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# Best Practices in Mentoring Undergraduate Researchers for Placement in an International Setting

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Abstract: Undergraduate research experiences in international settings combine multiple High Impact Practices and benefit the student participant in several direct ways. Additional benefits to mentors at both sending and receiving institutions are described here, including new avenues for funding and being recognized as part of a pipeline of talented researchers. Characteristics that indicate likelihood of students producing publication-quality results have been identified, and mentors are encouraged to recognize these and facilitate their development in undergraduate scientists. Through intention and application, mentors can improve the training of a generation of global scientists.

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Impacts of STEM research in today's rapidly globalizing society are all around us: from discoveries that affirm Einstein's century old predictions and shape the way we perceive the universe, to global economic powerhouses in the culture and business worlds that were not even in our imaginations just a few years ago. This is why training our youth to be knowledgeable and effective to innovate and discover in a global society is so important. Fortunately, interest in STEM fields for this same young population has been described as contagious.<sup>1</sup> Nations and cultures also struggle with increasing numbers of socially disadvantaged, culturally displaced, and minority populations and how to engage these peoples. These populations form a specific focus of this manuscript, though many of the themes apply broadly. Effective training requires effective mentoring. Popular and peer reviewed literature well beyond the domain of scientific research espouses that if one wants to move ahead, one of the best things he or she can do is to find an effective mentor.<sup>2,3</sup> Mentoring is most definitely a continual practice,<sup>4,5</sup> and taxonomies and inclusive practices have been developed and reviewed.<sup>6-13</sup>

Research experiences for undergraduates that involve work in a laboratory or field setting abroad lie at the intersection of at least two High Impact Practices: research and global learning.<sup>14</sup> Such experiences also involve challenges and potential rewards unique to international collaboration. Here we identify characteristics and practices that support effective mentoring of young scientists, in particular undergraduate researchers seeking placement in an international research experience and the research mentors both sending and hosting the student.

The community of scholars behind this work came together over the year 2015 and early 2016 with an overarching theme of articulating ways to enhance research success of undergraduate students who are able to perform authentic research abroad. Stakeholder representatives then met at a workshop from April 17-19, 2016 in Stillwater, Oklahoma. The workshop focused on the following three goals associated with the theme:

- 1) *To define characteristics that facilitate young students' research success in an international setting.*
- 2) *To discuss best practices to engage indigenous and socially disadvantaged peoples across cultures to inspire enhanced participation in authentic STEM research*
- 3) *To identify ways in which local mentors (faculty in the sending country) can engage in research their students do abroad for the benefit of the students and their own benefit*

## **Goal 1 Characteristics that facilitate international research success**

This section focuses on skills and attributes that best enable younger students to generate new knowledge in their area of scholarship. Indeed, the personal generation of a critical body of “publication quality” results, as well as their analysis and interpretation and the creativity or novelty behind them are key elements in being recognized as a co-author of a publication or co-inventor of a discovery. The collaboration identified the following 15 characteristics as those that most enable research success, combined with a solid traditional academic background. A best practice for students, mentors in the sending country, and mentors in the host country is to carefully analyze these and other enabling characteristics and strengthen them well in advance of the international research experience. The characteristics are the following:

Identity<sup>15</sup> as a global scholar – Research success is facilitated when students are able to rapidly embrace their role as a part of the team in an international setting. This is often enhanced by embracing elements of the culture as well.

Grit<sup>16</sup> and work ethic – Independent of academic preparation, sustained effort is key to obtaining research results.

Tolerance of ambiguity – The process of moving abroad for 3-6 months and starting a research project in an international setting is fraught with unknowns. Accepting the associated uncertainty and calmly working through that uncertainty is useful.

Communication – This is useful at many levels, from appreciating the differences in key technical terms across languages and cultures, to speaking precisely and learning how to simplify research concepts.

Curiosity – Demonstrating authentic curiosity in the research area, informed by reading of the literature, can be an effective way to stimulate productive conversations about publication-quality results.

Confidence – Quiet confidence reinforced by delivering on small challenges is helpful, whereas overly timid behavior in a research project can slow results.

Cultural competence – learning and embracing cultural norms helps work get done efficiently. Likewise, being able to explain complementary aspects of culture in the student’s home country helps engage international co-workers.

