Evaluation of the 2018 Undergraduate Internship Program
May – December, 2018

Michael Hubenthal – IRIS Education and Public Outreach

January, 2021

Table of contents

Background

Since 1998, IRIS's Research Experience for Undergraduates (REU) program has facilitated opportunities for more than 200 undergraduate students to work with leaders in seismological research, conduct fieldwork using modern seismological equipment, and produce research products worthy of presentation and recognition at large professional conferences. This program capitalizes on the 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 the program is to provide undergraduates with research opportunities early in their educational careers and encourage more students representing a more diverse population to choose careers in Earth science and seismology. Three major evaluation outcomes follow from this goal and a fourth relates to the virtual aspect of the internship community. Each has a correlated method of evaluation, with defined success metrics (Table 1).

Table 1: Outcomes 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 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

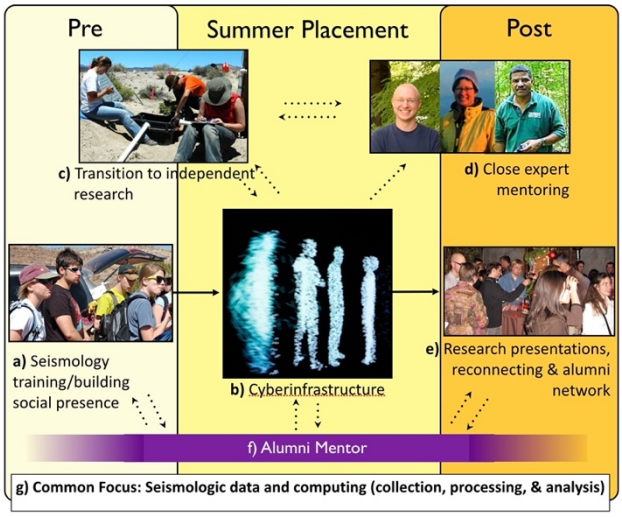

Figure 1: IRIS's distributed REU model. Solid lines indicate interns' pathway while the dashed lines indicate interactions between elements of the model.

IRIS's REU operates as a distributed REU site (Figure 1), where geographically dispersed interns are connected in supportive learning communities through the use of cyberinfrastructure while maintaining a close mentoring arrangement. 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. The IRIS distributed REU site follows the general timeline described in Table 1.

Pre-Internship Preparation - Participation in the program begins with a series of online community building exercises and virtual learning activities focused on developing scientific computing skills. Next, participants gather for a 6-day orientation to develop a strong sense of community and an introduction to some of the most exciting aspects of modern seismology. The orientation week is held annually on the campus of New Mexico Institute of Mining and Technology (NMT) as it is exceptionally well-suited for hosting the orientation program. Classroom sessions use a variety of active learning strategies to explore topics including: history and theory of seismology, earthquakes and Earth structure, geophysical inverse theory, general reflection and refraction theory, and seismic processing. Lab sessions build on the virtual learning to go deeper into computing packages and tasks that interns are likely to encounter (e.g. MATLAB, Python, GMT, and Seismic UNIX). The orientation also provides hands-opportunities to install and use research-grade field equipment. Throughout the week, the close association with NMT faculty, IRIS staff, internship alumni and other interns fosters a sense of the broader seismological and scientific community and culture. This naturally leads to discussions of graduate student life, strategies and opportunities to fund graduate education, as well as other long-range professional issues. The capstone event is a career panel and bonfire where students engage with near-peer representatives, frequently program alumni, from industry, academia and nearby government labs to explore career paths in seismology and geophysics.

The orientation also introduces interns to the learning process of a scientific internship, empowering them to self-monitor their progress during the summer through the use of IRIS's Science Skills self-reflection guide. Additional sessions explore effective habits of independent workers, professionalism in interactions with your mentor, and technical skills such as reading scientific literature. Students also learn to use online communication/collaboration technologies to foster group cohesion and collaboration while at their respective internship sites. Finally, we also include sessions ensure that students understand the policies and procedures of the program with special attention given to the development of an inclusive culture that is free from discrimination and harassment.

Internship at Remote Sites - Following the orientation, students travel to their internship site to meet their science mentor and begin the 8 to 12-week research process that is the core of the IRIS internship program. Regular mentoring by science mentors is a critical component of this learning as the process enables students to successfully navigate their research and develop both the methodological skills and the intellectual proficiencies vital to become a successful researcher. As student work with their mentors, they are encouraged to reflect on both their research progress and personal growth through the student of the IRIS Self-Reflection Guide.

While interns are generally working on research projects independently, the computing basis of their work provides common areas for IRIS interns to collaborate while distributed at their research placements. Remote collaboration occurs in Slack as it is much faster and more efficient than traditional communication tools such as email. Here all interns subscribe to general "channels" for broad interactions as well a channels that are relevant to their summers research.

During this period interns are also expected to complete weekly assignments. These assignments are designed and sequenced to encourage the development of a suite of products that will become the

foundation for presenting their results, provide opportunities to reflect on their work and solidify learning gains, and allow them to benefit from other's experiences such as the alumni mentor and the program facilitator who regularly provide feedback on intern work. Assignments are supplemented with regular webinars on a range of topics including science communication, use of social media as a scientist, intern lightning talks, and tips on how to write an AGU abstract. To accommodate the multiple time zones and field schedules, all webinars are recorded to allow absent students to keep up with the content. The webinar schedule extends into the fall semester to help interns prepare for AGU and the preparations for graduate school, via a mix of both in house webinars and the Institute for Broadening Participation's collection of webinars and short handouts.

Presentation at a Professional Meeting - The culmination of each student's internship experience is the opportunity to attend a professional conference and present the results of their summer research. In nearly all cases, interns and their mentors choose to attend the Fall meeting of the American Geophysical Union (AGU). Attendance at the AGU meeting brings closure to the research project, offers interns an opportunity to share their experience and expertise with their new peer community, and provides meaningful exposure to the full spectrum of Earth science research as a viable career option. Building on the tips and strategies presented to students in the pre-AGU webinar, the alumni mentor and the program facilitator guide students through their first few days at AGU. During this process students begin to network with the broader IRIS community with a special emphasis on introductions to potential graduate advisors. To further integrate the current cohort of interns into IRIS's robust alumni community, IRIS annually holds an alumni mixer at AGU. Here, current interns meet again face-to-face, and network with internship alumni who can provide valuable information about graduate school opportunities and facilitate connections with others in the field. The 2017 mixer attracted over 60 current and former interns, science mentors, orientation staff, and supporters from within the IRIS community. To further improve the intern's AGU experience, IRIS interns are also integrated into the mentoring and student interaction opportunities provided at the meeting by AGU's education program.

Methods

Data to describe the demographics of the intern population was collected from participants applications. Data to evaluate the orientation week experience was collected via a pre-survey emailed to participants roughly one-week prior to the orientation. A follow-up survey was sent to interns roughly one-week following the orientation. Eighteen of nineteen participants responded to the pre-survey (94.7% response rate) while 13 responded to the post-survey (68.4% response rate) creating 13 pre/post pairs of data. Some returned surveys were not complete. As a result, the number of responses per item may vary. Interns perceptions on the rest of the program was collected through a 40 item, post-participation survey. This survey was sent roughly two weeks following the end of the program with a reminder sent one week following. Of the 19 interns in the program, 14 returned the post experience survey for a response rate of 73.7%.

