

Investigating the academic pathways and careers of
alumni of the IRIS Undergraduate Internship Program
(1998 – 2018)

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Executive Summary

Since 1998 the Incorporated Research Institutions for Seismology (IRIS) Undergraduate Internship Program has facilitated 8-10-week summer opportunities for 216 undergraduates to conduct seismological research and present their results at a professional conference. The goal of the program is to encourage more students, representing a more diverse population, to choose careers in Earth science. This evaluation focused on measuring the outcome, “Program alumni will seek geoscience careers.” The program defines success for this outcome as “at least 75% of alumni will attend graduate school in a geoscience field and/or work in a geoscience career.” Several key evaluation questions were developed, answered, and two key recommendations identified.

Question 1: To what degree do program alumni seek geoscience careers? 76.8% of respondents, who had completed their undergraduate degrees and are enrolled as a graduate student or employed full-time, are doing so in the geosciences.

Question 2: Do the academic pathways of alumni vary by population? Academic pathways traveled by male and female alumni are similar. However, differences between racial and ethnic groups exist. 14.5% of underrepresented minority (URM) respondents pursued a PhD directly after their bachelor’s degree, compared to 37.2% and 54.5% of majority and Asian respondents. Conversely, 19.0% of URM respondents did not attend graduate school compared to 9.1% and 0% of majority and Asian respondents.

Question 3: In what employment sectors are alumni employed? Responding alumni of the IRIS Undergraduate Internship Program are primarily employed in the geosciences (70.8%). While jobs spanned 18 different employment sectors, 51.0% report employment in the following three sectors; 4-Year Colleges and Universities (22.9%), Oil and Gas (15.6%), and the Federal Government (12.5%).

Question 4: Do employment sectors of alumni vary by population? Alumni employment sectors vary by race and ethnicity, and gender. URM respondents are primarily employed the Oil and Gas sector (33.3%); a rate double that of their majority respondents. Majority alumni are primarily employed in the 4-Year Colleges and Universities (25.0%) sector; a sector that employs only one URM respondent. The primary employment sector for both men and women is the 4-Year Colleges and Universities sector (24.4% and 21.6% respectively). However, few women are employed in the Federal Government (6.7%) and Research Institutes (2.2%) sectors compared to their male counterparts (17.6% and 11.8% respectively).

Question 5: How and to what degree has the program influenced participants’ academic/career trajectories? The program has a positive effect on participants’ academic/career trajectories. For example, nearly 80% of alumni reported that the program was either “Very influential” (50%) or “Influential” (29.8%) to their academics or careers. The most commonly reported influence was increases in knowledge and experience. The second most common influences were increases in interest in the research process and the field of geophysics broadly. Alumni also reported that the development of a social network within the geophysics community was also an important influence.

Recommendations:

- Enable current participants’ to make informed decisions, by making aggregate information about alumni academic pathways and careers of alumni available. Supplemental information about academic and career options in geophysics should also be generated or garnered from other organizations.
- Develop interventions to reduce or minimize differences in both academic pathways and employment between populations. Additional data should be collected about participants’ graduate school decisions, awareness of career possibilities, and any perceived barriers.

Introduction

Since 1998 the IRIS Undergraduate Internship Program has facilitated 8-10-week summer opportunities for 216 undergraduates to work with leaders in seismological research, conduct fieldwork using modern seismological equipment, and produce research products for presentation at a professional conference. This program capitalizes on the IRIS Consortium's distributed yet extensive resources and potential mentor pool, which are far more substantial than any individual institution could furnish. As a result, the program provides students with exposure to many of the broader aspects of the geosciences and research opportunities across the full spectrum of specialties within seismology, including interdisciplinary efforts. The goal of this program is to encourage more students, representing a more diverse population, to choose careers in Earth science.

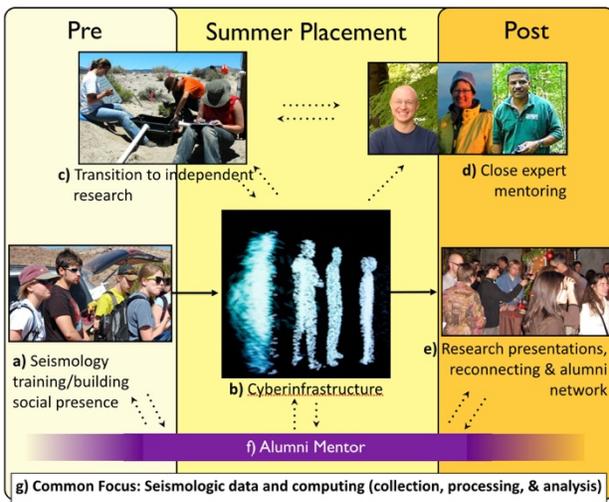


Figure 1: IRIS's distributed REU model. Solid lines indicate interns' pathway while the dashed lines indicate interactions between elements of the model.

IRIS's Research Experience for Undergraduate (REU) site operates as a distributed REU (Figure 1), where geographically dispersed interns are connected in supportive learning communities through the use of cyberinfrastructure while maintaining a close mentoring arrangement (Hubenthal & Judge, 2013). Key elements of this model include: a) An orientation where interns learn seismological and computing basics and share common experiences to establish a social presence and build the cohort; b) A cyberinfrastructure to nourish group cohesion and enable peer-learning and collaboration while at remote sites; c) A transition to independent research through carefully structured research experiences leveraging goal setting and self-reflection tools; d) Close faculty mentoring; e) Attendance at a professional conference to

present research results, reconnect, and integrate into the alumni network; f) An alumni mentor who provides experienced, consistent support throughout the entire process and beyond, and g) A common scientific focus emphasizing the acquisition and analysis of seismic data to help address broader Earth science questions. While less common than standard single location REU sites, distributed sites center around the close mentorship and collaborative learning that are essential features of undergraduate research (Lopatto, 2009; Hunter et al., 2006), and have been shown to result in outcomes comparable to those experienced by students in traditional in-person REU sites. These include both short-term outcomes such as a sense of community, scientific self-efficacy, scientific identity and scientific values alignment (Alford et al., 2017), and long-term involvement in the STEM career pipeline (Hubenthal & Judge, 2013).

