global and community-based learning (Association of American Colleges and Universities, n.d.). Another high impact category applies for many participants, a first-year experience, as the majority of ELCIR programming occurs across the spring and summer semesters of their freshman year culminating in the fall of their sophomore year.

The intention of ELCIR is “for underrepresented first generation ethnic minority students to be engaged in a research course” (Garcia et al., 2017, p.2). Participant selection is based on the student’s status as an underrepresented minority and/or as a first-generation college student, his/her grade point average and resume, and a response to a question about what s/he expects to gain from participating in the project. A letter of recommendation from a faculty member is also requested and considered as part of the participant application. In its first year (2015), ELCIR received applications from 55 students and was able to accept 17 as participants. In the second year (2016), 70 students applied for 30 slots. In 2017, the third year of the undertaking, 44 students applied and 25 were accepted followed by 80 applicants with 66 accepted in 2018 and 60 applicants with 36 accepted for 2019. The average acceptance rate was 56.3%.

The ELCIR program did not include course credit in 2015. However, a one-credit course, ENGR 291 – Engineering Learning Community Introduction to Research, was added in 2016 in response to a suggestion from the TAMU Dean of the COE. Inclusion of course credit has been maintained since that time. The initial course consisted of workshops regarding research, global competency, and travel preparation that were conducted with the ELCIR cohort in the spring of their freshman year. It has since been expanded to include more specificity in some areas and to accommodate several additional topics. These include “introduction of the ELCIR Program purpose and goals, introduction to research topics, introduction to LSAMP/NSF sponsored responsibilities, research and research abroad expectations, [a] seminar on cultural competency, expectations [regarding] living with host families, [and] traveling/departure official documents” (Garcia et al., 2017, p. 3).

The two-week international experience is a trip to Merida, Mexico where participants attend an introduction to research seminar (two hours per day), make visits to research sites and participate in research expeditions, receive hands-on experience in research labs, conduct their own research, visit cultural sites, and participate in cultural learning activities. The research course in the summer experience has been taught by “Dr. Medina-Cetina and the vice president for research of Universidad Marista” (Garcia et al., 2017, p. 4). Zenon Medina-Cetina is an Associate Professor of Civil Engineering at TAMU. Participants can select from a group of topic areas in which to conduct research. These are “energy, coastal dynamics, logistics, aquifers and early warning system[s]” (Garcia et al., 2017, p. 2) which were chosen because faculty from TAMU collaborate with researchers in Yucatan in these areas.

Upon return to the United States, participants complete research reports and create research posters based on their investigations in Merida, Mexico. An online community is maintained as part of the project and used as a

resource for exchanging materials, offering guidance, and then providing critiques when students are developing their research papers and presentations. Research posters are presented at TAMU COE in September each year.

The West Texas Office of Evaluation and Research (WTER), the TAMUS LSAMP external evaluators, developed a survey for LSAMP-funded students to complete after their participation in the ELCIR international experience. Survey questions were designed to identify the impact participation in the research experience had on students and to gather participant suggestions for improvement of future LSAMP-supported international research experiences. Following five years of ELCIR programming, WTER compiled information gathered from the participants. This paper describes participant self-reports of interest in similar experiences, the impact of ELCIR on personal confidence, and regarding educational and career plans. These findings come from survey responses gathered from the 91 of 115 participants in five distinct cohorts (79.1% response rate).

Pertinent Literature

First-Generation Students

The ELCIR project exists to prepare underrepresented minority and/or first-generation college students for international research experience during their first year in college and to facilitate that experience in the summer between students' freshman and sophomore years. As such, literature regarding the characteristics of and best practices for first-generation students is reviewed here.

In 2000, Thayer wrote "The dimensions of under-representation of students from low income, first generation, and ethnically diverse backgrounds in colleges and universities are still enormous" (p. 3). Unfortunately, this remains the case as "low-income and first-generation students are still less likely to go to college than their more privileged peers" (Engle & Tinto, 2008, p. 5). While the enrollment rate for these students doubled in the 30 years between 1975 and 2005, it still lags behind college-going high-income students (54% compared to 81%) (Engle & Tinto). And first-generation students who reach college do not fare as well as their peers. A US Department of Education study in 1988 found "first generation students persisted and attained credentials at lower rates in both four-year institutions and two-year public institutions" (Thayer, 2000, p. 5). This was also reported by Ishitani in 2006 and again by Pratt, Harwood, Cavazos, and Ditzfeld in 2017. Even when controlled for mitigating factors, first-generation status "still had a negative effect on educational attainment" (Thayer, p.5) at every type of institution of higher education. First-generation students obtain bachelor's degrees in six years at rates lower than students with at least one parent who attended college (Engle and Tinto, 2008). When considered as an aggregate of all institutions, the graduation rates are 11% for students who are both first-generation and from low-income families, 26% for students who are either first-generation or low-income, and 55% for their peers who do not have these characteristics.