Mentor feedback as collected through a 21-item survey. The survey was emailed to all 15 mentors at the completion of the program. Two reminders sent over a two-week period to those that did not respond. The effort generated 12 complete surveys for an 80% response rate.

Across all surveys, descriptive statistics were calculated for all closed-response items with the average score on the scales and the standard deviation within the sample reported. Where appropriate, pre/post pairs of data are also reported. Open-ended items and 'Other' responses for close-ended items were

analyzed using a thematic analysis approach (Braun and Clarke, 2006). Here, responses were repeatedly read and re-read by the authors until major clusters were identified that represented the data set without losing the detailed nuance of the individual responses. Based on these clusters, categories were developed and refined until incremental improvements did not add substantial information or detail, nor did it alter the data narrative.

Population

Mentors

The population of mentors that responded to our survey were comprised of nine women and three men. All identified as white, but one also identified as Hispanic or Latinx. Seven respondents had mentored previously in the program, while the remaining five were first time mentors in the program.

Student Applications and Selection

The program received a total of 85 applications for the summer of 2018. Of those, 72 applications were complete and considered for the 17 position resulting in an acceptance rate of 24%. This applicant pool met the recruitment metrics set by the program. The majority of the applicants 54.2% were female, and 18.1% identified as an URM. Most of the applications receive were from Juniors (54.2%) followed by Sophomores (25%), Seniors (16.7%), and then Freshman (4.2%).

From these applications, IRIS EPO staff created a "short list" of 35 applications. The short list was even more diverse than the overall pool as 57.1% of applicants identified as women and 20.0% as members of an URM community. These applications were then considered by the 3 person selection committee comprised of faculty from across the IRIS community. This committee then selected the applicants that would be offered positions within the program for the summer 2018.

2018 Intern Cohort

The 2018 IRIS intern cohort was comprised of 17 students from the United States, plus two international students, both of whom were from Columbia. The group consisted of 3 sophomores, 12 juniors, and 4 seniors. Ten of the interns identified themselves as female, 9 identified as male, and none described their gender as non-binary. The program is keenly interested in recruiting and supporting students from populations traditionally underrepresented in the geosciences. According to the National Science Foundation these underrepresented minorities (URM) include students who identify as Hispanic or Latinx as their ethnicity, as well as students who identify their race as American Indian or Alaska Native, Black or African American, or Native Hawaiian or Other Pacific Islander. Including the both international students 3 of the 17 U.S.-based interns identified as a member of an URM. This is slightly below the

programs identified goal of 20%. The majority of interns (n=11) attended IRIS member institutions. The interns had a variety of majors. The most common was Geology/Earth Science (n=9), followed by Physics (n=5), Geophysics (n=4), and Mathematics (n=1). All but one of the interns reported prior undergraduate research experience.

Results

Overall, interns perceived the program as well run with 93% of participants agreeing that details and logistics about the internship program were clearly explained or someone was available to answer my questions. In fact, only three students had general, minor suggestions to improve the overall running of the program. The remaining results of the evaluation have been organized below using the three primary components of the program; Pre-Internship Preparation, Internship at Remote Sites, and Presentation at a Professional Meeting.

Pre-Internship Preparation

One of the goals of the internship is to successfully connect the interns in a beneficial way. Prior to participating in the internship program students were asked about how important they felt it was that they have an opportunity to become connected to the other IRIS interns. The majority of students felt that it was "important" (35.3%) or "very important" (29.4%). The remainder felt that it was only "moderately important" (35.3%) for them to build this connectedness. To help the program better understand students' expectations around connectedness, interns were also asked before the start of the program to describe several actions that they and the other interns would engage in that would demonstrate their idea of "connectedness". Participants gave a range of responses, however, all focused on communication that would largely occur through social media, blogs, and group chats. *" I would consider staying connected to mean talking over email or social media both during the time of our internships and afterward*." They emphasized that the content of these connections would focus on having opportunities to share in each other's research experience… *" I think it's important to have a group that is all experiencing the same type of experience to know that your struggles are not just your own. Being able to stay in contact and update each other on successes and issues I think will keep morale high and help prevent people from burning out or feeling like they should give up."* They also had a desire to help each other wherever they can… "*To me it just means staying in contact with one another and being a resource for when things are hard."* Additionally, the interns also appeared to be able to see value of the group beyond the internship experience. *"We may follow up after the internship to see if we have career opportunities due to the internship. It provides a platform of highly intelligent and driven people to interact. This may lead to future connections in academia or professional settings."* In this way, some saw connections among the group as the foundation of a social network.

The orientation week is designed to build this strong sense of community among the interns. To explore how well this design worked, students were asked to what degree they agreed with a series of questions about group cohesion. As illustrated in Figure 2 below, all respondents either "Agreed" (n=1) or "Strongly Agreed" (n=10) that the group members spent time getting to know one another, that the group atmosphere was comfortable, and that there were feelings of unity and togetherness among the group. Likely as a result of this sense of cohesion and community among the interns, most felt that it was extremely (n=6) or fairly (n=3) likely that they would stay in touch with their fellow interns over the summer; though a few felt this was only somewhat likely (n=2).

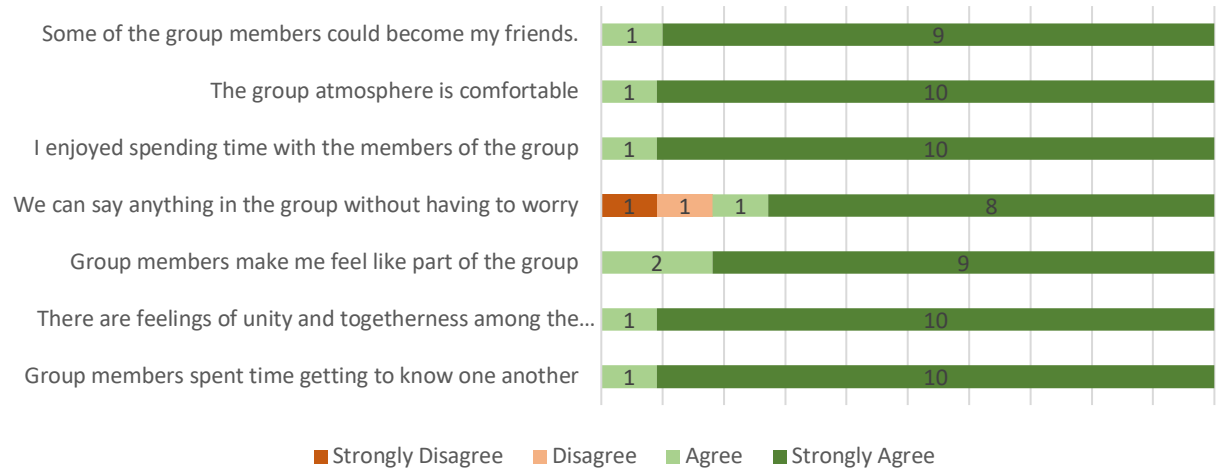

Figure 2: The degree of students' agreement to various statements about relationships among the interns (n=11). Responses indicate that a majority "strongly agreed" that a sense of cohesion and community among the group was established.