The program has four primary outcomes measured as part of its programmatic evaluation, (Table 1). However, this evaluation is focused on measuring Outcome #3 which states that "Program alumni will seek geoscience careers." The program defines success for this outcome as "at least 75% of alumni will attend graduate school in a geoscience field and/or employment in a geoscience career." To measure this outcome and understand the results in context, several key evaluation questions were developed.

- 1) To what degree do program alumni seek geoscience careers?
- 2) Do the academic career paths of alumni vary by population?
- 3) In what employment sectors are alumni employed?

- 4) Do employment sectors of alumni vary by population?
- 5) How and to what degree has the program affected participant’s academic/career trajectories?

Table 1: Four outcomes used to measure the success of the IRIS Undergraduate Internship Program

Outcome	Evaluation	Success Metric
1. The internship program will attract a more diverse population	Applicants’ racial, ethnic and gender responses will be collected as part of the application process	The average percentage of applications from racial and ethnic minorities will comprise at least 15% of the applicant pool while the average percentage of female applicants will comprise 50% of the pool
2. The internship program will encourage a more diverse population	Survey of accepted interns measuring gender, race and ethnicity	Population of interns accepted to the program will average at least 20% of participants from communities traditionally underrepresented
3. Program alumni will seek geoscience careers	Long range tracking of the education and careers of alumni	75% of alumni will attend graduate school in a geoscience field and/or employment in geoscience careers
4. Interns will feel and demonstrate a beneficial connectedness	Perception data collected as part of the follow-up survey, and analysis of transcripts	80% of interns will agree or demonstrate they were connected in a beneficial way to the other interns

Based on surveys conducted prior to participation in the program, most interns come into the program already planning to attend graduate school. For example, interns, from 2010 to 2018 were asked what was the highest degree they expected to eventually attain. Indicative of a strong intention to attend graduate school, Doctoral (58%) and Master’s degrees (23.5%) were selected by a majority of participants. The remaining 18.5% of interns were undecided about what terminal degree they expected to attain. Many interns seem to see the program as a way to “test the waters” as 73.1% report the opportunity to see “if going to grad school in science” was for them. While many are planning on graduate school, few are set on seismology/geophysics as their career field. For example, when identifying reasons for participating in the IRIS internship program, the three most common reasons to participate were; “I wanted to do something different than what I had done before” (59%), “The research project(s) sounded interesting” (54%), and “I wanted to know if geophysics was for me” (47%) (Davey & Davis, 2018). Therefore, it seems that the program has the greatest opportunity to influence what field the students are likely to pursue post undergraduate graduation.

Methods

Data for this study was collected via an online survey consisting of 21 open and closed-ended items (Appendix A). These items covering the following general topics:

- Basic contact information
- Academic history
- Full-time employment information
- Any influence the program has had on educational/career trajectory
- Demographic information

This survey was administered via IRIS’s new Alumni Tracking System which minimizes respondent burden by piping responses, where applicable, from previous census efforts conducted in 2011 and 2014. Using existing contact information, alumni were sent a unique URL inviting them to participate in the study by updating their information. The survey was sent to 216 alumni in June of 2018. When unsuccessful, email

contact was supplemented with web/LinkedIn/Facebook searches and communication. This effort generated 169 responses from alumni (69.4%). To achieve a more complete picture of alumni career pathways, alumni-completed surveys were supplemented with surveys that were updated by IRIS staff. These staff-completed surveys were limited to alumni who met the following criteria. First, they must have completed the 2014 survey so information about the influence the program had their educational/career trajectory was available. Second, details about alumni's educational/career history had to be publicly available to allow IRIS staff to verify the accuracy of the information already in the database from the 2014 survey, and make updates as needed. This process produced 18 more completed surveys for a total of 187 completed surveys for a completion rate of 87.0% for the 2018 alumni census.

Data Analysis - Academic pathway data (e.g. degree attainment, date of completion) and employment information (e.g. type, position) were analyzed in R by tabulating the responses for all possible degree and employment statuses (boxes in Figure 2). Similarly, pathways between categories were mapped and the number of alumni who had followed each pathway were similarly tabulated. Filtering provided pathway information for sub-populations including Male/Female and Majority/Underrepresented Minority (Figure 3a & 3b). Alumni who do not identify as either binary category of gender were not included in the gender analysis as they comprise only 1% of the sample.

Two Likert-style items were used to measure, in retrospect, the degree of influence the alumni perceived the program had on their educational/career trajectory, and the effect the program had on their interest in the geosciences as a career. Descriptive statistics for each were calculated in R.

The ways in which the program influenced the alumni's educational/career trajectory were collected through an open-response item "Briefly describe ways the internship influenced your educational/career trajectory (both positive and negative)". These data were analyzed in two ways. First, a sentiment analysis of these responses (Figure 3b) was conducted. A sentiment analysis is a systematic effort to identify, extract, quantify, and study affective states and subjective information from text. Here, the polarity, or positive or negative nature of the response was analyzed in R using the package "sentimentr" with an unmodified dictionary (Rinker, 2019). This package examines each sentence in a block of text for valence shifters or polarized words that communicate a negative or positive attitude, as well as amplifiers (e.g., "I *really* like it.", de-amplifiers (e.g., "I *hardly* like it."), and adversative conjunctions (e.g., "I like it *but* it's not worth it.") that assist in the conveyance of attitude. Then it assigns a value from -1 to 1 to each. Individual sentence scores are summed and an average score for the text block is calculated based on the number of sentences in the block.

The ways in which the program exerted influence on the alumni's educational/career trajectory were determined through coding of this open-response item. An initial deductive coding pass was made using codes from existing literature on undergraduate research opportunities (Gentile, et al., 2017) and frameworks for evaluating programmatic impacts on participants (e.g. Allen, 2008). Subsequent coding passes revised the original structure and accommodated emergent themes.

The employment of alumni employed full-time was initially coded into three primary categories which included the following; "Non-Science", "Geoscience", and "Science, Technology, Engineering, or Math (STEM) (other than the geosciences)." Assignments were based on manual web searches of the employer to determine the type of service provided by the employer. This was then used in combination with position information provided by alumni to provide the coding. Each alumni's employment also received a secondary, more detailed, employment code based on a list of major sectors used by the American Geosciences Institute (AGI) (Wilson, 2018). AGI's list is primarily derived from the 2017 North American

Industry Classification System (U.S. Census Bureau, 2017). However, key sectors for the geosciences were broken out for emphasis and clarity.