Etiquette and ethical standards: Understanding the standards of behavior in a foreign country, as well as similarities and differences with the home country are enabling elements in research success and in working as part of a group.

Teaming ability – No matter how independent and prepared a given student is, there is always dependent-to-independent character to any international research project. The ability to work well in a team is crucial.

Commitment and follow through - Many steps have to be put in place to launch an international research project. It is useful for a student to listen such that a given mentor only has to ask for something one time.

Long-term vision – Best results come when the international research is viewed as a continuum with effort “before”, “during” and “after” the time abroad.

Independence – The ability to accomplish tasks alone is very helpful, particularly when the student is sufficiently mature to ask for help when needed.

Ability to get help – The ability to draw from a network of people for help and to recruit and engage multiple mentors who are expert in specific techniques or research areas is a valuable tool to rapidly generate high quality results.

Serenity – To calmly be aware of strengths and weaknesses, to “feel good in one’s own skin” can smooth over many of the day to day challenges of research and of living in a new place.

Decisiveness – Knowing immediate and longer term goals and reaching strategic decisions easily greatly facilitates research success

## **Goal 2 Engaging peoples across cultures**

Engaging the talent pool associated with potential students from indigenous peoples, displaced peoples and minority populations represents an important, growing, and largely untapped opportunity in many areas of the world. In many cases, it is best to inform these students at a much younger age than their undergraduate years, while also speaking to families, communities, and teachers about the benefits of research abroad. One best practice is to speak to these

cultures in their own languages and to include characteristics like those in Goal 1 above that many parents can easily appreciate and get behind. It is anticipated that engaging the families and communities of these populations has a positive and stabilizing effect. Likewise, communicating the distinctive practices, characteristics, and cultures of other indigenous cultures around the world may provide a valuable tool to inspire early interest in STEM and international research.

Lanor Curole, Program Director at the United Houma Nation in Louisiana notes that it is critical for a professor or administrator to ask a group of people what they need. It can be tempting or even usual for scientists to begin a conversation by presenting what they believe they can do or their areas of expertise. It can be more productive to begin by asking and listening. This facilitates a better long term relationship.

Appropriate support for students in experiences that may span three or more cultures in multiple nations includes preparatory meetings prior to travel, regular journaling and processing about scientific and cultural updates during the experience abroad, and post-travel correspondence regarding continued experiments and publication. These support structures are described in greater detail below.

### **Goal 3 Connecting Mentors**

The main focus of this manuscript is on ways in which local mentors (faculty in the sending country) can engage in research their students do abroad for the benefit of the students and for their own benefit.

Mentors sending students to research experiences abroad can maximize the benefit to the students, their research groups, and their own careers through intention and application. Junior faculty benefit durably from a student forming the bridge between the sending mentor and an investigator abroad that has complementary research interests and capabilities. The act of sending a well-trained student to the research group of a like-minded international scientist is one of the easiest ways to initiate a profound and thoughtful exchange of ideas between groups. Students must have made sufficient progress in their coursework to undertake the research at hand, but they are truly ready when they are also sufficiently intellectually mature to learn new science when immersed in a group of graduate students and post-doctoral researchers instead of a classroom environment. Student gains can be maximized through the sending mentor's empowerment of familiarity in the field of research, including techniques and methods, vocabulary, and prominent or seminal efforts in the field. The mentor can also pre-train their student based on anticipation of new

concepts or methods that will be encountered. Often in a matter of minutes of direct conversation between the sending and host mentors a clear idea of learning goals can be developed that the student would not be able to develop alone. Beyond student learning gains, the professional and scholarly benefit to the sending mentor includes the documentation of international collaboration, enhanced impact factor publications, potential for research presentations, and increased access to scholarly resources and financial support.

**Junior Faculty: *What benefits should a junior faculty member know about that could come along with their student's thoughtful, intentional placement in a lab abroad?***

Junior faculty are often highly focused on publishing research papers and securing grant funding. The opportunity to send a student abroad for research presents a clear opportunity for co-authorship of research papers, and the thoughtful, intentional placement of the student in a laboratory with complementary research interests and capabilities can lead to a lasting scholarly partnership. The ability to prepare a student to hit the ground running in a short duration research experience via technical and cultural training is critical to student success, while complementarity between sending and host group research capabilities can greatly expand the possibilities for future work. For example, a theorist might send a student to an experiment-focused laboratory, or two experiment-focused labs may find harmony in different techniques and methods, such as electrochemistry and photochemistry.

