Work in Progress: Design Considerations for an International Research Program for Students: Learning from Existing Programs

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Abstract
International research experiences not only help engineering students develop global competencies, but also offer benefits and opportunities for faculty members. This work-in-progress paper explores the benefits, opportunities and challenges that faculty members identify in leading an NSF-funded International Research Experiences for Students (IRES) program for undergraduate and graduate engineering students. U.S.-based faculty and a sample of international partners from nine IRES programs were interviewed to understand how they have structured their programs and what the outcomes of the programs have been for students and their own research productivity and larger-scale collaborations. A variety of program design decisions including student deliverables, in-country logistics, and unique program features were found to influence both faculty members' research and the departments and colleges hosting the IRES programs. Best practices for faculty coordinating international research programs include identifying research outputs for the program early, designing a program structure that facilitates these planned research goals, and considering participation of undergraduate versus graduate students.

Introduction
Although developing global competence is important for engineering students to be successful in the globally connected workforce, many students find it challenging to participate in traditional study abroad programs for financial or scheduling reasons [1]. One type of programming that addresses these concerns is international research experiences, which not only support the development of students' global competencies and technical engineering skills [2], but also provide benefits and opportunities for faculty members who coordinate these experiences. While research has focused on the benefits to students who participate in international research experiences [2]-[6], very little research has examined how the coordination of research experiences for undergraduate and graduate students may benefit faculty members. Faculty involvement has been highlighted as an important factor in encouraging student participation in international programs, and research experiences have been highlighted as an important option to consider for both faculty and students in STEM disciplines [7]. As described by Knight et al. [8], identifying potential motivating factors for faculty to support students going abroad is an important first step for expanding international opportunities for students.

This work-in-progress begins to fill this gap by examining the benefits and opportunities that faculty members identify in leading an international research experience for undergraduate and graduate engineering students. Through interviews with faculty who have been awarded the National Science Foundation's International Research Experiences for Students (IRES) grant and a sample of their international collaborators, this study also seeks to examine differences in how faculty choose to structure international research programs, how the program structure influences the benefits faculty identify, and identifies several best practices in the coordination of international research programs. Although we do not believe that a single model should be

applied to all programs, we hope this paper helps program leaders think through the tradeoffs associated with selecting different structures for their international collaborations.

Background
The National Science Foundation's International Research Experiences for Students (IRES) program supports international research experiences for U.S. undergraduate and graduate engineering students. IRES programs seek to develop globally connected future researchers while also facilitating broader long-term collaborations between U.S.-based and international research groups. Faculty and student exchanges are expected to result in international linkages between the researchers that bring new insights and methods to U.S.-based research projects, leading to transformative research. Faculty members who are awarded IRES grants coordinate student travel to non-U.S. locations for periods of several weeks to a semester for immersive experiences under the mentorship of appropriate collaborators.

Historically, the IRES program has funded international cohort experiences where IRES students are recruited and prepared by the U.S. PI(s), then travel to the foreign site to conduct research under the direct supervision of foreign research mentors. Although the National Science Foundation amended its award process in 2018 to include two additional types of IRES programs aimed at graduate students, this work-in-progress paper focuses solely on the international cohort experience, what the NSF now calls Track I: IRES Sites (IS). This model engages a group of undergraduate and/or graduate students in collaborative research at an international site for a typical duration of 6-10 weeks.

Methods
In this project, we conducted a comprehensive evaluation of nine IRES programs through a case study analysis. The selected cases included engineering-focused IRES experiences for ease of comparison. In selecting cases, we sought to diversify the selection along the following dimensions: global region of host university, U.S. institutional type, and U.S. institution location (see Table 1). Case studies included interviews with all U.S. PI's, a selection of additional international and U.S. faculty researchers, and select student alumni.

Table 1

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
US University - Carnegie Classification	Doctoral University: Very High Research Activity (Public)	Doctoral University: Very High Research Activity (Public)	Doctoral University: Very High Research Activity (Public)	Doctoral University: Very High Research Activity (Public)	Doctoral University: High Research Activity (Public)	Doctoral University: Very High Research Activity (Public)	Doctoral University: Very High Research Activity (Private)	Doctoral University: Very High Research Activity (Public)	Master's Colleges & Universities: Larger Programs (Public HBCU)
US University - Region	Southeast	Southeast	Southeast	Midwest	West	Southeast	Northeast	Southeast	Southeast
Country	China	UK	Australia	South Africa	Portugal	Germany	Japan	Germany	Ghana

Data collection focused on the following topic areas:

1) *Impact on Student Researchers*
   - How has IRES influenced students' career plans and motivation to participate in global research collaborations during their careers?
2) *Impact on Faculty Collaborators*
   - How has IRES and resulting linkages influenced their research and teaching?
   - What factors facilitated and hindered achievement of IRES research goals?
3) *Impact on Participating Institutions*
   - How has IRES influenced ongoing and future research collaborations between institutions?
   - How has IRES influenced the educational environment at participating institutions, including educational exchange/future study abroad opportunities?
4) *Impact on Quality of Research Outcomes (e.g., on Knowledge Environments)*
   - In what ways has the research process been transformed as a result of IRES?
   - How has IRES led to the identification of methods/approaches outside the US that could facilitate better research?