First-generation college students have been and remain less likely to be academically prepared for college (Thayer, 2000; Atherton, 2014; Mangan, 2017) and more likely to discontinue study in college (Choy, 2001; Engle and Tinto, 2008), often in their first year (Choy, 2001; Ishitani, 2006; Pratt, Harwood, Cavazos & Ditzfeld, 2017). They are more likely to be from low-income households, to be racial minorities (Lee, et al., 2007; Atherton, 2014; Zinshsteyn, 2016), and to attend college part time (Hsiao, 1992; Choy, 2001; Tym et al., 2004). First-generation students are also less likely to participate in on-campus social groups and academic support programming (Tym et al., 2004; Choitz & Reimherr, 2013; Pratt, Harwood, Cavazos & Ditzfeld, 2017) and more likely to work while in school (Lang, 2015; Mangan, 2017; Sanacore and Palumbo, 2015).

The families of these students may question the need to attend college (Thayer, 2000; Tym et al., 2004) and are unable to provide guidance regarding college-going processes or advice about academic and practical concerns in the college environment (Swecker et al., 2013; Mangan, 2017). "Although families may offer encouragement and financial support, their inability to understandably relate to the college experience creates a unique and difficult situation for some students" (Longwell-Grice et al., 2016, p. 41). This is manifested as limited cultural and social capital (Tym, et al., 2004; Atherton, 2014; Lang, 2015) and can result in a sense of discomfort, isolation, or feeling that one does not belong in college (Atherton, 2014; Longwell-Grice et al., 2016). As reported by Longwell-Grice, students experienced "a type of cultural dislocation and referred to feeling lost and at times marginalized... 'I feel like there's [sic] unwritten rules of a culture and it takes a while to really adapt to them, and I feel like even now I haven't really caught all of 'em'" (2016, p. 37). A program director at Boston

University who was a first-generation undergraduate and graduate student stated for an interview in the Chronicle of Higher Education:

I think I'll always feel like a first-generation student, even though I've now been part of academia for over a decade. There are still components that seem very new to me or that I don't understand. I don't know if it ever leaves you, the feeling that the system wasn't necessarily set up for you (Zamudio-Suarez, 2016, p. 13).

This can be exacerbated by well-intentioned faculty and staff whose communication can include unintended biases (Lee, 2016), who assume students understand the culture of higher education (Lee, 2016), that students' values align with the expectations of the system (Johnson, 2016). It is, in fact, possible for "first-generation students [to] get the message that they are not only less typical members of their college communities, but also less legitimate ones" (Lee, 2016, p. 30).

Researchers and student service professionals have sought means to address these circumstances. As noted by Thayer, "While it may be possible to improve retention rates by attending only to the selection process or only to the learning environment, the greatest gains will result from addressing both at once, and connecting the two processes together" (2000, p. 4). This will require, as Doubleday stated, institutionalization of "a commitment to first-generation students" (2013, p. 20) in the form of a truly nurturing environment (Sanacore and Palumbo, 2015). As two administrators said separately to Zinshsteyn (2016) and Mangan (2017), the concern should be whether "the university [is] ready for the student" (p. 4 and p. 7, respectively). The following practices are advocated as reflecting this orientation and being efficacious in respect to first-generation students.

1. Establishing a means of purposefully identifying, recruiting, and tracking first-generation students (Doubleday, 2013).
2. Proactive use of information to assist students (Zinshsteyn, 2016; Sanacore & Palumbo, 2015).
3. Bringing first-generation students to campus early for introductions, orientation, and support programming (Gullatt & Jan, 2003; Doubleday, 2013).
4. Creating a first-year student program for first-generation students (Tym et al., 2004).
5. Focusing on the "distinctive features of first-generation students" (Doubleday, 2013, p. 20) in order to "use the backgrounds of incoming students to support their [development of] 'cultural capital'" (Sanacore & Palumbo, 2015, p. 26) necessary to navigate higher education.
6. Nurturing first-generation students "through a consistent and cohesive support system" (Sanacore & Palumbo, 2015, p. 26) that includes "a variety of programs that meet students' continuing needs" (Doubleday, 2013, p. 20).
7. Working through a system of relationships...
 - a. ...in and through careful monitoring of students and proactive advising (Swecker et al., 2013; Zinshsteyn, 2016; Sanacore & Palumbo, 2015).
 - b. ...through mentoring (Doubleday, 2013), internships, and other forms of interaction with faculty (Longwell-Grice et al., 2016).
 - c. ...through peer group cohorts or networks (Tym et al., 2004; Longwell-Grice et al., 2016) including learning communities (Engle and Tinto, 2008).
8. Focusing on building community and promoting engagement while maintaining fun (Doubleday, 2013).
9. Providing practical assistance by...
 - d. ...guiding "students to register for courses that reflect a balance of their abilities" (Sanacore & Palumbo, 2015, p. 26) and that are "rigorous...with clear goals [and that] that offer students readily accessible and adequate support" (Sanacore & Palumbo, 2015, p. 26).
 - e. ...emphasizing "to students how crucial it is to attend class" (Sanacore & Palumbo, 2015, p. 26).
 - f. ...organizing panel presentations such as "juniors and seniors from different backgrounds to discuss how they adapted to college life... [and] pursued resources and people to help guide them in decisions" (Sanacore & Palumbo, 2015, p. 26).
 - g. ...supporting writing skill development through modeling, one-on-one or small group practice and feedback, and commenting on drafts of students' written assignments prior to submission (Sanacore & Palumbo, 2015).
10. ...working to "acknowledge, and ease when possible, financial pressures" (Doubleday, 2013, p. 20).
11. "Keeping track of your success and failures" (Doubleday, 2013, p. 20) and seeking to learn from them.