When asked about the orientation week's agenda, most respondents agreed or strongly agreed that the agenda was well-balanced, well-facilitated, and likely to be useful to them (Figure 3). The fieldtrip to Magdalena's and the observatory tour (n=11), the interactions with other interns (n=11), and the opportunity to learn what graduate school is like (n=7) were identified most frequently as the "best parts" of the orientation week.

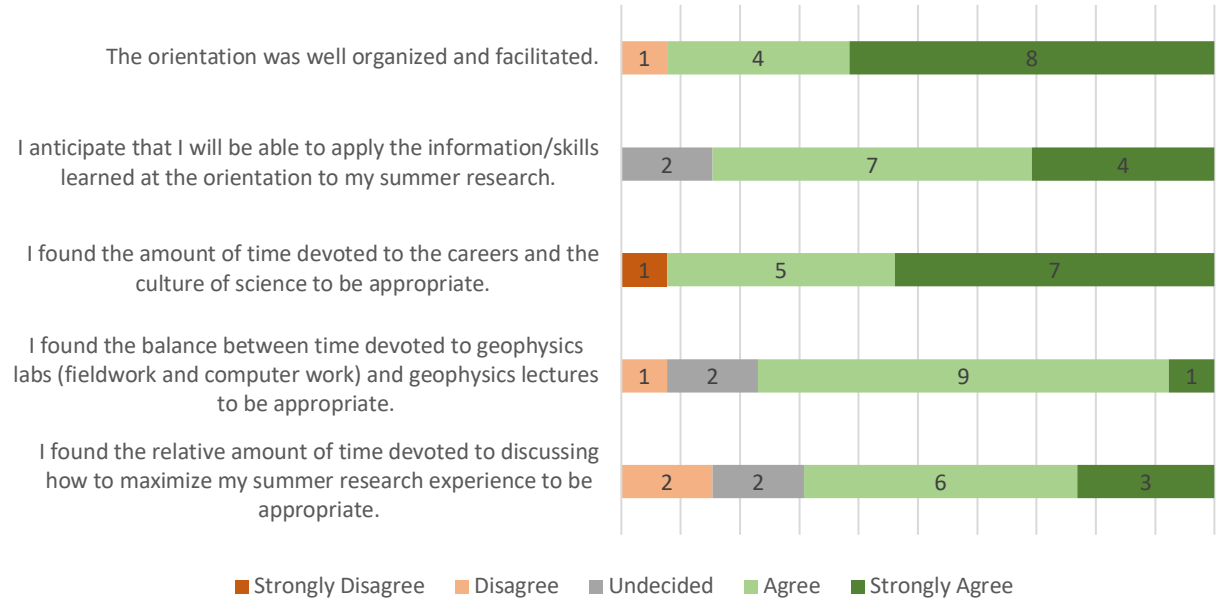

Figure 3: The degree of students' agreement to various statements about the 2018 IRIS Internship Orientation week suggest that most students found the balance of content in the agenda to be about right (n=13).

Students were also asked about their perceptions of the quality of each instructor who staffed the orientation week. As illustrated in Figure 4, most participants perceived the overall quality of the instructors as good or very good. One student did note that instructors could have done a better for

students with little to know geology background had they started their lectures with a little bit more of an overview or giving them an additional pre-orientation assignment.

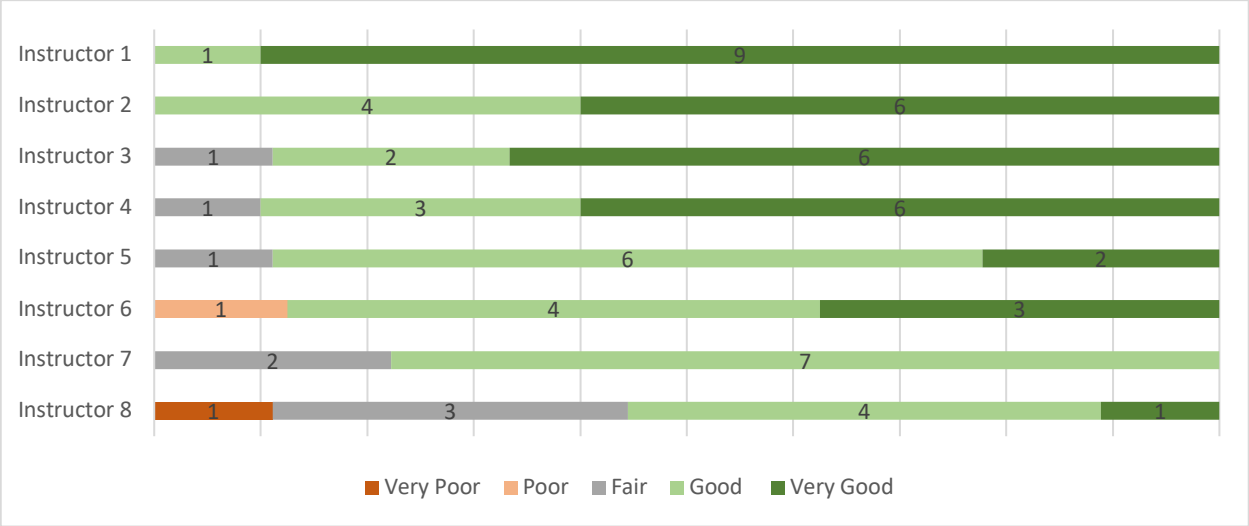

Figure 4: Students' perceptions of the overall quality of the orientation week instructors.

While the orientation agenda was received positively by most and the instructors were largely perceived as good or very good, there were a few students who did not agree with the balance of the agenda or its facilitation (Figure 2 above). Details about what didn't work for these students could be found in follow-on extended response items. For example, students were asked to identify the "Worst Parts" of the orientation week. Only a handful identified any and the two most frequently selected included classroom/lab work (n=4), and the welcome/social evening on first night (n=2). While it is not completely clear what it was about the classroom/lab work that made them the worst parts, it seems possible that the density of the agenda may have contributed. For example, one student noted… *"I would suggest providing longer breaks or more frequent short breaks, so that the material would be more well comprehended by the students."* Another noted that as a result of the dense agenda *"we were never on schedule and I think this stressed a lot of us out and could get a little frustrating at times".*

One of the primary learning goals for the orientation agenda, is to enhance students understanding of the career pathway to become an seismologist. In general, students arrive at the internship program believing they know quite a bit about career pathways in geophysics and seismology (Table 2). However, after the orientation students we see an overall upward shift I students reported understanding of these topics overall; in particular with regard to careers available. However, changes in students' knowledge of the graduate school application process and what courses you have to take to become a seismologist or geophysicists appears to be more variable. Therefore, the content and resources presented should be revisited and perhaps we should consider including extending the learning about coursework and graduate school as a summer webinar.

Table 2: Interns' perceptions of their knowledge about career pathway factors before and after the orientation week.