We used a combination of site visits and web-based video interviews to gather data. Interviews with PIs lasted 60-90 minutes and student interviews lasted 30-45 minutes. All interviews were transcribed and analyzed to understand variation across programs. In this work-in-progress paper, we focus our attention on the different structures of the programs and what that means for faculty and institutional outcomes.

Results

Across the nine programs, this study found five different program structures, each with different impacts on the faculty member, their institution, and research outputs. A summary of program models is described in Table 2.

Table 2

Program Model	Faculty-to-faculty	Single faculty	Department-level broker	College-level broker	Network
Description	Faculty (PI) leads research in collaboration with international partners	A single PI runs research laboratories domestically and internationally	Faculty PI serves as a "broker" between different domestic departments and international partners	College-level PI serves as a "broker" between multiple domestic departments and international partners	Existing professional network structures the collaboration
Cases	4,5,6,8,9	1	3	2	7

The faculty-to-faculty model was the most common among our cases, where a faculty PI leads both the research undertaken by students and coordinates the logistics of the IRES program (cases 4, 5, 6, 8, and 9), with student research activities co-supervised by an international partner. Impacts on the faculty member included expansion of the PI's research areas, scholarly

publications, access to the recruitment of new graduate students, and the securing of new grants to support their research. The impacts on the broader institution for some of these programs included the recruitment of postdocs and new graduate students from the international partner institution to the host institution. The quality of research was improved via interdisciplinary connections, and new cohort models for undergraduate research were also developed from this kind of structure.

The second model involved a PI who ran laboratories both at their home institution and at the overseas institution. This single faculty structure was unique to Case 1, which took place in China, in that the faculty member held a staff position at the partner university in addition to the full-time appointment at their home institution. For the faculty member, this model held a valuable benefit in that they were able to create a larger research team which directly worked with their research projects at the partner institution. This model also strengthened the strategic partnership between the domestic institution and the Chinese institution. A disadvantage, however, was that because students worked with the PI both domestically and abroad, this model cultivated very few new collaborations at the host institution.

A third model included the faculty PI serving as a "broker" to a different department; students' research projects focused on a different engineering discipline than the faculty PI, and the partnership stemmed from prior relationships (Case 3). In this case, the faculty PI's responsibilities were primarily in the administration of the program and negotiation of the relationship with the partner institution abroad. This model has several advantages, including strengthening the research collaborations at the home institution via the relationship between the PI's home department and the department overseeing students' research. In addition, it strengthened the partnership with the overseas partner by broadening research across disciplines. Positive impact on the PI's home institution included that as a result of the collaboration cultivated in this model, more faculty became involved over the life of the grant, creating more affiliations with the overseas partner. This led to clear research benefits, including the development of new projects between faculty at the home institution and the overseas partner.

In the fourth model, the faculty PI served an administrative role in the college and served as a "broker" to a number of different departments (handling the administration of the IRES program so they could focus on the research). This model, similar to the prior "broker" model, was successful in jump-starting new research collaborations and strengthening existing collaborations, leading to increased publications and jointly supervised graduate students. Because of broad participation across five departments and involvement at the administrative level, this approach also strengthened the college's strategic partnership with the overseas institution in the U.K. Direct communication at the dean level with the partner institution led the partner to create a reciprocal research program to send its students to the United States, as well as to lobby the NSF-equivalent in their country to create a reciprocal funding opportunity.

Lastly, the fifth model involved a network-wide program (Case 7). This model was unique in that it involved students being recruited from institutions across the country through an existing professional network and then placed in multiple research labs at the partner organization overseas. Rather than building on relationships between individual faculty members, this model capitalized on a professional global network. Benefits included that the overseas organization is

now sending graduate students to the United States for research in the summer. New proposals are also being submitted for other collaborations between the networks. This model had unique benefits for U.S. students in that it broadened access to international research opportunities for students at smaller institutions. It also provided greater opportunities for placing students in experiences that matched their research interests. Although this program targeted undergraduate students, this model could provide a clear advantage for graduate students because selecting from a range of different research topics would increase the likelihood of finding alignment with their dissertations.

Concluding Discussion
In this work-in-progress paper, we explored structural differences between nine different IRES programs. We identified five different structures among our sample and demonstrated that the structure of the program appears to influence the magnitude, scope, and the kinds of impacts of the program on faculty members and the institution. Faculty PIs leading the endeavor on their own tended to realize greater individual and research benefits. Knight et al. [8] suggest that offering "carrots" may be important for spurring faculty involvement in international programs, and this model structure aligns most closely with the metrics that research universities typically consider for faculty members' paths to promotion. Although there is a greater logistical demand on an individual faculty member, the model could support their career trajectory. Our findings support previous suggestions that research programs may be an effective approach for incorporating STEM faculty and students into international experiences [7].