12. Involving the families of first-generation students but doing so with realistic expectations (Doubleday, 2013).

International Experiences for Undergraduates Studying Engineering

“A study conducted by three researchers with the Center for International Business Education and Research found that almost 40% of U.S. companies surveyed missed international business opportunities because of a lack of internationally competent personnel” (Garcia et al., 2017, p. 1). Conversely, Fortune 500 companies and the Carnegie Foundation, have stated that engineers of the 21st century will spend appreciable portions of their careers in environments rich with global connections (Borri et al., 2007). This is the case as “95% of consumers live outside of the United States” (Daniel et al., 2014 as cited by Garcia et al., 2017, p.1). To function in such a setting, engineers need to have a global mindset and be prepared for the global job market (Chan & Fishbein, 2009). In light of these facts, “engineering colleges must develop strategies that provide global perspectives and international experiences to help their students prepare for the current engineering work place and responsibilities” (Borri et al., 2007). “Research abroad, internship abroad, and study abroad, are some of the ways universities have found to provide a global perspective to students” (Garcia et al., 2017, p.1). However, there is very little extant literature regarding study abroad programs for first-generation and minority students (Chang, 2017). In preparation for this discussion, no articles were found about study abroad programming with first-generation and minority students that had a focus on engineering other than Garcia, Alves, Pariyothorn, Myint, and Hardman (2017) which also discusses the TAMU ELCIR program.

Undergraduate Research in Engineering while Studying Abroad

Undergraduate research (UR) is broadly accepted as an advantageous means of educating students in science, technology, engineering, and mathematics (STEM) including students from underrepresented groups (Hernandez et al., 2013; Carpi et al., 2017). It is supported as a modality in federal grants funded by the US Department of Education, the National Science Foundation, and the United States Department of Agriculture and is increasingly common in the field of Engineering (Berger & Bailey, 2013).

Authors like Coker and Porter (2016) have considered study abroad as one of a set of experiential education options at American universities. Others, like Chang (2017), have considered impacts of study abroad experiences for specific subsets of American university students. Yet, a limited number of publications exist describing study abroad programming based in research experiences specific to engineering students.

Parkinson (2007) completed a review of the types of study abroad programs available to engineering students and generated categorical labels. He found eight varieties and his label for the pattern practiced in ELCIR is research abroad. A small count of articles exists describing “research abroad” initiatives for engineering students. For example, Dibiasio and Mello (2004) report on outcomes for students in a program at the Worcester Polytechnic Institute. They describe a variety of outcomes, including those relevant to accreditation, and found that post-participation the students “satisfy our important educational objectives at higher performance levels than non-participants” (p. 250). Olson and Lalley (2012) describe a “short-term study abroad program for business and engineering students at the end of their freshman year” (p. 325), a pattern similar to ELCIR. The authors report on participant continuation with study abroad and language study and former participants’ interaction with international students and activities. Yet, neither focuses on minority or first-generation college students. Only Garcia, Alves, Pariyothorn, Myint, and Hardman (2017), which also discusses the TAMU ELCIR program, isolates information specific to minority and first-generation engineering students engaged in completing research in a sort-term international experience. Thus, very little is known about the impact of international research experiences on minority and first-generation college students who are study engineering.

Literature Describing the ELCIR Project

Analysis of ELCIR outcomes has been published by Garcia, Alves, Pariyothorn, Myint, and Hardman (2017) with the American Society for Engineering Education. They conducted a mixed methods investigation using pre- and post-participation surveys with the 2015 and 2016 ELCIR cohorts. They showed ELCIR participation yielded “positive results related to students’ retention...desire to do research and/or pursue further higher

education, and global competency development” (p. 4). They “also observed an improvement [in]...GPA and retention” (p. 4). These outcomes parallel some of the measures taken in the ELCIR project evaluation survey but do not cover all the concepts students addressed in the post-participation survey upon which this article’s material is based. Garcia, Alves, Pariyothorn, Myint, and Hardman’s (2017) data is also limited to two cohorts while this article addresses data from five annual cohorts.

The information presented herein will address a gap in the literature. There is limited extant information related to study abroad by minority and first-generation engineering students. None found by the authors, with the exception of Garcia, Alves, Pariyothorn, Myint, and Hardman (2017) which also considers ELCIR, includes students in these categories conducting undergraduate research in an international setting. Thus, this discussion of five years of material from the TAMU ELCIR project supplies material new to the literature regarding study abroad experiences and provides the basis for further investigation of the impacts international research experiences have on specific subsets of undergraduate engineering students.

