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Citation for the original published paper (version of record):
Abu-Youssef, M., Öhrström, L., Weiderud, P. et al (2018). Global Engagement in Science: The University's Fourth Mission?. Science & Diplomacy, 7(2)

N.B. When citing this work, cite the original published paper.

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SCIENCE & DIPLOMACY

A quarterly publication from the AAAS Center for Science Diplomacy

Lars Öhrström, Peter Weiderud, Morsy Abu Youssef, and Omar M. Yaghi, "Global Engagement in Science: The University's Fourth Mission?" *Science & Diplomacy*, Vol. 7, No. 2 (June 2018). http://www.sciencediplomacy.org/perspective/2018/global-engagement-in-science-universitys-fourth-mission.

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Global Engagement in Science: The University's Fourth Mission?

Lars Öhrström, Peter Weiderud, Morsy Abu Youssef, and Omar M. Yaghi

In this article, the authors—three scientists and a diplomat, working across multiple continents—intend to impart some of the broad perspective and deep experience they've gained over the years as professionals. The diplomat among us, stationed in the Middle East, has played a role in fostering peace in a region long beset by conflict. Drawing from accumulated lessons, we intend to discuss how others can be encouraged to contribute to global science, regardless of their background or national origin. In taking on this challenge, we will share insights from our various tenures as operators of bilateral aid programs, members of international science organizations, and participants in government negotiations and other events featuring the development of global science. Specifically, this article was spurred by discussions at the SwedAlex Symposium on Scientific, Social & Cultural Sustainability through Chemical Research, held in Alexandria, Egypt, in 2017.[1] *This conference included science leaders and researchers from six countries who shared their experiences in science collaboration across borders.*

During the discussions at the SwedAlex meeting, it quickly became apparent that transnational scientific collaborations face many challenges. These challenges—institutional, governmental, and societal—have already been the subject of numerous studies. In this paper, the focus will be on individual

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scientists or administrators based at universities, research institutions, or scientific organizations, and how they can use existing resources to advance the global effort to develop science. This emphasis on the individual, to be sure, differs from the usual purview of science diplomacy, which tends to involve negotiating tables, government offices, and think tanks where policies and agreements are hammered out. But a spotlight on the individual can have a large and lasting impact in promoting the end goals espoused by science diplomacy. For the individual researcher or administrator, one objective of this paper will be to offer guidance in the context of less-than-ideal funding and infrastructure. Issuing from such a discussion, the paper suggests ways for science diplomats to improve existing programs and perhaps initiate new ones toward this end.

The idea of the empowered individual scientist likewise comes from observations at SwedAlex. Emerging scholars, filled with energy and ideas, have shown themselves to be particularly strong candidates for developing their own independent research and making meaningful scientific contributions beyond their national borders. In turn, the science journeys undertaken by these scholars in their home countries underscore the need for such talent to be nurtured by their home institution as well as government agencies.

Background

Science and engineering are more relevant than ever in today's global society. In seeking to discover how the world works in increasing detail, scientists recognize the accelerating urgency with which they must address energy, environment, sustainability, and water-related challenges. Scientists represent a tiny fraction of the world population, but they are implicitly responsible for solving a great proportion of global problems. This is why knowledge must be shared across borders. A small country with relatively few scientists, for example, should be able to benefit from the expertise of larger, wealthier countries with more expansive infrastructure. In other words, bringing about comprehensive solutions to today's challenges relies on inclusive, worldwide engagement of scientists and engineers in research.

This article, with its focus on the individual, suggests a scheme for making science truly more global, while facilitating equal opportunities for all people to contribute and exchange ideas. We go further by drawing the conclusion that fostering these equal opportunities must be the university's "fourth mission," and therefore become part of every researcher and administrator's portfolio.[2] While the actions we suggest largely dwell on the individual level, we urge policy makers, science diplomats, and university administrators to design projects, programs, and incentive systems to facilitate collective action as well.