Results

Academic Pathways – The results reveal that alumni follow several primary pathways through the academic system and on to a career. The most common post-bachelor’s pathways(Figure 2) is to a Master’s degree program (51.2%). The second most commonly pursued pathway post-bachelor’s is to transition directly into a PhD program (35.4%). Only 9.8% transition directly from their bachelor’s to the workforce. Ultimately, 76.8% of respondents, who completed their undergraduate degrees and are enrolled as a graduate student or employed full-time, are doing so in the geosciences. An additional, 18.0% are pursuing advanced degrees or are employed full-time in some other non-geoscience but (STEM) field. Only 5.2% of alumni report having left the geosciences and STEM altogether. At the time of the survey 9 students were neither employed full-time nor enrolled as a student post-bachelors. Since the survey was conducted in June, these are primarily students who have recently graduated and not yet moved on to the next stage of their academic or career pathway. For example, 5 of 9 students had recently received an advanced degree in the geosciences and 2 others had recently completed their bachelor’s degree.

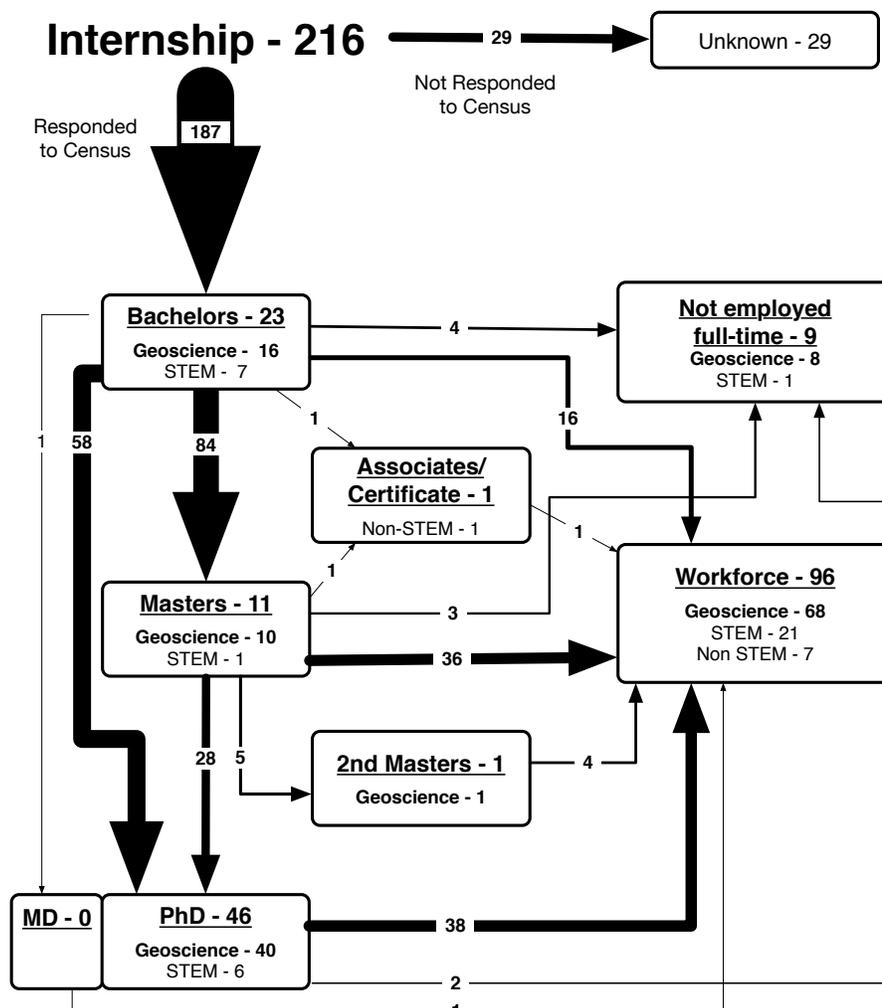


Figure 2 – Alumni career paths post IRIS internship. Arrows are labeled with the number of interns who completed that pathway and are scaled accordingly. Boxes indicate a snapshot of the number of interns that are in that stage of their career as of the time of the survey. For example, 23 alumni are still completing their bachelors, 58 alumni completed undergraduate degrees and enrolled directly into a PhD program, and 36 alumni have completed Master’s degree and entered the workforce).

Pathway data was also disaggregated by demographic information to investigate variability between populations. As illustrated in Figure 3a primary academic pathway differences between men and women

are generally small, less than <6% for each primary pathway. However, primary pathway differences between racial and ethnic groups varied with all but one having differences of more than 10% between populations. For example, as illustrated in Figure 3b 14.3% of URM alumni transition directly to a PhD program out of their bachelors, a rate that is much lower than both majority (37.2%) and Asian (54.5%) alumni. Conversely, 19.0% of URM alumni transitioned directly to the workforce without a graduate degree. Only 9.1% of majority and 0% of Asian alumni opted for this pathway.