	I know a great deal		I know a moderate amount		I know very little		I know nothing	
	Pre	**Post**	Pre	**Post**	Pre	**Post**	Pre	**Post**
Variety of careers available in seismology/geophysics	11.8%	**15.4%**	64.7%	**76.9%**	23.5%	**7.7%**	0%	**0%**
What courses you have to take to become a seismologist/geophysicist	11.8%	**30.8%**	58.8%	**38.5%**	29.4%	**15.4%**	0%	**15.4%**
The graduate school application process	11.8%	**30.8%**	58.8%	**53.4%**	29.4%	**7.7%**	0%	7.7%

Additionally, the orientation week also seeks to enhance students scientific skills and knowledge. Post orientation surveys indicated that students' skills and knowledge have increased at least a little across a variety of areas (Figure 5). Topics that students would be least likely to have previously encountered in their academic instruction, such as getting the most out of the summer and the relationships they are likely to develop, "increased a lot". Meanwhile, a topic like Matlab, that many students had prior experience with, mostly "remained about the same.

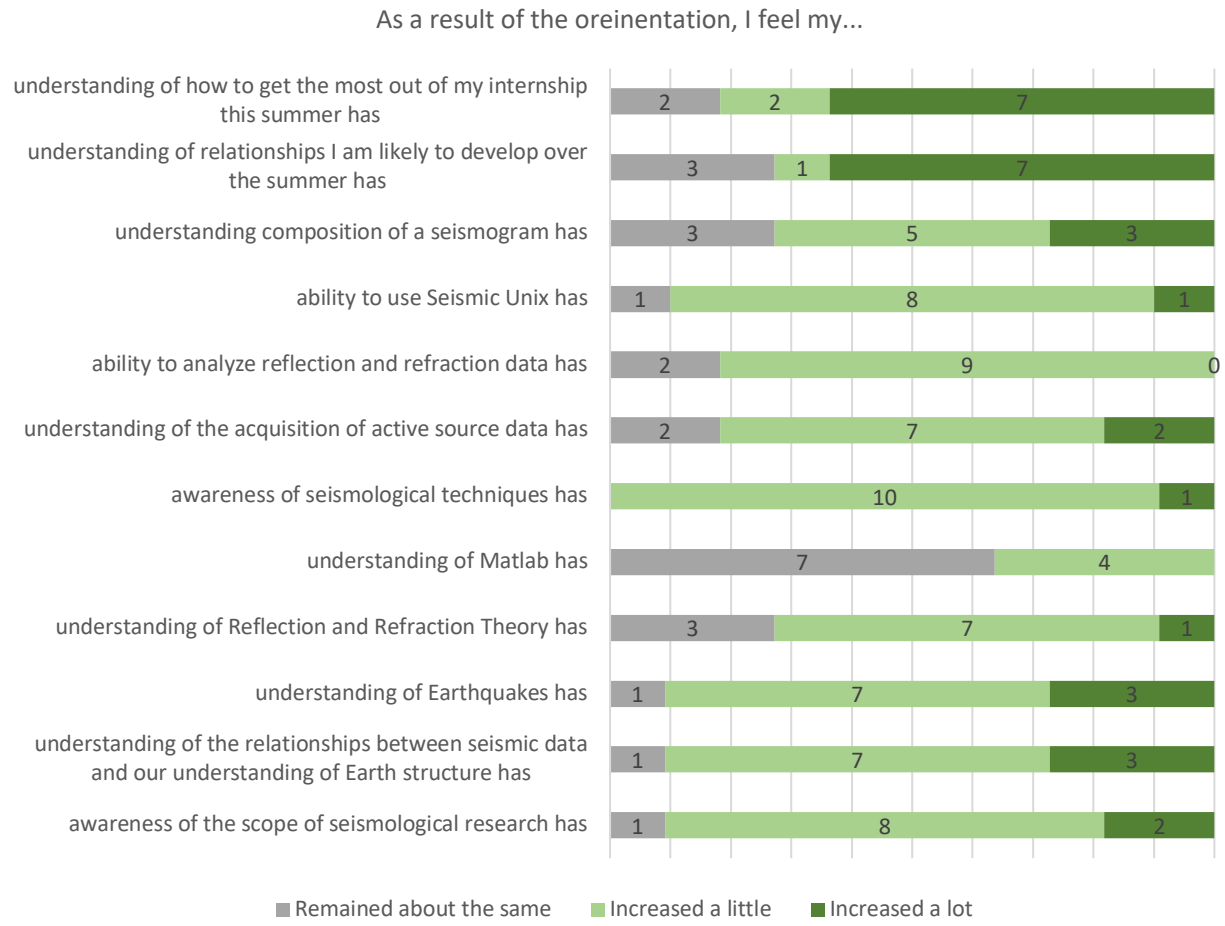

Figure 5: Student self-perceptions of their own learning at the orientation week.

Finally, interns' sense of preparedness both, before and after the orientation week was measured. As illustrated in Figure 6, most interns felt only somewhat prepared prior to the orientation week, with four feeling not at all prepared. However, after the orientation week, interns' sentiments had shifted toward

being more prepared. Most now felt fairly well prepared, while few felt somewhat prepared and none felt not at all prepared.

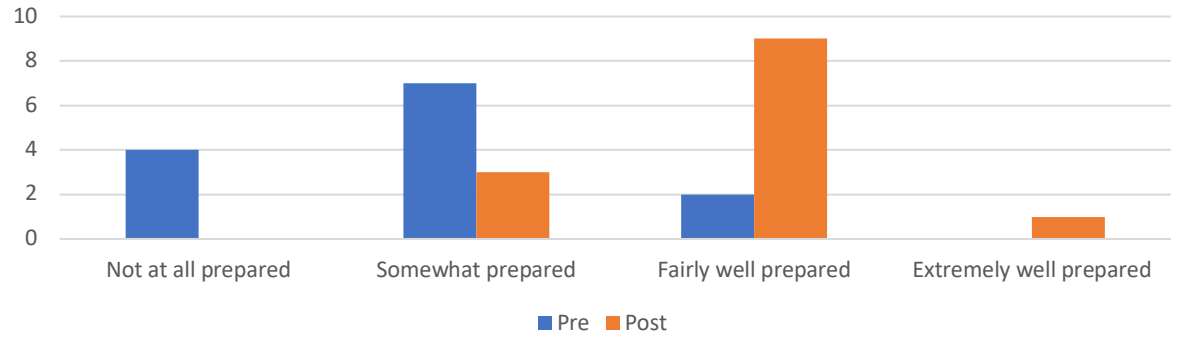

Figure 6: Changes in paired-student responses indicates that students' sense of preparedness for their summer experience increased after participating in the orientation week

Internship at Remote Sites

Maintaining Cohort - As illustrated above in the discussion above, the Orientation Week is a powerful experience that is able to bond students together into a cohort. Students reported that the group spent time getting to know one another, that the atmosphere was comfortable, and that there were feelings of unity and togetherness among the group (See Figure 1 above). To measure if these feelings were maintained, students were asked at the end of the program, to what degree they agreed with seven statements dealing with group cohesion. As illustrated in Table 3, the group appears to have been strongly connected all respondent agreed or strongly agreed with each of seven statements dealing with group cohesion.