Faculty sending a student abroad may earn a reputation for sending out good scientists and become recognized as a key part of a powerful pipeline. In return, they may get talented students sent to work in their own laboratory. Indeed, faculty themselves may also be invited to visit labs abroad, where they may exchange skills and techniques or forge collaborations that open up new grant opportunities, such as Human Frontier Science Program, which *requires* investigators from at least two continents.

**Student Readiness: *When is it most optimal to send your student to a lab that is in resonance with yours? When might it be unfair to or less optimal for the student? Can you accelerate the ability of a socially disadvantaged student who might be too inexperienced?***

Students planning research abroad require appropriate training, for example in specific techniques and seminal work in the field; perhaps more important is their state of readiness to learn and converse with the host group and while contending with the myriad of other factors associated with cultural immersion.

The workshop repeatedly revealed the importance of mentors also accounting for the impact of the Native American, Hispanic, African-American, or Pacific Islander student *leaving* their families and their culture for the time abroad. With this in mind, prior research experience is seen to be one of the most important predictors of success in research abroad. Previous co-authorship of a submitted or accepted peer-reviewed paper may seem an obvious general indicator of success in research. When corroborated by a thoughtful skills assessment and recommendation of a sending mentor, such success supports more detailed characteristics that indicate readiness.

Not to be overlooked is an honest assessment of the student's progress in their undergraduate coursework. The process of preparing to go abroad is a stress on academics. Many students returning to a "normal" semester in college from a full-time research experience will want to continue devoting a substantial amount of time to research, and it is critical that they be positioned well to succeed in their remaining coursework while balancing research, family, financial, and other concerns.

Students who might be externally classified as "socially disadvantaged" may display personal aptitudes that are strengths in research abroad: curiosity, lack of fear of failure, the ability to rapidly learn a new language in an informal setting, or an appreciation and respect for as yet unfamiliar aspects of culture. Systematic preparation can accelerate student preparedness. For example, Lynda Gonzales, a Director of Student Programs at University of Texas, Austin hosts weekly sessions starting months ahead of the exchange date for students intending to do research abroad and covers cultural aspects of the hosting institution and region as well as scientific aspects of the proposed research. Geanncarlo Lugo, a Senior Research Associate at Université Paul Sabatier recommends making contact with the hosting advisor at least six months in advance to improve the sending mentor's ability to prepare the student with the right aspects in mind.

It can also be important to assist the student in engaging the student's family, helping the student to assist his or her family in seeing the value of both research experience and living abroad. Within this scope, it is important to appreciate cultural values and histories that could present barriers. For example, Dode Barnett, a Council Representative at the Muscogee Creek Nation noted that their community has a history of family trauma; just two generations ago, children were taken from families and placed in institutional schools, from which many did not return. Two ways to help families see the benefits of research abroad and also improve the support network for the student are 1. to articulate a clear pathway for the return of the student empowered with new skills and 2. to engage one or more co-mentors within the student's home community, be it a family member, educator, or other leader. A student returning with an advanced degree or technical skills may be well positioned to

be a community leader. A standing community leader may be able to convince a student's immediate family of the value of such skills and achievements.

**Student Gains:** *How can you optimize learning and professional gains for the student you send?*

Mentors can help prepare students for both the broader scientific goals in their field and in specific experimental practices and design principles. Mentors can also work to optimize the timing of the student's research abroad in the context of their coursework and informal scientific learning.

Many students return from research experiences abroad understandably excited and hungry for further work in research. It is important for mentors to aid them in continuously refining their long term professional goals, balancing success in traditional academics, and in seeking an understanding of how best to achieve those goals. These students will have had more practice than many of their peers at acting as an ambassador for their home institution and region, and according to surveys administered by the American Association of Colleges and Universities (AAC&U), they are considered more employable by a majority of major corporations. The AAC&U also lists "research" and "global learning" as High Impact Practices.<sup>14</sup>

John Banks, Director of the Undergraduate Research Opportunities Center (UROC) at California State University, Monterey Bay and Lynda Gonzalez of the University of Texas both stress the importance of students journaling or blogging *during* their time abroad in addition to processing before and after the experience. Videoconferencing is recommended by many mentors as a good way to support a student abroad, to understand their progress in real time, and to ensure that the student knows that the mentor is there for them should they need assistance.