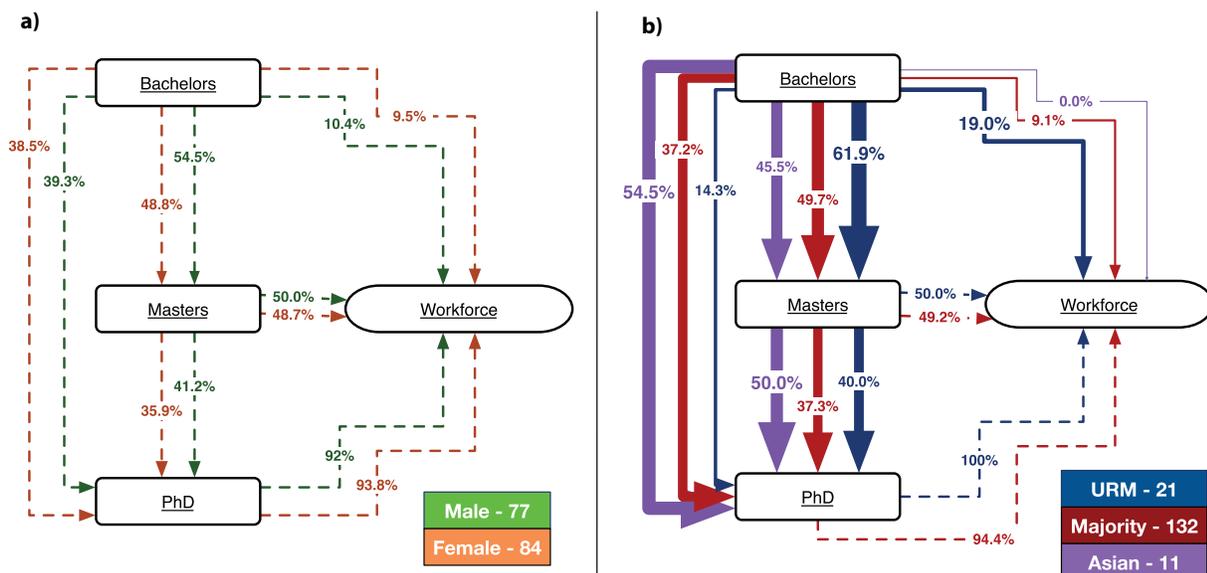


Figure 3 – Primary academic pathways for male and female alumni (Figure 3a), and underrepresented minority (URM), Asian and majority alumni (Figure 3b), are compared by percentage. Pathways with differences of greater than 10% across groups are indicated with solid lines and scaled accordingly. Meanwhile, pathways with differences of less than 10% across groups are indicated with a dashed line and are not scaled.

Careers - An analysis of primary full-time employment categories of alumni (n=96) finds that 70.8% of alumni are employed in a geoscience field, 21.9% are employed in a non-geoscience STEM field, and the remaining 7.3% are employed in a non-STEM field. Disaggregation by gender (Figure 4) reveals that a slightly higher percentage of male alumni are employed in geoscience careers (74.5%) than women (66.7%). Both male and female alumni appear to leave STEM fields at similar rates, 7.8% and 6.7% respectively.

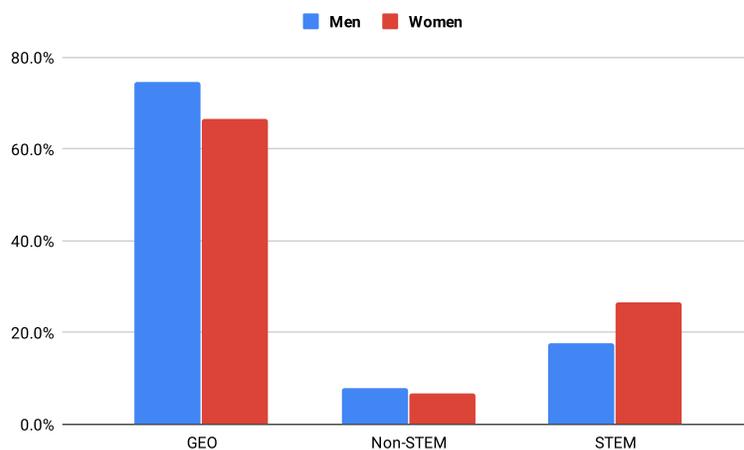


Figure 4 – Percentages of male (n=51) and female (n=45) alumni employed full-time in broad employment categories.

Disaggregating primary employment categories by race and ethnicity (Figure 5) reveals that 72.6% of majority or Asian alumni are employed in the geosciences while only 58.3% of alumni from URM communities are employed in the geosciences. Conversely, 16.7% of underrepresented minority alumni are employed outside of STEM fields, while only 6.0% of majority alumni are employed outside of STEM fields.

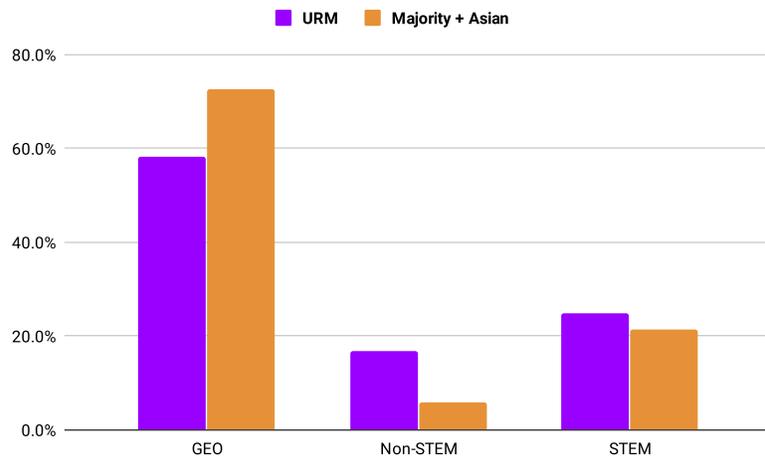


Figure 5 – Percentages of URM (n=12) and Majority + Asian (n=84) alumni employed full-time in broad employment categories.

A more detailed analysis of alumni employment (Figure 6) reveals that program alumni are employed in a wide spectrum of employment sectors. Corresponding with the large percentage of alumni who pursue PhDs, 4-year Colleges and Universities (22.9%), the Federal Government sector (12.5%), and Research Institutes (7.3%) make up first, third and fourth largest employment sectors for alumni. Employment in the Oil and Gas sector (15.6%) is the second largest sector of employment.

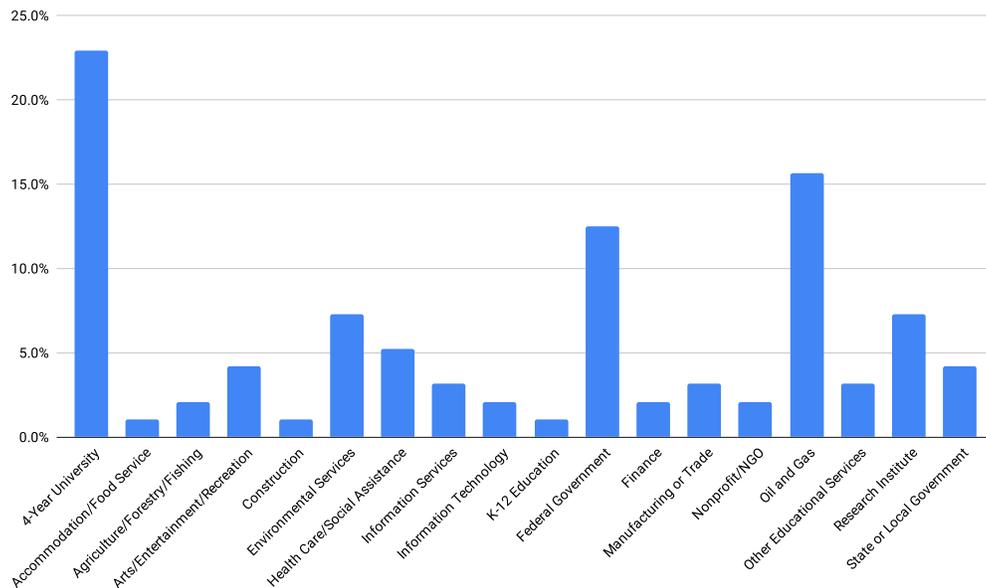


Figure 6 – Percentage of all alumni employed full-time (n=96) by employment sector.