Research Focus and Questions

The survey administered included questions about the impact the study abroad and research program had on participants’ interest in similar experiences, on their personal confidence, and regarding their educational and career plans. The research questions investigated were: Does participation in a two-week, study abroad program which focuses on improving understanding of engineering research while providing research and cultural experiences impact:

1. Participant interest in other international experiences?
2. Confidence about international travel?
3. Interest in graduate school?
4. Career choice?

And, is there a difference in impact based on gender, ethnicity, or race?

Method

The ELCIR experience involves, as described above, preparatory workshops in the spring, a two-week study abroad program, an online learning community following the study abroad experience, and summary of research results including an individual poster presentation. Near the end of fall semester, the project team asks each of the participants from the previous summer’s cohort to complete an IRB-approved survey. The post-participation survey had 18 closed-ended questions that employed five-point Likert scales and four open-ended, short answer questions. There are also four demographic questions: year in school, gender, ethnicity, and race. Four of the closed-ended questions, two sets of two questions, were retrospective pre- and post-participation queries in which the students relayed recollection of their understanding prior to participation and their assessment of their post-participation understanding. These retrospective question sets were used to gather information about student awareness of and interest in graduate school. The 2015 survey was administered online using the Qualtrics platform. The surveys were administered in physical form in 2016 through 2019, to increase response rate, and then mailed to WTER for data analysis and reporting. One hundred and fifteen students participated in ELCIR during the four years under consideration. Of these, 91 completed anonymous post-participation surveys, a 79.1% response rate. This is within the 95% confidence level at a 5% margin of error.

WTER utilized descriptive and inferential statistics with the quantitative data and open and axial coding (Kolb, 2012) with the qualitative data to analyze the survey responses. No pre-participation data was gathered making comparison with pre-participation understanding and perspective impossible for all but two queries. Only the two retrospective queries facilitated pre- and post-participation comparison. A control group was not defined therefore comparisons to non-participants could not be made.

The material that follows describes responses from the post-participation survey completed by five different sets of participants following ELCIR participation in the summers of 2015 to 2019. None of the students repeated the experience resulting in 91 unique individuals completing the survey in the five-year period.

Description of Respondents

Demographics

All the students had an interest in engineering and had been recruited from the TAMU College of Engineering Regents' Scholars program for first-generation college students. While envisioned as a program for students transitioning from freshman to sophomore year, there were several older students in the respondent pool. Of the 91 respondents, 80 classified themselves as sophomores (87.9%), one was a freshman (1.1%), eight were juniors (8.8%), and one was a senior (1.1%). One additional participant did not provide an answer to this question on the survey (1.1%). Most of the older students, six of the nine, participated in 2019 (five juniors and one senior). The remainders were three juniors, two in 2018 and one in 2015. Since ELCIR recruiting, orientation, and initial programming takes place in the spring of the academic year, the international experience occurs in the summer, and the summarizing programming occurs in the fall, the survey respondents who were freshman and sophomores, 89.0% of the total group, would have freshmen upon entry into the program.

There were 44 females 45 males, almost an exact 50/50 split between females and males, and two persons who did not specify a gender in the sample (Table 1). This represents a slight shift toward females when compared to the overall cohort. The ethnic identity of the survey respondents was similar to that of the overall cohort, the majority of the respondents (89.0%) identified as Hispanic, which shows there was a slight oversampling of non-Hispanics.

Table 1. Comparison of Cohort and Sample Demographics

| Characteristic | Cohort | | Sample | | |
|---------------------------------|------------------|--------------|---------------------------|--------------------------------|-----------|
| | Female | Male | Female | Male | No Answer |
| Gender | 50 | 65 | 44 | 45 | 2 |
| Ethnicity | Hispanic | Non-Hispanic | Hispanic | Non-Hispanic | No Answer |
| | 107 | 8 | 82 | 8 | 1 |
| Race (distribution in cohort)* | African-American | Asian | Hawaiian/ Pacific Isl. | Native Amer./ Alaska Native | White |
| | 5 | 1 | 1 | 17 | 83 |
| Race (distribution in sample)** | 7 | - | - | 6 | 69 |

* Twelve students did not respond to this question. ** There were also seven responses of Other, four individuals who did not respond, two students who selected two races, and one who wrote in "Mexican."

The distribution across races was similar but with a slight variation between the entire cohort and the sample for African Americans and a moderate variation for Native American/Alaska Native. The majority of the cohort and the survey respondents were Hispanic, 93.0% and 89.0%, and identified as White, 77.6% and 77.5% respectively. Overall, the sample parallels the cohort with limited variation which was most pronounced in proportion of females to males, 5% more females in the sample, and in respect to underrepresentation of persons identifying as Native Americans/Alaska Natives.

International Travel Experience and Prior Study Abroad Experience

Students were asked to respond to a set of prompts about their international travel and study abroad experience. Forty-one had no prior experience with international travel. Forty-seven had traveled internationally. Three noted prior study abroad experience. They were two sophomores and a junior who were all female Hispanics who identified as White. This was a small enough group and there was sufficient variation in the responses from them to other queries to prevent bias in the survey findings resulting from prior experience in study abroad programming.