Table 3: The degree to which the 2018 intern agreed with statements measuring group cohesion. The cells of responses considered by the program to be positive by the program are colored green, neutral responses are gray, and negative responses are orange (n=11).

	Strongly agree	Agree	Disagree	Strongly disagree
Group members communicated with one another during the summer	**57.1%**	42.9%	0.0%	0.0%
There are feelings of unity and togetherness among the group	**64.3%**	35.7%	0.0%	0.0%
Group members make me feel like part of the group	**64.3%**	35.7%	0.0%	0.0%
We can say anything in the group without having to worry	**57.1%**	42.9%	0.0%	0.0%
I enjoy communicating with the members of the group	**78.6%**	21.4%	0.0%	0.0%
The group atmosphere is comfortable	**71.4%**	28.6%	0.0%	0.0%
Some of the group members could become my friends	**78.6%**	21.4%	0.0%	0.0%

When asked explicitly if they felt they were connected in a beneficial way during the summer, all but one intern agreed (35.7%) or strongly agreed (57.1%). The remaining intern was undecided. When asked to elaborate on what made the connections beneficial, students reported that they felt a strong sense of support from the other interns. For many this was derived from the commonality of the experiences they all had even though they were physical located in different places working on different problems. *"We had a group chat that we used a lot and we used it to express our fears, frustrations, successes, etc... It was great to have people in the same boat as me to connect with."* However, beyond providing support, they also indicated that it was simply enjoyable to communicate! *"It was fun to hear about the other interns experiences and share my own."* Likely as a result, all interns reported being "very satisfied" (78.6%) or "satisfied" (21.4%) with their relationship with the other interns.

Participants were also asked how connected they felt to other undergraduate students at my mentor's institution. In comparison, only 14.3% “Strongly Agreed” that they were. The rest were “Undecided” (50.0%), “Disagreed” (14.3%) or “Strongly Disagreed” (21.4%). Students were asked to describe why they felt this way. Of the 9 interns who responded to that item, 7 indicated that there were no other interns working in their department/lab during the summer. *“I did not really see any undergrads during the summer in the department”.* The other two students indicated that there was only one other undergraduate student, or that it was hard to get to know the other undergrads as they were either part of a group of local interns or were students on campus. A few responses indicated that the interns developed relationships with graduate students in the absence of other undergrads. This data suggests that the virtual communications are very important for the success of the individual interns within the program as without it, the students would be very lonely, and would not have the support they need to be successful.

Mentoring **-** Mentoring of interns is one of the most critical components of the internship at remote sites. Interns in the IRIS program are each mentored by two mentors. The first mentor is the alumni mentor, who is there to provide broad, near-peer advice and support. Where appropriate, the alumni mentor also provides technical support with issues of coding, data manipulation, etc. In this case, the size of the group required two alumni mentors. The second mentor is the science mentor who oversees the interns day-in and day-out research. This is an established researcher who guides the interns throughout the summer, mirrors ways to think about the scientific problems, coaches the interns in how to best handle data, and helps to position the intern’s research within a larger scientific problem.

All but one of the 2018 intern agreed or strongly agree that it was helpful to have the alumni mentors available, and that the alumni mentor served a positive role in the interns’ summer experience (Table 4). When probed about what role the alumni mentors played, students provided a range of responses that illustrate the spectrum of interactions interns had with them. Most had little to do with students actual research over the summer and instead focused on issues around graduate school, preparing for the field, and other sorts of career choices. Intern responses ranged from having little interaction with them over the summer… *“I liked having (the mentors) at the orientation, but I don't feel like they contributed a whole lot to my experience after orientation was over”.* Other students, described going to the mentors for concrete advice about preparing for a career in geophysics and seismology… *“I talked to (Mentor) a little about classes I should be taking, and she gave me great advice. This influenced me to take Linear Algebra and Differential Equations before I graduate even though it’s not required for my major.”* On the other end of the spectrum, some interns asked the alumni mentors many questions, appreciated the alumni mentors role as near-peers and even saw them as role models. *“I loved have a grad student alumni, because it was like looking in a crystal ball to the future (I hope). (Mentor) really showed what it looks like to take full advantage of your opportunities and use them to succeed. I felt like (Mentor) was the resident expert on doing well in grad school and getting into the schools I want. All of the alumni were so kind and informative - it made me excited to think that my group might all end up as successful and cool as they are.”*

Table 4: The degree to which the 2018 interns (n=14) agreed with statements regarding the role of the alumni mentors in their summer experience. Responses suggest alumni found these interactions to be a positive experience. The cells of responses considered by the program to be positive by the program are colored green, neutral responses are gray, and negative responses are orange.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
It was helpful to have the alumni mentor available to answer questions and post comments on the blogs and the Facebook group.	**64.3%**	28.6%	7.1%	0.0%	0.0%
Overall, I felt the alumni mentor served a positive role in my summer experience.	**78.6%**	14.3%	7.1%	0.0%	0.0%

The 2018 interns also reported a high degree of satisfaction with the mentoring they received from their primary science mentor. All the interns, with one exception which will be discussed below, indicated that the mentoring they received was either "Very effective" (71.4%) or "Effective" (21.4%). As illustrated in Table 5, this effectiveness was demonstrated for most interns, across a number of different dimensions of mentoring. For example, 85.7% of the interns "strongly agreed" their mentor treated them with respect, and "strongly disagreed" (64.3%) or "disagreed" (21.4%) that when their mentor gave them advice, it made them feel stupid.

While these are all positive outcomes, there appears to be some room for improvement. For example, ideally, all mentors would encourage and enable their intern to pursue their interests and would ask frequently what the interns thought. These are the sorts of small shortcomings that might be addressed through the development of mentoring tools that include an overview of mentoring, suggestions for improving mentoring based on actual intern feedback, and the use of data like these to illustrate to mentors places they may want to be more attentive and intentional.

The student who was the exception and described the mentoring they received as "not effective" and selected the most negative responses to describe their interactions with their mentor represents a unique case for the program. Both the intern and the mentor did not fulfill all the obligations described in the "contract" they each sign at the beginning of the summer. As a result, the situation escalated to the point of being unsalvageable by the time the program facilitator intervened mid-way through the summer, and resulted in the student not completing an AGU poster presentation. Based on this experience, it is recommended that additional check-ins be developed and implemented earlier in the program. This could be as simple as a quick email sent to mentors and interns every two weeks asking how things are going. Responses could be based on a Likert scale (e.g. 1 – Poor 2 – Fair 3 – Good 4 – Very good 5 – Excellent) with an explanation requested for responses of three or lower.