Employment data was disaggregated by gender (Figure 7) and race and ethnicity (Figure 8). Both men and women are employed across 14 or more sectors. However, as illustrated in Figure X the three most common employment sectors for women are the 4-Year Colleges and Universities (24.4%), Oil and Gas (17.8%), and Environmental Services (8.9%) sectors. For men the sectors differ slightly. The 4-Year Colleges and Universities (21.6%) sector is still the most frequent. However, this is followed closely by Federal Government (17.6%) and Oil and Gas (13.7%) sectors. Employment in the Federal Government and Research Institutes sectors are notable as they are the two sectors where there are the largest differences in employment percentages between men and women.

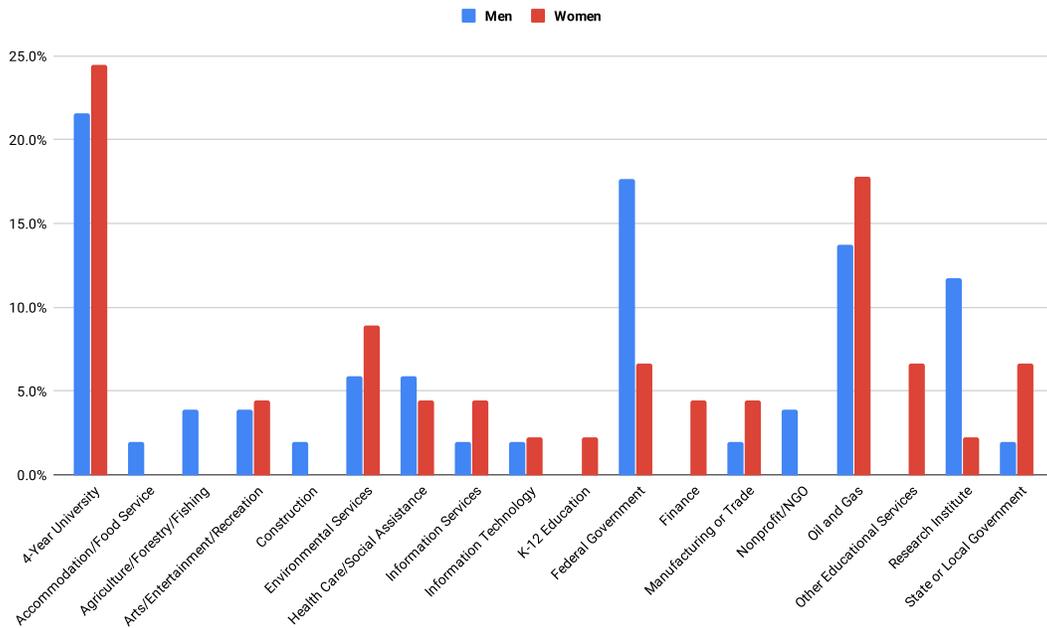


Figure 7 – Percentage of male (n=51) and female (n=45) alumni employed full-time by employment sector.

Disaggregation of employment data by race and ethnicity (Figure 8), reveals that majority plus Asian alumni are employed across a much broader spectrum of career fields than URM alumni and differ in primary employment sectors. For example, majority plus Asian alumni are employed primarily in the 4-Year Colleges and Universities (25.0%), the Federal Government (14.3%), and Oil and Gas (13.1%) sectors. While UMR alumni are employed primarily in the Oil and Gas sector (33.3%) with only one alumni (8.3%) employed in the 4-Year Colleges and Universities sector, and none employed in the Federal Government sector.

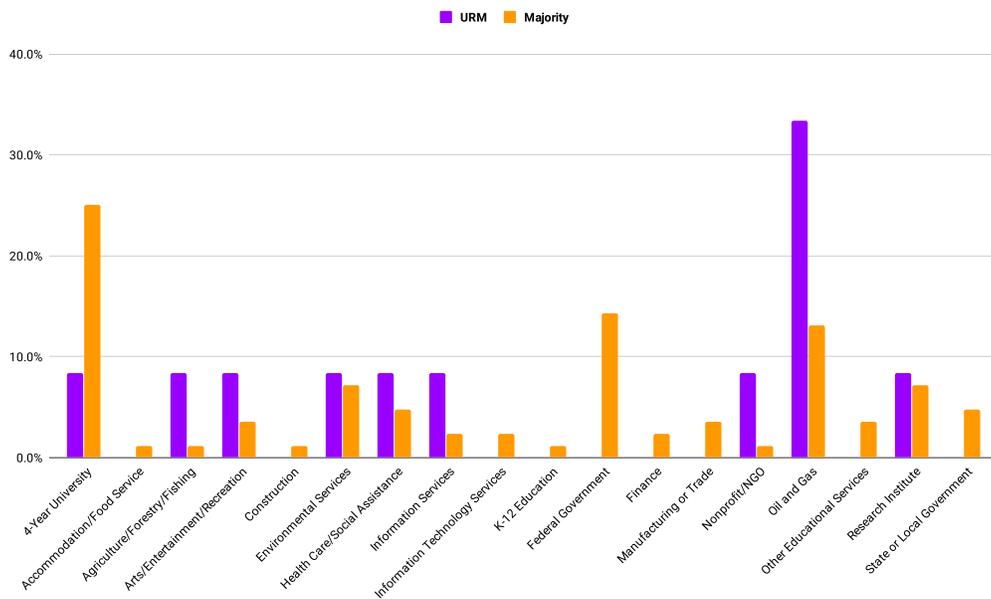


Figure 8 – Percentage of URM (n=12) and Majority + Asian (n=84) alumni by employment sector.