Results

Propensity to Engage in Undergraduate Research

Participants were asked in two ways whether the ELCIR experience encouraged an interest in continuing involvement with research. One question asked about interest in another international research experience and the second about the impact the ELCIR experience had on interest in continued involvement with research. Responses to both questions were positive. In respect to another experience like ELCIR, 87 of the 91 respondents either agreed or strongly agreed. There was one student, a female junior whose ethnic identity was Hispanic and racial identity was White, who submitted a response of Strongly Disagree. However, this was an outlier value as no other student submitted a response lower than Neither Agree or Disagree and all the other upper level students submitted responses of Strongly Agree. There were no significant differences, in fact there was little difference at all between responses when disaggregated and compared by gender, ethnicity, and race.

Table 2. Interest in Another Study Abroad Opportunity and Continuing Research Involvement*

| Survey Statement | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|--|-------------------|----------|---------------------------|-------|----------------|
| I would like to participate in another international research experience like this one supported by LSAMP. | 1 | 0 | 3 | 20 | 66 |
| My LSAMP international research experience made me want to continue my involvement in research. | 1 | 1 | 11 | 40 | 37 |

* Responses do not total 91 as one student did not answer these survey questions.

This response pattern was supported by the qualitative comments gathered from participants many of which noted appreciation for the experience, change of perspective, and hope that ELCIR will persist so that others might have the opportunity to participate. Students felt that ELCIR participation “enhanced...global competence, and it allowed me to see things as a bigger picture.” This was accomplished by “expanding...cultural awareness,” encountering “perspectives from different people with different experiences,” learning about self (“I learned a lot about myself and my ability to adapt to an unfamiliar environment”), forming new understandings like a “culture of sustainable thinking...Always practicing ‘green’” or “understanding of how the US and Mexico are connected and interdependent,” facilitating ethnic and cultural connections (“connect with the roots of my ethnicity;” “where my parents are from;” “learned about Mexican culture”), and learning regarding the field of engineering (“how engineers work towards solving issues of ocean erosion in relation to Mexico and issues faced elsewhere around the world;” “learn more about what is going on in other parts of the world in regards to both culture and academics;” “even in developing countries there are great strides toward making discoveries and useful applications with a means of research”). As one of the purposes of the ELCIR project is to prepare students for research internships, especially in international settings, these are very positive outcomes.

The impact on interest in continuing with research is strong and positive but with Agree as the median score rather than Strongly Agree and two students submitting negative responses (Table 2). The answer of Strongly Disagree came from the same student who strongly disagreed with desiring another similar experience. Like with the preceding question, there were no statistically significant differences between groups when the responses were disaggregated by gender, ethnicity, and race although the responses were less favorable and included some disagreement.

The final question regarding propensity to engage in research asked whether the student had participated in another undergraduate research (UR) undertaking in the time between their summer experience and the administration of the survey in the late fall. The n for this query was 81 persons as it was not asked in 2015. Sixty-six of the respondents had not become involved in another UR project while 15 of them did including the young woman who strongly disagreed with interest in another international research experience and that ELCIR impacted her interest in continuing with research endeavors. Apparently, she had a less than positive experience in the Yucatan but even that did not dampen her interest in research. It should also be noted that ELCIR programming extends into the fall, a factor that has the potential to dampen interest in another UR undertaking. ELCIR participants have project summaries to prepare at the beginning of the fall semester and are mentored in

research poster preparation. This culminates in a poster presentation by each student on the campus of TAMU during the fall semester. The continuing involvement with ELCIR could dampen immediate interest in a second commitment to UR in the fall.

Participant testimony, which was consistent across gender, ethnicity, and race, was that ELCIR elicits interest in another similar experience, impacts, but at a slightly lower level, desire to have a continuing involvement with research, and did not appear to have a pronounced immediate impact on student involvement with undergraduate research. The final statement must, however, be taken in context. The students had a continuing commitment to ELCIR activity in the fall. Fifteen of 81 respondents indicated they did add a UR commitment in that time period. That is 18.5% of the respondents which is only slightly lower than the average for the entire engineering student pool at TAMU. Approximately 25% of TAMU engineering students participate in UR prior to graduation (Garcia et al., 2017). No source indicating when the majority of them initiate this process was available but having 18.5% begin in the fall of their sophomore year while completing summer research programming is a strong response when the overall average is 25% during a four-year degree program.

Confidence in Travel Abroad

ELCIR participation appears to increase participant confidence regarding travel outside the United States. Eighty-seven of 90 students who responded selected Agree or Strongly Agree when asked whether their ELCIR experience had increased their confidence in traveling abroad. Two students selected Neither Agree or Disagree and one did not reply to this question (Table 3). With such a large percentage of the respondents providing a positive response, there were no significant differences found when responses were disaggregated by gender, ethnicity, or race.