Table 5: The degree to which interns agreed with statements about interactions between themselves and their primary science mentors. The cells of responses considered by the program to be positive by the program are colored green, neutral responses are gray, and negative responses are orange.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Technical/scientific assistance and guidance from the mentor, their graduate students or other staff was readily accessible throughout the internship.	**78.6%**	21.4%	0.0%	0.0%	0.0%
My mentor treated me with respect.	**85.7%**	0.0%	7.1%	7.1%	0.0%
I felt I could trust my mentor.	**71.4%**	14.3%	7.1%	0.0%	7.1%
I liked being around my mentor.	**71.4%**	14.3%	7.1%	0.0%	7.1%
My personal development is at least as important to my mentor as producing science results.	**71.4%**	7.1%	14.3%	0.0%	7.1%
My mentor encouraged and enabled me to pursue my interests.	**57.1%**	28.6%	14.3%	0.0%	0.0%
My mentor was interested in what I wanted to do with my education and career.	**71.4%**	7.1%	14.3%	0.0%	7.1%
My mentor talked to me in ways I don't like.	7.1%	0.0%	7.1%	14.3%	**71.4%**
When my mentor gave me advice, it made me feel stupid.	7.1%	0.0%	7.1%	21.4%	**64.3%**
I wish my mentor asked more about what I thought.	7.1%	0.0%	14.3%	35.7%	**42.9%**
My mentor did not actively help me achieve my goals.	7.1%	0.0%	14.3%	28.6%	**50.0%**
Throughout the internship I monitored my progress towards "my own" goals and adjusted them when necessary.	**35.7%**	**35.7%**	14.3%	14.3%	0.0%
My mentor provided (in-person or via the internship facilitator) clearly stated written goals for my internship.	28.6%	**35.7%**	14.3%	14.3%	7.1%
Throughout the internships I monitored my progress using the mentor's goals and adjusted them with the host PI when necessary.	21.4%	**35.7%**	28.6%	7.1%	7.1%

Learning - The production of research is certainly an important outcome for a scientific internship experience. To that end all but one of the respondents agreed (50%) or strongly agreed (43%) that their work contributed in a meaningful way to the overall success of the mentor's research. However, it is through this process that the primary goal of the experience, personal growth and development of the of the participating student, occurs. Growth takes paces across a spectrum of constructs and includes scientific knowledge, understanding of and ability to participate in scientific inquiry broadly, conduct research skills within a specific field of study, etc. Participants' post participation perceptions (Table 6) reveal that the largest increase in learning focused on the knowledge of and ability to use technology to study geophysical data. This is not surprising as a the majority of the summer is spent learning about scientific computing and the processing of digital data sets. Areas where slightly smaller gains were reported focused on design and conduct scientific investigations and defending a scientific argument. Again this is not surprising as many of the interns don't gain direct experience in these topics. For

example, most IRIS interns work on a research project that had already been designed before they arrive. Also, due to the limited time window of a summer research experience, most don't make enough progress to develop the project far enough along to defend their ideas (e.g. author a publication). However, the vast majority of the interns strongly agreed (79%) or agreed (14%) that they will easily apply the knowledge and skills learned during the internship to their future career goals and 100% of respondents agreed or strongly agreed that overall, the IRIS internship program was one of the best learning experiences they have ever had.

Table 6: Interns perceptions of changes in their abilities and understanding related to the processes of scientific research. The cells of responses considered by the program to be positive by the program are colored green, neutral responses are gray, and negative responses are orange.

	Increased a lot	Increased a little	Remained about the same
My ability to gather, manage and convey scientific information has	**64.3%**	35.7%	0.0%
My understanding of the process of scientific inquiry has	**64.3%**	28.6%	7.1%
My ability to design and conduct scientific investigations has	**50.0%**	**50.0%**	0.0%
My ability to defend a scientific argument has	**42.9%**	**42.9%**	14.3%
My knowledge of, and ability to use, the technologies to collect and study geophysical data has	**85.7%**	7.1%	7.1%
My ability to use scientific literature and media to broaden my knowledge has	42.9%	**57.1%**	0.0%

Future Intentions - Over 82% of interns arrived to the program expecting to attain a graduate degree, while the rest were undecided. Most were expecting this to be a PhD (53%) but many others were planning on a master's degree (29%). After participating in the program the percentage of interns undecided about the possibility of a graduate degree decreased to 7%, while the number planning to pursue a PhD degree increased to 71%. The percentage of interns planning on a Master's degree decreased slightly to 21%.

When asked about the field they were interested in pursuing a career in prior to the program, just over half the interns enter very interested in a career in the geosciences broadly. When asked specifically about the geosciences, over 75% reported being very interested. Following participation in the program, 89.2% of participants reported that their desire to pursue a career in geophysics had either "Increased a Little" (35.7%) or "Increased a lot" (57.1%) as a result of their experiences.

Presentation at a Professional Meeting

An important component of the IRIS Internship Program is the opportunity for all interns to attend the Fall meeting of the American Geophysical Union (AGU) to present the results of their summer's research. In 2018, all of the interns "Strongly Agreed" or "Agreed" that the program adequately prepared them to attend the Fall AGU meeting. When asked how valuable it was for them to attend AGU as part of the internship program, the responses were unanimously the most positive option, "Very Valuable". To explore why AGU was such a valuable experience, interns were asked to identify reasons from a list. Students were permitted to select more than one option and to write in "other" reasons. As illustrated in Table 7, the most frequently selected response focused on strengthening their connections with the rest of the cohort, the opportunity to showcase their summer's work. Other reasons frequently identified included the opportunity to explore a range of research topics, and networking with potential graduate school advisors, and helped the interns to feel like they fit into a geophysics career.

Table 7: Reasons that interns (n=13) valued their experience presenting their research at the Fall AGU meeting, and the frequency with which each reason was selected. Respondents could select all that applied.

Answer Choices	Frequency
It allowed me to strengthen my connections with the other IRIS interns.	13
It allowed me to showcase the results of my summer's work.	13
It exposed me to a range of research.	12
It enabled networking opportunities with potential graduate school advisors.	12
It enabled networking opportunities with graduate students.	11
It helped me feel like I fit into an geophysics career.	11
It enabled networking opportunities with other undergraduate students.	5
It exposed me to a range of career options outside academia.	3

With an eye towards continuous improvement, interns were also asked to describe what would have made attending AGU more valuable. The most frequent response indicated that the overlap of the meeting with finals week was problematic. However, this is outside of the control of the program as most science meetings have some overlap with the academic calendar. The second most frequent suggestion was to create a list of suggested talks/posters, and AGU short-courses for the interns to visit. Given the size of AGU many interns find the meeting overwhelming and they have difficulty identifying the sessions that are likely to be the most worthwhile.

Mentors' Perceptions of the Program

Overall - Mentors perceptions of the internship program and their effectiveness as mentors were largely positive. As indicated in Figure 7, mentors were satisfied that the selection committee had provided them with a well-qualified student. Moreover, all but one "Agreed" (n=6) or "Strongly Agreed" (n=5) that their intern made meaningful contributions to their ongoing research. Most, "Agreed" (n=2) or "Strongly Agreed" (n=7) that hosting an intern this summer was beneficial and a worthwhile use of their time. Three additional were undecided about this. When asked how likely they were to participate in the program again, 11 mentors indicated that they were "Likely" (n=5) or "Extremely Likely" (n=6) to do so. The remaining mentor indicated that they were Extremely Unlikely to participate in the program again. However, they noted this was "mostly a function of their workload, which is outside of the program".