Program Effect - To explore the question of whether and to what degree the program played a role in shaping alumni’s academic/career trajectories, participants were asked to indicate the degree of influence they felt the program exerted in shaping their educational or career trajectory. As illustrated in Figure 9, 50.0% of alumni described “Very influential”, while an additional 29.8% of alumni described the program as “Influential”. Less than 10% of participants found the program to be “Of little influence” on their educational or career trajectory.

To better understand in what ways the program influenced students educational or career trajectories, participants were asked two questions. The first question asked if in retrospect, alumni believed that the IRIS Internship Program increased their interest in a geoscience career. As illustrated in Figure 10, 65% of alumni indicated that their experience in the program had “Increased” their interest in a geoscience career, while an additional 27.0% reported that the program “Maintained” the interest they already had.

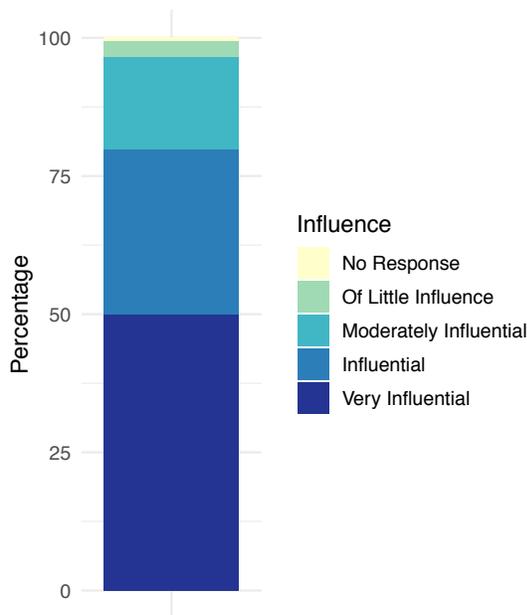


Figure 9 – Degree of influence program alumni perceived the program had in shaping their educational or career trajectory.

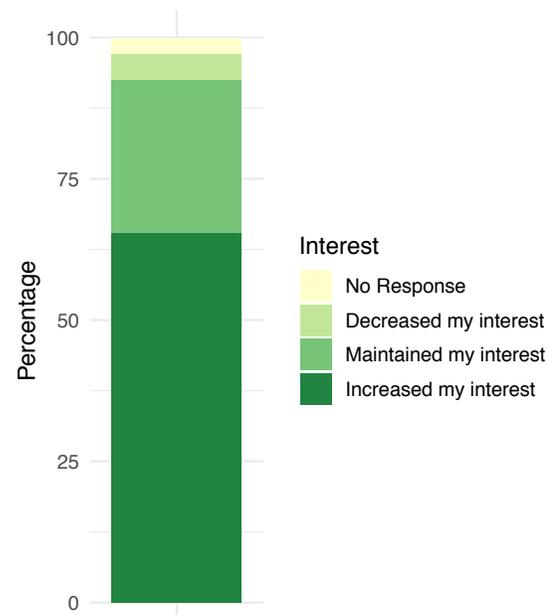


Figure 10 – Change in interest in a geoscience career reported by alumni post program participation.

Using an open-ended prompt, alumni were asked to describe ways in which they felt the program influenced their educational and career trajectory. A sentiment analysis of alumni’s responses (Figure 11) indicates that most alumni used positive language when describing the influence the program had on them.

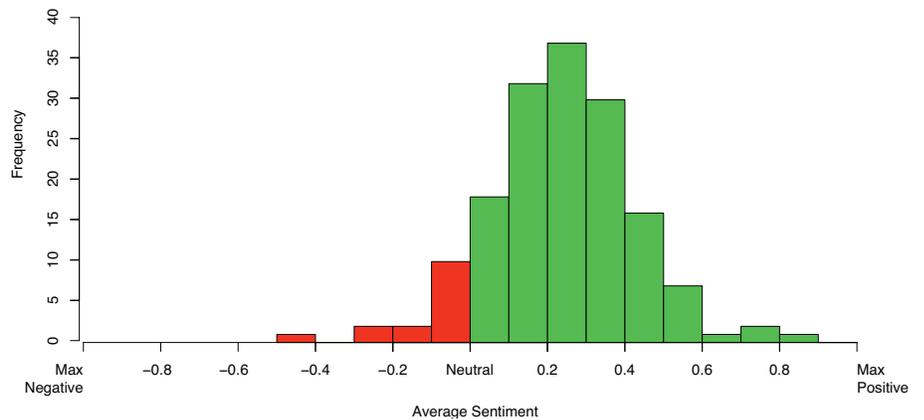


Figure 11 - A sentiment analysis of participants’ open-response descriptions of ways the program influenced this trajectory suggests this influence was positive.

A content analysis of these responses reveals six primary influences of the program on interns' educational and career trajectories (Table 2). The most frequent reported influences were on interns' knowledge, interest, and network. Each of these primary influences was explored more deeply through a secondary coding scheme (Tables 3 and 4). Here we find that the program influenced interns' education or career trajectory by providing interns with knowledge of what scientific research entails and experience in it, geophysics content knowledge broadly, knowledge of what graduate school life is like, and knowledge of various career types available through the geosciences. The program also influenced interns' interests in geophysics specifically, continuing on to graduate school, the geosciences broadly, career types, and the process of conducting research. Finally, the program provided interns with a mechanism to build personal networks within the geophysics community. For some this resulted in key personal connections such as a graduate advisor or a potential employer. *"I also met my Masters adviser at the IRIS intern reception at AGU."* However, for many, it simply was a community they could feel connected to and see themselves becoming a part of. *"The internship introduced me to a really friendly community (unlike some other geoscience communities), and I didn't feel like I was an outsider. The scientists I worked with had similar backgrounds to me and I felt like I could see myself in their positions someday."*

Table 2 – Primary ways the program influenced the educational/career trajectory of alumni (n=158) and the frequency with which they were reported. While many alumni reported more than one way, knowledge, interest, and network were the most frequently reported.