Integrating Science in Society

For centuries, scholars have traveled far and wide to exchange information and discuss ideas. This is evident in the way we talk about science, using words like "chemistry" and "algebra," derived from Arabic. Similarly, the names of many chemical elements and compounds reflect a wide variety of origins, from the Swedish tungsten to the recently named element 117, tennessine, with its roots in Cherokee (American Indian language).[3]

However, this information exchange has not occurred in a vacuum. Knowledge has been connected with power: knowledge of geography to wage war and engage in trade, knowledge of ancient languages to confirm or disprove religious texts and historical claims, and knowledge of chemistry to advance domestic industry and provide a competitive edge over those without such expertise. Historically, formal diplomacy focused on advancing the interests of individual countries, with an informal dimension that fostered collaboration and understanding. This informal facet of diplomacy is likely the most important aspect of science diplomacy covered in this article. (The technical, research-based, academic or engineering exchanges with or without a formal diplomatic involvement supports both "science for diplomacy" and "diplomacy for science.")

Sometimes the international scientific endeavor has been challenged or even co-opted by other nonscientific agendas, notably Aryan physics in Nazi Germany, Lysenkoism* in Soviet Russia, and, recently, climate change denial. Such manipulation may occur when science is under the direct command of an authoritarian regime, or is seen as an elite concept, removed from the majority and only understood by a few. Therefore, it seems more important than ever to make science an integral part of society. Universities should be the vehicle for fostering such integration. Indeed, this integration will be a necessary step in resolving the challenges just expressed, and in achieving a more technically and socioeconomically stable society.

One should also note that more than a quarter of the world population is under fifteen years of age, with the fraction of youth in Asia over 30 percent and in Africa more than 40 percent.[4] Increasingly, the pool of talent will be found outside the countries that traditionally have hosted the strongest universities and research institutions.

Science and engineering literacy is also one of the most effective means of transcending borders and solving global problems. In this way, science is the great

**Trofim Lysenko argued that acquired characteristics could be inherited, and support of this idea by Joseph Stalin hindered the development of Soviet agriculture before and after the Second World War.*

equalizer; it has the potential to provide useful outcomes that can affect societies beyond the locale where discoveries initially are made. However, to truly become an equalizer, it requires equal opportunities to contribute and exchange ideas and people around the globe.

Some aspects of achieving equal opportunities, notably access to mega-science collaborations and visa and financial support, were recently addressed by Stefano Lami in this journal.[5] Others, which will not be addressed here in detail, are access to scientific journals and the opportunity to publish freely. Yet another issue that this piece notes briefly involves power and accessibility issues related to English as the predominant language of science.

Visiting fellowship opportunities also support global contributions to science and a leveled playing field. For example, salary-funded PhD students and researchers from higher-income countries (HICs) are easily able to relocate for brief (i.e., three-month) visits in foreign institutions. This is not the case for students and researchers from low- and middle-income countries (LMICs) with less generous, or nonexistent, salaries. Fiscal and bureaucratic impediments may become overwhelming for both host and guest, a topic that likewise deserves close treatment elsewhere.** This article, as already established, looks at some of the "softer" and often more personal aspects to the challenge of equal access within scientific fields.

The Case for Scientific Collaboration

The scientific enterprise is rooted in the creation and expansion of research communities that work together to solve critical problems, despite possible social, cultural, and economic differences. Scientists seldom articulate how to approach and succeed in such endeavors. One corresponding necessity is to provide examples of diverse researchers from countries of all income levels who have created innovative solutions in order to foster credibility and model collaborations for other sectors. Model collaborations, from the perspective of both high- and low-income countries, exist at several levels: one-on-one collaborations and interactions, research groups, multi-team endeavors, and joint partnerships among national and international scientific organizations.

Then there are models of success to approach such collaboration. These include demonstrating respect for degrees earned and experiences gained, along with high

***We have noted cases of government grants in which the conditions of the grant and university interpretation of fiscal law may hinder use of the money in the intended way.*

standards and expectations for how colleagues are treated. For example, a principal investigator in a HIC who accepts graduate and postdoctoral students from LMICs should make reciprocal visits to those countries, while also considering them as potential locations for symposiums.