Table 3. Impact on Confidence in International Travel*

| Survey Statement | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|-------------------|----------|---------------------------|-------|----------------|
| The LSAMP international research experience increased my confidence in my ability to travel abroad. | 1 | 0 | 2 | 20 | 67 |

* Responses do not total 91 as one student did not answer this survey question.

The one student who submitted the response Strongly Disagree was the same person who submitted that response in respect to interest in another international experience like ELCIR and whether participation in ELCIR had impacted her interest in continuing to have an involvement with research. This pattern and the divergence of these responses from those of the rest of the cohort confirms that the individual's experience during the program and therefore, her perspective, was an outlier.

Graduate School

The evaluation survey asked about student awareness of and interest in graduate school, their plans for graduate school, their perspective regarding the affordability of graduate school, and the likelihood that their family would be supportive should they decide to attend graduate school. A related question was the highest degree a student intended to obtain.

Awareness of, Interest in and Plans to Attend Graduate School

Of the survey questions concerning graduate school, two were retrospective queries which asked students to compare their present perspective with what had been their perspective prior to participating in the ELCIR programming. The first of the retrospective questions asked about awareness of graduate school and the second about interest in attending graduate school. Responses were solicited on a customized five-point scale. The possible responses were, listed from lowest to highest, "Never heard anything about graduate school," "Only had a little information about graduate School," "Had some basic knowledge about graduate school," "Had

some understanding of graduate school,” and “Had a good understanding of graduate school.” Only four years of data is available for this question as it was added to the survey in 2016.

The response pattern for the awareness of graduate school prior to program participation was an almost perfect bell curve with 36 responses at the midpoint, “Had some basic knowledge about...,” and a nearly evenly balanced response pattern around it (Table 4). There were 19 and 16 responses each for “Only had a little information about...” and “Had some understanding of...,” four responses of “Never heard anything about...” and six for “Had good understanding of...” The responses skewed strongly in a positive direction following ELCIR programming with the median value moving up one category, 80.2% of responses occurring in the top two categories, no responses in the lowest category (“Never heard anything about...”), and only one response of “Only had a little information about...”

Table 4. Students’ Awareness of Graduate School Before and After Participation in LSAMP-Supported International Research Experience

| | Never heard anything about grad school | Only had a little information about grad school | Had some basic knowledge about grad school | Had some understanding of grad school | Had good understanding of grad school |
|--|---|--|---|--|--|
| Before their LSAMP international research experience* | 4 | 19 | 36 | 16 | 6 |
| After my LSAMP international research experience* | 0 | 1 | 15 | 34 | 31 |

* n = 81 as this question was not asked in 2015.

A query regarding interest in graduate school, also added in 2016, demonstrated a pattern similar to awareness of graduate school. Answers skewed positive toward interest in graduate school post-ELCIR (Table 5). Prior to ELCIR participation, three students had “Never heard anything about graduate school” while 29 were “Not at all interested in graduate school.” The remainder of the students, 49 in total, were split 30 “A little interested,” 12 “Interested,” and seven “Very interested in graduate school.” Following the international research experience, all students had heard about graduate school and only six were “Not at all interested...” in graduate school, a reduction by 28.4 percentage points. The remaining 75 were “A little interested” (n=22), “Interested” (n=29), or “Very interested” (n=24) which represent increases of 125% for interested and nearly 250% for very interested. The customized scale and specifically the unknown value difference between “Never heard anything about...” and “Not at all interested...” made conversion of the responses to numeric values and statistical analysis of difference between the means impossible.

Table 5. Students’ Interest in Graduate School Before and After Participation in LSAMP-Supported International Research Experience

| | Never heard anything about grad school | Not at all interested in grad school | A little interested in grad school | Interested in grad school | Very interested in grad school |
|---|---|---|---|----------------------------------|---------------------------------------|
| Before their LSAMP international research experience | 3 | 29 | 30 | 12 | 7 |
| After their LSAMP international research experience | 0 | 6 | 22 | 29 | 24 |

* n = 81 as this question was not asked in 2015.

Another survey question added for the 2016 summer experience and used following it asked whether the students would be attending graduate school. The prompt for the question was “Which of the following best describes your plans regarding graduate school?” There were six possible answers on an idiosyncratic scale: (1) “Not go,” (2) “Might go,” (3) “Probably will go,” (4) “Go right after graduation,” (5) “Go at some time in the

future,” and (6) “Other” which, when elected, was followed by a text box in which the respondent was asked to describe the pattern they anticipated. Six students responded they were “Not at all interested in graduate school” following ELCIR (Table 5) and seven indicated that they would not go to graduate school (Table 6). All seven had answered they were “Not at all interested in graduate school” prior to participating in ELCIR. Four submitted that description to characterize their interest following their ELCIR experience and three said they were “A little interested in graduate school.”

Table 6. Students’ Plans for Graduate School

| Not Go | Might Go | Probably Will Go | Go Right After Graduation | Go At Some Time in Future |
|--------|----------|------------------|---------------------------|---------------------------|
| 7 | 26 | 13 | 22 | 13 |

* n = 81 as this question was not asked in 2015.