The "broker" and network structures might be better approaches for colleges that are seeking to achieve broader internationalization goals. For the "broker" approach, a faculty or administrator PI can think more strategically and recruit faculty members on both sides of the partnership to participate in the program, which can have magnification effects that can expand internal relationships (e.g., the faculty broker) or institutional collaborations (e.g., the college broker). In a similar broader model, a network-wide program takes advantage of an existing consortia of institutions that collaborate around a common research area. This approach could be a better model for graduate students because it becomes easier for students to find a suitable international project that aligns with their program of study. This approach contrasts with that of the individual faculty PI-structured projects, for example, because those more individualized collaborations tend to be much more focused on a particular research topic. Such alignment may help graduate students gain the support of their advisors to participate in an international program, which has been highlighted as a best practice in providing such opportunities to graduate students [9].

In addition to these differences in impacts across structures that future program leaders might consider when organizing their programs, we also identified a series of consistent themes. First, PIs noted that the biggest challenge with IRES concerned NSF's restriction that international partners could not receive direct funding. Since this is the case, the domestic PIs felt like they were in a situation where they were asking international hosts to volunteer their time to mentor students, and so it became especially important for the project to generate a research output so that the host could justify their time spent on the project. There were also tradeoffs with respect to the student population that was involved in the collaboration. Involving undergraduates helped

advance their specific skill level and offered a recruitment source for graduate programs, but their involvement tended to result in fewer research products relative to graduate students. Graduate students, in contrast, had a bit less flexibility in terms of their topic areas if they were to remain on track with their own thesis or dissertation work. An NSF workshop on international experiences for graduate students suggested that faculty members may be hesitant to support the involvement of their graduate students in such programs because they believe such involvement may reduce the student's productivity and increase their time to degree [9]. However, finding funding for global experiences was identified as the largest concern for faculty in a pre-workshop survey [9], for which the IRES funding program could be a potential solution.

In summary, we hope this work-in-progress can highlight some of the different tradeoffs that are involved in deciding the structure of an international research experience program for students. Although we are not recommending one model over another, we do want to flag that there should be a different set of expectations with respect to faculty and institutional impacts as a function of that structure decision. The next step in this research is to explore differences in students' experiences and outcomes across these different structures.

References

[1]   A. Parkinson, "Engineering study abroad programs: Formats, challenges, best practices," *Online Journal for Global Engineering Education*, vol. *2*, no. 2, pp.1–15, 2007.

[2]   K.A. Davis, Y. Jalali, D.B. Knight, V. Lohani, & R. Müller, *Student learning in international research programs: A comparison across cultural contexts*, *2*018 ASEE Annual Conference and Exposition, June 24-27, 2018, Salt Lake City, UT.

[3]   L.M. Hatfield, C.T. Amelink, N.P. Sanderlin, H.E. Lyne, & B.K. Jesiek, *Student outcomes of participating in an international research experience*, 2017 ASEE Annual Conference & Exposition, June 25-28, 2017, Columbus, OH.

[4]   B.K. Jesiek, Y. Haller, & J. Thompson, "Developing globally competent engineering researchers: Outcomes-based instructional and assessment strategies from the IREE 2010 China research abroad program," *Advances in Engineering Education*, vol. 4, no. 1, pp. 1–31, Winter 2014.

[5]   C. Matherly, G.R. Ragusa, S. Phillips, & C.A. Chapman, *International vs. domestic research experiences for undergraduates (REU): A three-year assessment of the preparation of students for global workforces*, 2016 ASEE Annual Conference & Exposition, June 26-29, 2016, New Orleans, LA.

[6]   G.R. Ragusa, C. Matherly, & S. Phillips, *Comparison of the impact of two research experiences for undergraduate programs on preparing students for global workforces*, 2014

IEEE Frontiers in Education Conference, October 22-25, 2014, Madrid, Spain.

[7] T. Giedt, G. Gokcek, & J. Ghosh, "International education in the 21st century: The importance of faculty in developing study abroad research opportunities" *Frontiers: The Interdisciplinary Journal of Study Abroad*, vol. *26*, pp. 167–186, Fall 2015.

[8] D.B. Knight, H.M. Matusovich, M.S. Artiles, K.A. Davis, T. Kinoshita, D. Bairaktarova, K. Hodges, T. Knott, W.C. Lee, M. McGlothlin Lester, L.D. McNair, K. Reid, & D.R. Simmons, *Sustaining a study abroad program at scale: What motivates faculty members to engage in such programs?* 2018 ASEE Annual Conference and Exposition, June 24-27, 2018, Salt Lake City, UT.

[9] B.S. Mitchell, M.E. Besterfield-Sacre, R. Bhandari, & B.K. Jesiek, "Final report: Best practices in international research experiences for graduate students," NSF Workshop, Tulane University, New Orleans, LA, January 10, 2019. [Online] Available: http://nsfworkshop.wp.tulane.edu/wp-content/uploads/sites/378/2019/04/NSF-2019-Workshop-on-International-Research-Experiences-Final-Report.pdf.