**Professional Benefit:** *How can a mentor optimize professional benefit to his or her own research group or other professional structure?*

While benefits of international research placements for students are easily recognized, mentors sending students abroad must consider benefits to themselves and other student researchers they mentor. The opportunity to author publications provides fuel for further intellectual pursuits and grant proposals, and other benefits may wait beneath the surface. As mentioned earlier, deeper integration into the scientific community composing one's field of research can have benefits that include direct feedback on the scientific merit and broader impacts of research ideas. There is no substitute for the peer review process, but it is invaluable to be able to get feedback from trusted colleagues on



experimental design, scientific conclusions, and aspects as simple as a paper's title *before* submission.

International collaboration often leads to high impact publications, improving the *quality* of a faculty member's publications in addition to the *quantity*. Connections may also be made that strengthen the identity of the sending mentor in the worldwide community of their area of scholarship or to businesses and entrepreneurs that can improve broader impacts in global pursuits such as improving biotechnology and energy.

As mentioned earlier, sending mentors may forge connections that make them eligible for funding reserved for global research projects. They may also have access to new resources for research. Geanncarlo Lugo of Université Paul Sabatier studies tuberculosis in a laboratory setting, as the disease is not common in Toulouse. He has had improved research access to patients who suffer from tuberculosis around the world through international research collaborations and in turn is able to offer collaborators access to one of few laboratories having within its BSL3 facility permanent confocal imaging and other advanced methods.

There are also mechanical, political, and administrative benefits and risks of which mentors should be cognizant. It is important for faculty to seek institutional support from their provosts, deans, and other campus leaders. Faculty can communicate that international student research experience has been shown to increase the retention and advancement of underrepresented minorities (see discussion of High Impact Practices above), diversifying the pipeline to graduate school and academia. Some campuses, including California State University, Monterey Bay, have embarked on systematic internationalization efforts; international placement of undergraduates for research experiences aligns nicely with such efforts and can be a good avenue for drawing international students to US universities.

## **Assessment**

Effective assessment of the goals and outcomes described above can take many forms. The Association of American Colleges & Universities (AAC&U) provides Valid Assessment of Learning in Undergraduate Education (VALUE) rubrics for a variety of outcomes,<sup>17</sup> including the HIP Global Learning. This rubric describes benchmark, milestone, and capstone outcomes for several sub-areas, including Understanding Global Systems and Applying Knowledge to Contemporary Global Contexts. These in turn may be assessed in student work that spans from journal entries and related products, presentations, and proposals, as well as surveys asking mentors in the sending and hosting countries to assess these outcomes at the opening and the close of a student's

experience abroad. Regular student journal entries, emails, and blog posts that begin before arrival at the host institution, continue through time there, and conclude after return to the sending institution were mentioned above as broadly important to a successful program, and it is worth noting this timeframe again here in the context of assessing both long duration research experiences and shorter duration experiences such as those occurring over part of a summer or a spring break.<sup>18,19</sup>

Such instruments are also appropriate for assessing growth in an inventory of students' STEM research skills that span laboratory methods, data analysis, and use of technical terminology. Program-level success in student research may of course also be assessed by examining the quantity and quality of student co-authored publications in peer reviewed journals and somewhat less commonly patent applications based on applied research. Progress towards publication-quality data and subsequent drafting, submission, and revision of manuscripts is well known to take its own course on its own timeframe. To this end, research experiences of greater than three months, preferably on the order of six months, have been found to offer greater chances of achieving publication and having accepted manuscripts in hand at the time of programmatic assessment.

## Conclusions

Mentors can identify undergraduate researchers who are likely to generate publication-quality results in an international research placement by looking for characteristics that include grit, curiosity, and tolerance of ambiguity. International research placements represent an excellent avenue for engaging under-represented groups and people across cultures in STEM careers, as many of the characteristics may be found as strengths across all peoples. Journaling and processing during the research experience abroad have been identified as important, and the experience should be held to begin before going abroad and continue after returning home. Mentors from the sending institution may gain broader access to funding sources, higher impact publications, and recognition as part of a pipeline of talented researchers, especially if research complementarity is found with the mentor at the hosting institution.

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