The student who submitted the Strongly Disagree responses noted in Tables 2 and 3 was not a part of this group. She intended to “Go right after graduation.” A total of 91.4% of the participants felt that they might, probably would, or would go to graduate school and 43.2% stated they would go immediately after graduation or at some time in the future. When disaggregated by gender, ethnicity, and race, there was no indication of differences in response patterns. For example, the seven students identifying as African-American/Black reported they fit in four different categories. The programming and experiences in the ELCIR project appear to increase interest in attending graduate school for students (Table 5). This is confirmed by the pattern of change in the responses (Tables 5 and 7). Only a small percentage of the students, 7.4%, entered the program “Not at all interested in graduate school” and maintained that stance. All the other students persisted at their existing level of interest or became more interested and none of the students had their level of interest decrease.

Table 7. Shift in Responses Regarding Interest in Graduate School

| Prompt | Same Response | Moved Up One Category | Moved Up Two Categories | Moved Up Three Categories |
|--|---------------|-----------------------|-------------------------|---------------------------|
| Never heard anything about graduate school | - | - | 2 | 1 |
| Not at all interested in graduate school | 6 | 16 | 5 | 2 |
| A little interested in graduate school | 4 | 18 | 8 | - |
| Interest in graduate school | 5 | 7 | - | - |
| Very interested in graduate school | 7 | - | - | - |

* n = 81 as this question was not asked in 2015.

Affordability of Graduate School and Likelihood of Family Support When Attending

The students participating in ELCIR were asked about the affordability of graduate school and whether their family would be in favor of their attending. Their responses show similar patterns (Table 8) with the median and peak responses for both being Agree although the first question was worded in the negative.

Table 8. Affordability of Graduate School and Likelihood of Family Support

| Survey Statement | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|-------------------|----------|---------------------------|-------|----------------|
| I would like to go to grad school, but I just don’t see how I can afford it.* | 2 | 7 | 23 | 34 | 24 |
| My family would be supportive of my going to grad school.* | 3 | 3 | 9 | 39 | 36 |

* n = 90 as one student did not answer this question.

For this group of students, 93.3% of whom are at least a little interested in graduate school, the concern about affording that interest exists but is paralleled by slightly stronger certainty that their family would be supportive of them attending graduate school. Like has been the case with all other queries, there were no statistically significant differences in the responses between groups when disaggregated by gender, ethnicity, or race.

Highest Degree Planning to Seek

The ELCIR participants were asked about the highest degree they planned to pursue. The question stem was “Which of the following best describes the highest degree you plan to obtain?” Responses possible were: (1) bachelor’s degree, (2) master’s degree, (3) PhD, and (4) other professional degree (MD, LL, etc.) (Table 9). The responses were slightly misaligned with the expressed interest in graduate school, intention to attend graduate school, and family support for attending graduate school (Tables 5, 6, and 7). Twenty-two students indicated that they would stop study upon completion of a bachelor’s degree (Table 9) while only seven, 8.6%, indicated they would not go to graduate school (Table 6). This difference may be related to the 13 students who indicated they would attend graduate school in the future (Table 6). They might have responded based on their intention to pause between undergraduate and graduate degree study. It might also be a product of the youth of the respondents and a recent shift in perspective. It is possible that an increase in interest experienced in the preceding months had not yet caused some of the mostly early-career students to modify the specifics of their long-term educational plans.

Table 9. Highest Degree to be Sought

| Bachelor’s Degree | Master’s Degree | PhD | Other Professional Degree (MD, LL, etc.) |
|-------------------|-----------------|-----|--|
| 22 | 46 | 12 | 1 |

* n = 81 as this question was not asked in 2015.

Career Choice and Interest in Employment Outside the United States

ELCIR participants were asked whether they would “consider a job in another country” because of their experience in the ELCIR program. Only three students disagreed with this statement (Table 10) and one of the informants who strongly disagreed was the same party who strongly disagreed that she would like another international experience like ELCIR (Table 2), that participating had increased her interest in continuing in research (Table 2), and had increased her confidence in traveling abroad (Table 3). This is further indication that her experience may have been negatively impacted in some idiosyncratic manner. That 77.8% of the students agreed or strongly agreed is a positive result since engineering careers are increasingly “internationalized” (Borri et al, 2007; Chan & Fishbein, 2009).

Just under 50% of the students, 47 of 90 respondents, agreed that the “LSAMP international research experience helped in [their] career choice” (Table 10). While shifted in a positive direction, this was, understandably, the lowest level of impact for any of the areas queried. One short-term international research experience may not provide sufficient depth and breadth of exposure to information about career potentials and forms of professional engagement to influence students’ career goals.

Table 10. International Employment and Career Choice

| Survey Statement | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|--|-------------------|----------|---------------------------|-------|----------------|
| Because of my LSAMP international research experience, I would consider a job in another country.* | 1 | 2 | 17 | 23 | 47 |
| My LSAMP international research experience helped me in my career choice.* | 3 | 12 | 28 | 24 | 23 |

* n = 90 as one student did not answer this question.