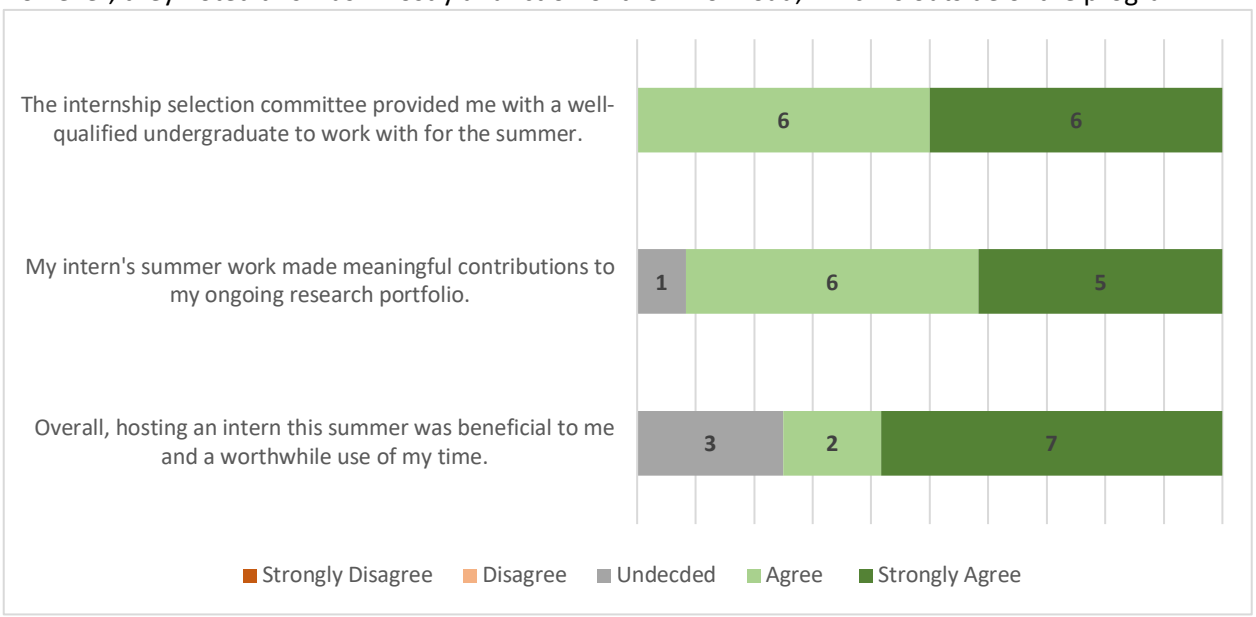

Figure 7: Mentors' agreement with statements about the internship program were largely positive.

Given these largely positive views of the program, it is not surprising that mentors unanimously indicated that they would recommend the IRIS Undergraduate Internship program to collogues. When asked what they would say, 10 of 12 respondents indicated that through their colleagues would have the opportunity to work with high-quality undergraduate students (e.g. “I was highly impressed with the preparation and motivation of my intern”, “The maturity and preparation of the interns are high due to the selection process”). In addition, two other themes emerged, albeit with a less frequency. Three mentors noted that working with an undergraduate student on research is a large time commitment. Two other responses noted the quality of the program’s facilitation (e.g. “program has a solid and ongoing infrastructure that works well”).

Programmatic Tools/Processes - The survey also asked mentors to provide feedback on the tools the program implements. Specifically, mentors were asked about the students’ blogs and the self-reflection guide which are designed to support the mentoring process.

Faculty mentors were asked to what degree they agreed with the statement “I was aware that my intern kept a blog as part of the internship program and I occasionally looked at it.” Most mentors “Agreed” (n=5) or “Strongly Agreed” (n=4) that they were aware of interns’ blogs and occasionally looked at them. Three mentors disagreed with this statement. A follow-up probe found that while mentors may be aware of and look at the blogs, many perceive them as unimportant or even a negative aspect of the program. For example, seven of twelve responses indicated that the blogs seldom played a role in the mentoring process (e.g. “we did not discuss the blog. So, the blog is not significant”). Two other responses expressed concerns that the blogs were public rather than private. One was concerned about the accuracy of the information that was being posted (e.g. “I would rather the blog was private, because at times I worried that my intern was writing things that were incorrect”) while the other had concerns about the dissemination of preliminary results (e.g. “One issue is release of preliminary (and proprietary) results. Of course, interns are eager to share their discoveries, but a blog is not the right medium nor time”).

While the overarching perception of the blogs appears tepid among mentors, one mentor did describe how the blog played a role in enhancing their mentoring by illuminating the intern’s thinking.

> “Part way through the summer, after reading my intern's blog, I realized they were lacking the bigger picture context of their work. I also realized that my intern was perhaps treating the data analysis too much like a blackbox. Though I am still not sure how much I succeeded at changing that, I did spend quite a bit more time discussing these subjects with the intern.”

A few mentors did identify potential benefits of the blogs that were outside of the mentoring process. These included the opportunity to communicate science, keep track of their summer experience, and maintaining connection with the other interns. However, it was unclear if these were benefits they witnessed or simply ideas of how blogs might benefit participants.

Mentors expressed varied perceptions of the usefulness of the self-reflection guide. Most perceived it as “Useful” (n=7) or “Extremely Useful” (n=2). However, the remaining three perceived the tool each as “Somewhat”, “Slightly”, or “Not at all useful”. As illustrated in Figure 8 below, a majority of mentors Agreed or Strongly Agreed that the self-reflection guide served a number of beneficial roles. These included illuminate areas that needed improvement and areas where growth occurred, assess my intern's progress during the summer. While many found the self-reflection guide to be useful, using the self-reflection guide did not seem to appeal to the mentors. For example, only three of twelve indicated

that they looked forward to completing the self-reflection guide, and only one of twelve indicated that they intended to use the self-reflection guide or a modified version of it with other students in the future.