Count	Primary Codes	Description
115	Knowledge (and/or Experience)	Understanding of a particular scientific topic, concept, process, phenomena, theory, or career central to the project
105	Interest	A feeling or emotion that causes attention to focus on an object, event, or process
50	Network	An association of persons or an interconnected group
32	Skills	The ability to do something well
21	Attitude	A way of thinking or feeling about someone or something
18	Resume	General experience or specific accomplishments that contributed to hiring

Table 3 - Categories of knowledge (and/or experience) influenced by the internship program.

Count	Secondary Codes	Description	Sample Responses
38	Research	The creative and systematic collection, interpretation and evaluation of data to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications	<p>"The internship provided examples of what engaged scholarly research looks like"</p> <p>"I learned a lot more about the nitty gritty details of what doing research required"</p>
27	Geophysics	The study of the physics of Earth	<p>"(The internship) helped develop my well-rounded Geophysics background"</p> <p>"I gained a wealth of knowledge in the Geophysics field"</p>
21	Grad School	Various degrees types, graduate student life, working with a graduate advisor, etc.	<p>"(The internship) gave me a taste of life in graduate school"</p> <p>"It gave me and understanding of... the dynamics of a research group at a major university"</p>

19	Career Types	Types of jobs available (e.g. national labs, contractor, federal agency, academia, oil and gas industry) or what a various job types are like	<p>“The internship helped me plan out a future career by showing me what geophysicists do”</p> <p>“I got to meet and speak with researchers from many different backgrounds and who had chosen unique career paths which gave me options to consider”</p>
10	Other	Other	“I learnt a lot more about... how to present my science”

Table 4 - Categories of interest influenced by the internship program.

Count	Secondary Codes	Description	Sample Responses
40	Geophysics	The study of the physics of Earth both as a field broadly and as a research methodology	<p>“it shifted my search for graduate schools to programs that are heavier in seismology and numerical modeling”</p> <p>“I learned that... seismology was not the field I wanted to go into”</p>
26	Graduate School	The decision to attend graduate school or not, the terminal degree desired, and the path to reach targeted degree	<p>“My experience... led to me pursuing my doctoral degree”</p> <p>“Without the internship I doubt that I would have been motivated to stay in school prior to grad school for post baccalaureate coursework and subsequent graduate school”</p>
16	Geosciences	The study of the Earth in a broad sense and including sub fields other than geophysics	<p>“First and foremost, it helped to confirm my interest in the geosciences”</p> <p>“The IRIS internship furthered my passion for earth sciences”</p>
9	Career Types	Various types of jobs available (e.g. national labs, contractor, federal agency, academia, oil and gas industry) or what various job type are like	<p>“I found the lifestyle of an academic researcher very appealing”</p> <p>“Helped me come to the decision that I would like to remain in the academic environment to teach and conduct research rather than working in directly in industry”</p>
8	Research	The creative and systematic collection, interpretation and evaluation of data to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications	<p>“The IRIS internship helped me realize that I liked working on research projects”</p> <p>“The internship helped me begin to figure out that research wasn't the right career path for me.”</p>
7	Other		“I found out I really liked coding during this internship.”

Summary and Recommendations

This longitudinal study of alumni of the IRIS Undergraduate Internship Program was designed to answer five key evaluation questions exploring how and to what degree they seek careers in the geosciences.

Below, the results of the study are summarized by research question. Recommendations for the program follow.

Question 1: To what degree do program alumni seek geoscience careers?

This longitudinal study of alumni of the IRIS Internship program reveals post bachelor's degree behaviors, 86.6% of responding alumni enroll in either a Master's or PhD program. While the field of study alumni pursue does vary, 76.8% of respondents, who had completed their undergraduate degrees and are enrolled as a graduate student or employed full-time, are doing so in the geosciences. This is a rate greater than the target of 75% set by the program.

Question 2: Do the academic career paths of alumni vary by population?

The results of this study indicate that the academic pathways traveled by male and female alumni tend to be relatively similar. However, the study did find differences in pathways between racial and ethnic groups. For example, only 14.5% of alumni from URM communities pursued a PhD program directly after their bachelor's degree, while 37.2% and 54.5% of majority and Asian alumni (respectively) followed this path. Conversely, 19.0% of alumni from URM communities did not go on to graduate school compared to 9.1% and 0% of majority and Asian alumni respectively.

Question 3: In what employment sectors are alumni employed?

Alumni of the IRIS Undergraduate Internship Program are primarily employed in the geosciences (70.8%) or a non-geoscience STEM field (21.9%). While their jobs span a broad spectrum of employment sectors, 51.0% of all alumni are employed in three sectors. These include 4-Year Colleges and Universities (22.9%), Oil and Gas (15.6%), and the Federal Government (12.5%).

Question 4: Do employment sectors of alumni vary by population?

The project did find that these primary employment sectors do vary by both by race and ethnicity, and gender. For example, URM alumni are primarily employed the Oil and Gas sector (33.3%). This is a rate that is more than double that of their majority counterparts. Conversely, majority alumni are primarily employed in the 4-Year Colleges and Universities (25.0%) and Federal Government (13.4%) sectors. Both are sectors in which few if any URM alumni are employed.

While the difference in employment sectors for men and women does exist, it is smaller. For example, the primary employment sector for both women and men is the 4-Year Colleges and Universities sector (24.4% and 21.6% respectively). However, few women are employed in the Federal Government (6.7%) and Research Institutes (2.2%) sectors compared to their male counterparts (17.6% and 11.8% respectively.)

Question 5: How and to what degree has the program influenced participants academic/career trajectories?

Responses from program participants suggests that the program does have a positive effect on participants' academic or career trajectories. For example, nearly 80% of alumni reported that the program was either "Influential" (29.8%) or "Very influential" (50%) on their academic or careers. Alumni reported a spectrum of ways participation in the program influenced them. The most commonly reported influence was gains in knowledge and experience. Specifically, alumni reported gains in research experience, geophysics content knowledge, and knowledge of the graduate school process and life. The second most commonly identified effect the program had was to increase alumni's interest. For example, nearly two-thirds of alumni reported the program increased their interest in a geoscience career. Alumni also reported interest effects related to the field of geophysics specifically, and their desire to attending

graduate school broadly, or various degree programs or project types specifically. A number of alumni also reported an important influence of the program was the network the program provides. This included not only opportunity to make key connections (e.g. “graduate school advisors”), but also a community they could feel a part of.