Differences by Gender, Ethnicity, and Racial Identity

The sample was predominantly individuals who began participation in ELCIR in their freshman year and completed summer programming prior to their sophomore year of college (89.0%) and minorities (91.1%). Most of the participants and informants identified as Hispanic (93.0% and 89.0% respectively). The gender ratio among informants was 45 males to 44 females and two persons who did not provide a gender. To the extent possible, comparisons of response patterns, male to female or between ethnic and racial groups, were made. No significant differences in response patterns related to gender, ethnicity, or racial identity were noted.

Discussion

The LSAMP-funded ELCIR participants were first-generation college students who were predominantly minorities (93.0%). Finding means of encouraging students of this type to persist in college, to pursue and complete STEM degrees, and advance to graduate school is a significant concern in higher education (Thayer, 2000; Engle and Tinto, 2008; Mangan, 2017; Zinshsteyn, 2017). The outcomes realized in the ELCIR project suggest that UR projects that are encapsulated in a short-term study abroad program have the potential to impact persistence, STEM activity, and consideration of graduate school (Garcia et al., 2017). This may have been the case as the ELCIR project includes many of the best practices in programming for first-generation students noted above. Students become involved in ELCIR during their first academic year, are integrated into a cohort, hear from older students about their experiences, are provided close, personal guidance by faculty and staff, are mentored in research, writing, and presentation, receive scholarship funds (applied to travel), and are provided intellectually, socially, and culturally engaging opportunities that are all integrated as part of a “consistent and cohesive...system” (Sanacore and Palumbo, 2015, p. 26). Several of these are also noted as being high impact practices in higher education (American Association of Colleges and Universities, n.d.).

The ELCIR programming had a broad set of notable impacts beyond those reported by Garcia et al., (2017). This is summarized in the positive response received regarding participation in another experience like ELCIR. When coupled with statements participants made about areas of impact the project had, the value for undergraduates of study abroad programming that includes research is strongly evident. Students describe personal learning, improvement in cultural competency, expansion of perspective and understanding, opportunity to have experiences that will influence their thinking about their chosen discipline and in other areas, and forming connections to people and another culture. In the case of ELCIR, some of the Hispanic participants were able to connect with the culture of their parents or extended families. Confidence in one’s ability to travel abroad is, logically, a factor in student willingness to study abroad. That ELCIR showed marked increases for participants in this area is also a strong general benefit.

Student awareness of and interest in graduate school increased in the ELCIR cohorts. While the shift in awareness, and to some extent the shift in interest, can be attributed to the information sessions included in the programming, this should not be considered a simple artifact from distributing information. Students provided comments indicating that their perspectives were changed and horizons expanded through the international experience. It may be the simultaneous combination of providing information and related perspective-altering experiences that produced the strong response. There was a small inconsistency in reports regarding plans to attend graduate school and the highest degree to be obtained. This can be explained by two factors. Thirteen of the participants felt they would attend graduate school but would not go directly after completing their undergraduate degree. Second, the data shows attending graduate school involved the formation of a new intention for some of the students and strengthening of it for others. That a small group of early career undergraduates reported altered intent regarding the future but had not yet cognitively extended it to include next steps is plausible. Failing to transfer learning or intention from one area to another is common and the relative youth and inexperience of the respondent pool, sophomore first-generation college students, may have contributed to the inconsistency in response.

The responses regarding international employment and ELCIR impact on career choice may also reflect the youthfulness and inexperience of the informants. While 77.8% of the students said ELCIR participation increased their willingness to consider employment outside the United States, slightly less than 50% said ELCIR participation had helped them refine their career goals. These results may reflect the life stage of the informants. They were almost exclusively college sophomores. Students at that age may not have permanently settled on a

major and defined a set of career objectives. It is understandable that they would experience a sense of enthusiasm for a general concept without being able to apply it to the same degree in career planning.

The student respondents reported concern about their ability to afford graduate study but that they felt their families would be supportive of plans to attend (83.3%). The second characteristic stands in contrast to the common conception that families of first-generation and minority students are less supportive of pursuit of advanced degrees than their majority peers (Tym, McMillion, Barone & Webster, 2004; Longwell-Grice, Adsitt, Mullins & Serrata, 2016). While an isolated finding from a study with a small sample, this contrast is worthy of further study to determine whether it is site or population specific, represents a shift in perspective, or is an anomaly.

Conclusion

Overall, the programming pattern in the ELCIR project, as demonstrated by Garcia et al (2017) and in the findings from evaluation survey discussed above, had multiple positive impacts on STEM majors who, in this case, were also almost entirely from minority populations and all of whom were first-generation college students. While further and more detailed investigation is necessary for strong assertions of efficacy and generalizability to be made, the two investigations conducted suggest that UR programming encapsulated in a two-week study abroad program is an intervention worthy of consideration for increasing minority and first-generation college student persistence, success, and graduate school enrollment in engineering and, potentially, other STEM fields.

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