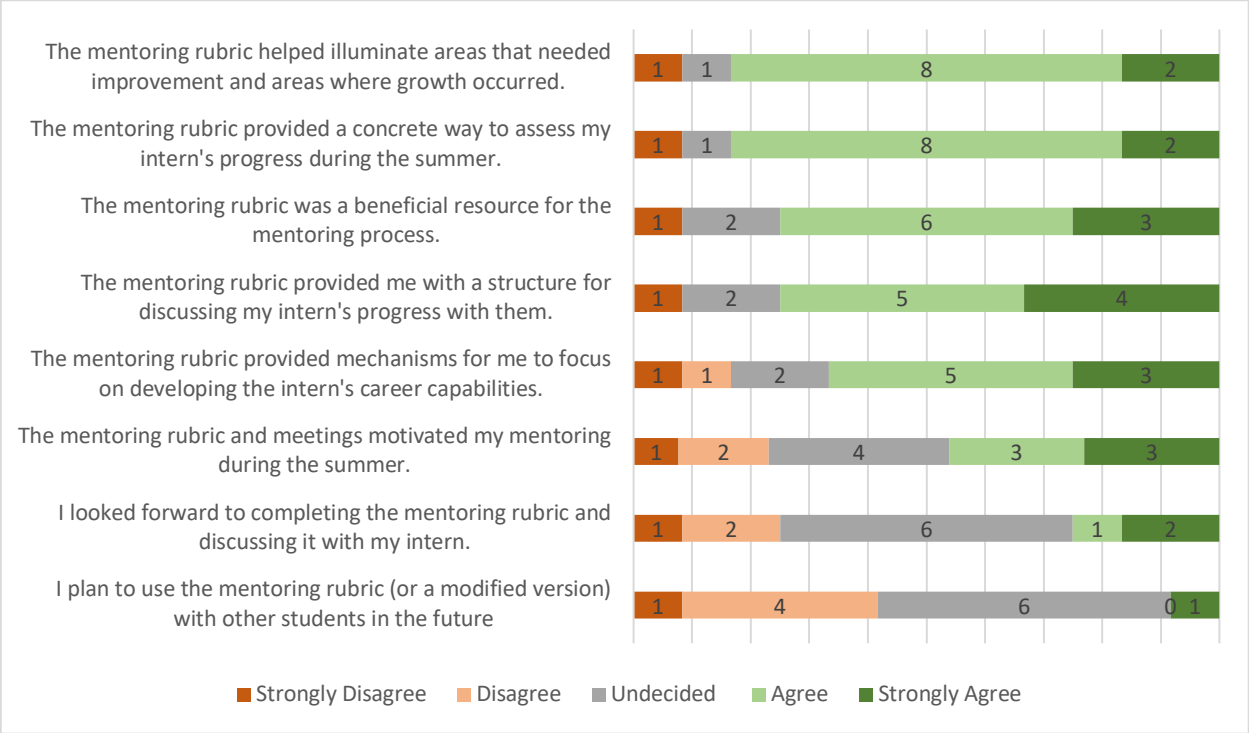

Figure 8: Mentors perceptions of the self-reflection guide. While most indicated it had positive attributes, responses also suggest that mentors do not enjoy using it.

When asked what would increase the usefulness of the self-reflection guide, mentors' offered only a few suggestions with no consistent themes emerging. For example, two mentors suggested making the tool more quantitative, one suggested making the tool shorter with only the key constructs, and a final response suggested using more peer-review or peer interaction for the tool.

Suggestions for Improvement – Finally mentors were also asked to provide additional comments that could help the program improve. Six of the mentors responded to the prompt. Two provided positive comments about the program suggesting it should continue on the existing course. One suggested changing the programs' process of matching students to projects by offering faculty more than a single student to select from. Another suggested revisiting the self-reflection guide to see if it is "still the best way to gage an intern's progress". Two others indicate that better communication between the mentors and the program might be helpful. For example, one indicated that they never received the mentoring rubric and so didn't use it. The other suggested "a weekly (short) email to all mentors with some updates about what the interns are doing in their weekly webinars, blogs, etc. In other words, some sort of communication that helps connect the mentors to the overall intern program (not just our intern)".

Summary and Recommendations

Overall, all but one student found that the program was well run and organized, and all describe the program as one of the best learning experiences of their lives. The program was successful in recruiting applications from the populations targeted. The selection process also seemed successful. However, the program did fall slightly short of the goal of accepting 20% of the interns from UMR communities.

Students experiences in all phases of the program were very positive. At the orientation, students reporting building a strong group cohesion, learning both skills and knowledge across a broad spectrum of topics from instructors that received favorable reviews. As a result, the mean perceived preparedness of the interns increased on the post survey. While in their placements, the evaluation revealed evidence of student learning and changes in students' future intentions. For example, all students felt the support they needed to be successful in their research was available, and that their projects contributed in a meaningful way to their mentors research portfolios. Importantly nearly all interns described increases in skills and knowledge that they could easily apply to their future career goals. In turn, this also translated into increased intentions to purse advanced degrees in seismology/geophysics. The one exception was the case of the intern-mentor pairing that fell apart and did not result in a final product for the summer leaving both parties unsatisfied with the experience. Recommendations to avoid such situations are included below.

Like the student participants, mentors conveyed very positive perceptions of the program. They were satisfied with the interns that were selected to participate in the program, with the research that was produced, and they perceived their experiences as successful.

While the evaluation did find that the program was successful on many measures, there were also areas where minor adjustments could further improve the program. These are presented below by programmatic phase.

Recruitment and selection

- Conduct additional advertising to increase the number of applications received and considered. From a historical perspective, the applicant poll was on the small side. A larger applicant pool will allow the selection committee to be more selective and will also contain applications from additional URM students.

Pre-Internship Preparation

- Develop new leveled instruction for scientific computing skills. This will allow the program to support both beginners while also enabling more advanced students to increase their skills as well.
- Continue to monitor the intensity of the agenda. The overscheduling of the orientation has been a consistent theme of feedback from interns over the past few years. While changes have been made, feedback from 2018 continues to suggest that additional attention is needed to address the fatigue that some students experience and ensure that the agenda runs on time.
- Expand learning opportunities regarding coursework necessary and the graduate school process for seismology/geophysics careers beyond the orientation week. The evaluation suggests that the current learning in the orientation week may not be adequate to fully answer students questions. Additional webinars on these topics, especially at the end of the summer, would allow students to revisit these important topics from the perspective of having participated in research.

Internship at Remote Sites

- Intentionally encourage GroupMe and/or social media as ways for the cohort to connect outside of Slack. Intern feedback suggests that such platforms have become an increasingly important element for connectedness.
- Refine mentoring tools to include additional prompts to ask the interns what they think and what their interests are and how best they might pursue those.
- Develop additional quick, perhaps even text based, check-ins for both the interns and mentors. Weekly implementation may catch budding issues before they become full blow problems.
- Add a summer webinar on planning research, and seismic experimental design. This is area where interns reported not gaining much knowledge since most interns work on projects that have already been developed.
- Increase communication with mentors throughout the summer… potentially highlighting blog posts etc. Increased communication might also include information about the theory underpinning the self-reflection guides and blogs as a way to gain additional mentor buy-in while also making them more useful.
- Revisit the blogs and explore if there are ways that they could be made more useful to the mentors and potentially address some of the mentors concerns with the blogs.
- Revisit the self-reflection guide to see what adjustments could be made to both increase its effectiveness and increase mentors use of the tool. Additional education for the mentors about how and why the self-reflection guides support student learning.

Presentation at a Professional Meeting

- Prior to AGU, create a create a list of suggested talks/posters, and AGU short-courses for the interns to visit. AGU is a huge event can seem overwhelming to newcomers. This cheat sheet, so to speak, would help students get a leg up quickly.

Evaluation

- Clean up the evaluation questions
    - Ensure parallel wording between the pre and post surveys to allow for a direct comparison.
    - Reduce unnecessary redundancy on the post survey. For example… “As a result of this internship, I plan to seek a career in a field of geophysics or seismology.” and “As a result of this internship, my desire to pursue a career in geophysics or seismology has”
- Include follow-up questions for interns who answer strongly negatively to statements about the mentoring they received. This would allow for the collection of important details from the small number of students where something went wrong.