Recommendations

- 1) To empower current participants to make decisions about their careers post-participation, information about alumni academic and career pathways and outcomes should be made available to participants. This should include both the academic pathway information identified through this census and details about the spectrum of employment sectors program alumni are employed in.
- 2) While this study identified variability in the academic pathway and employment patterns of various groups of alumni, it did not provide any insight into why these differences exist. Therefore, additional data collection about graduate school decisions, awareness of career possibilities and any perceived barriers is encouraged. Such additional detail could enable the program to develop strategies to ensure all groups have equal access to all academic pathways and careers.

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Appendix A: 2018 Alumni Census

Welcome Back Alumni!

We know your time is valuable so we have used your previous responses to "auto fill" the survey where possible.

First Name Last Name

The best email address to stay in contact with you

NEXT

Here is an opportunity for you, an alumni of the IRIS Program, to contribute to educational research! Please consider participating!

Please read the project description below and indicate your consent.*

- I agree and consent to have the responses from my IRIS application and this survey included in the research study
- I disagree and do not wish to have my responses to this survey and my original application to the IRIS internship program in the research study

Principal Investigator: Michael Hubenthal, Program Facilitator

Title of Project: Undergraduate Summer Research in Seismology - REU Site

Purpose of the Study: As alumni of the IRIS internship program, you are invited to participate in a project to evaluate the effectiveness of a summer research program for undergraduate students and to investigate impacts that participation in such programs may have on students' career perceptions and choices. Ultimately, we hope to learn how best to design such research experiences to maximize participant satisfaction and benefit.

Description of Study: Procedures Participation in this project entails the following two elements. 1) Completing a short, ~10 to 15-minute survey, on your educational and career path following your participation in the undergraduate research program will be included in the study. 2) Granting access, the to the responses you provided as part of your application when you applied to participate in the program for comparison.

Potential Risks: There are no known risks from having your responses included in this study beyond the potential inconvenience or privacy loss as a result of answering the survey questions. However, in any research, there is some possibility that you may be subject to risks that have not yet been identified.

Potential Benefits: We cannot and do not guarantee or promise that you will receive any direct benefits having your responses included in this study.

Confidentiality: Names and emails will be collected along with the data to allow tracking across the various data sets. However, we will be careful to keep all your responses confidential. After collecting the data, names and emails will be stripped and replaced with codes and the key will be destroyed. Coded, responses will be stored on a password protected system. Analysis will occur using coded data so researchers will not know who said what. If results from the study are published, data will be presented in aggregate and you will not be identifiable in the data.

Voluntary Nature and Withdrawal: Your decision whether or not to participate will not affect your relations with the investigators, the IRIS Consortium and Binghamton University. Your participation is completely voluntary. You may skip any questions you do not wish to answer. If you decide to participate, you are also free to withdraw your consent and to discontinue participation at any time without any penalty. Before participation, please ask questions on any aspect of the study that is at all unclear to you. If you have any additional questions later, will be happy to answer them. If at any time, you have questions concerning your rights as a research subject you may call Binghamton University's Human Subject's Research Review Committee at (607) 777-3818.

Questions and Contact Information: Before you sign the form, please ask questions on any aspect of the study that is unclear to you. If you have any additional questions, concerns, or complaints or wish to report a research related problem later, Michael Hubenthal (607-777-4612 or hubenth@iris.edu) will be happy to answer them. If at any time, you have questions concerning your rights as a research subject or you have questions, concerns, or complaints about the research, you may contact Binghamton University's Human Subjects Research Review Committee (HSRRC) at (607) 777-3818 or hsrrc@binghamton.edu.

Please print a copy of this form to keep.

NEXT

Please tell us about your educational history.

BACHELORS degree?

Not Applicable/Currently enrolled student/Earned – 1998/Earned – 1999/Earned - 2000/Earned - 2001/Earned - 2002/Earned - 2003/Earned - 2004/Earned - 2005/Earned - 2006/Earned - 2007/Earned - 2008/Earned - 2009/Earned - 2010/Earned - 2011/Earned - 2012/Earned - 2013/Earned - 2014/Earned - 2015/Earned - 2016/Earned - 2017/Earned - 2018

BACHLORS degree institution (e.g. University of Montana)?

BACHELORS degree field? (e.g. Geophysics, Accounting, Geological Science, Educational Studies etc.)

MASTERS degree?

MASTERS degree institution (e.g. University of Montana)?

MASTERS degree field? (e.g. Geophysics, Accounting, Geological Science, Educational Studies etc.)

PhD or other Doctoral degree?

PHD degree institution (e.g. University of Montana)?

PHD degree field? (e.g. Geophysics, Accounting, Geological Science, Educational Studies etc.)

OTHER Degree?

What kind of degree is this?

OTHER degree institution (e.g. University of Montana)?

OTHER degree field? (e.g. Geophysics, Accounting, Geological Science, Educational Studies etc.)

NEXT

Please tell us about your full-time employment.

Are you currently employed full-time? - Yes/No

Company/Organization

Position

Employment City

Employment State

NEXT

Please tell us about your experience in the internship program.

In retrospect, which best describes the effect your internship with IRIS had on your educational/career trajectory?

- Decreased my interest in the geosciences as a career
- Maintained my interest in the geosciences as a career
- Increased my interest in the geosciences as a career

In retrospect, how strong was the influence of your internship with IRIS in shaping your educational/career trajectory?

Non-influential/Of Little Influence/Moderately Influential/Influential/Very Influential

Briefly describe ways the internship influenced your educational/career trajectory (both positive and negative)?

In the space below, please describe up to three factors you felt have also been influential or very influential on your career trajectory as an undergraduate student (other than the IRIS Internship Program)?

First Factor

Second factor

Third Factor

NEXT

Please tell us about yourself.

Have either or both of your parents or legal guardians earned a graduate degree?

- Yes
- No

What is your ethnicity?

- Hispanic or Latino
- Not Hispanic or Latino

What is your race? Mark one or more races to indicate what race you consider yourself to be.

- White
- Black or African American

- Asian
- American Indian or Alaska Native
- Native Hawaiian or Other Pacific Islander

How do you describe your gender identity?

- Female
- Male
- Transgender
- Do not identify as female, male, or transgender

NEXT

Is there anything we have missed?

FINISH