A key here is dialogue. Scientists from all disciplines and geographic locations, politicians, and NGO leaders must talk with rather than about, around, and over one another, and, critically, they must listen to each other. On the one hand, this should, in theory, be relatively easy, with traditional borders disappearing thanks to new information-sharing technologies. On the other hand, societies are becoming more divided based on intellectual consumerism and identity association, rather than more united by shared goals and humanity. In the university context, a classic example is a 1960-80s debate in Sweden over economic growth and finite resources. In this case—one in which proponents argued that there was no necessary coupling between growth and the use of finite resources while opponents contended that there was—many researchers clearly did not understand the opposing side's arguments.[6]

Providing physical space and experiences for people from diverse backgrounds to meet, discuss, and learn from one another is essential for nurturing science, strong societies, and the growth of humanity. Many scientists already collaborate across borders, and they have an obligation to share experiences, especially among wider circles. On this front, international scientific collaboration is unique among global collaborative efforts in that science endeavors center on inquiry that pays no mind to ethnicity, culture, social status, gender, or nationality.

Ingredients for Successful Collaboration

One reason scientific collaborations need to be emphasized and promoted is to counter the somewhat misleading notion that individuals are at the center of discovery.[7] Focusing on one or a few individuals may help universities produce appealing promotional materials for the media, facilitate clicks on news articles, and help scientists and popular science authors to sell their books. But in so prioritizing individuals, the group effort is forgotten and many deserving individuals are denied public credit. A classic example is Marie Curie, seemingly the only pre–World War II female scientist garnering media attention, while, in reality, many other women, such as Hertha Ayrton, made important contributions to science.[8] Today, a similar dynamic may prevent scientists from LMICs from receiving the credit due them in scientific collaborations.[9]

The effectiveness of the collective effort, however, also depends critically on how we invite collaborators, interact with peers and students, and pursue teaching opportunities. Senior researchers and university leaders often agree that mixing people of different nationality, gender, background, and culture enriches and moves science forward. For example, members of more than forty-three nationalities have passed through the laboratory of Nobel laureate Sir Fraser Stoddart, a Scottish-born chemist now based at Northwestern University. In reflecting on this diversity, he said, "The infiltration of people from all over the world rescued Britain."[10] What he meant by this was that the scientific success of the United Kingdom could not have been achieved without talent recruited from all over the globe.

Yet diversity alone is not enough. For multicultural, multinational collaborations to succeed, participants must always uphold notions of respect and mutuality. Carefully implemented steps toward this end include treating all members of the collaboration as equals, avoiding the presumption that certain groups may underachieve, carefully considering language and preventing domination by native English speakers–also making clear that the group leader ensures that everyone contributes and feels comfortable doing so.

In the context of scientific collaboration, the notion must also be reinforced that democratization (i.e., spreading of scientific research and thinking) benefits society in general. This means acknowledging advances in countries with research traditions and strong institutions, as well as in countries with emerging research infrastructures. Such an approach can be aptly applied to solving global challenges, where cross-discipline and multinational coordination is essential, while underscoring the increasing relevance of science diplomacy.

Nurturing Talent

Education that enables a scientific career can begin in primary school or before, yet a substantial university education may compensate for shortcomings in the early years. Many countries are today responding to a rapid increase in undergraduate student enrollment; for example, a new university opens almost every week in China.[11] In other countries, notably on the African continent, it is unclear whether the increasing youth population will have access to robust higher education opportunities.[12]

Impediments to obtaining a university education are well known, especially the high costs. Even when money is available, families may refuse well-funded scholarships to study abroad out of fear of the unknown; here and in other respects, gender may be an important factor. Such fear is not unreasonable,

given that graduates often do not return to their home countries. From personal experience, the authors know that families often apply pressure on their children to earn money as soon as they earn their first university degree. This pressure may be prevalent across high-, middle-, and low-income countries. The utility of a PhD or a postdoctoral research position may seem unclear to families who know little of the inner workings of higher education and research.

Lead figures in multinational research groups must be aware of these factors and others, as well as the lack of role models for many students and researchers. Maintaining diversity at all levels of the scientific enterprise is thus essential,[13] particularly when discussing research papers in literature seminars, inviting researchers to deliver talks, or introducing students to senior researchers at conferences and meetings. This allows emerging scholars from all backgrounds to feel personal connections and sense a professional path forward. The need for role models persists as graduates pursue careers as university-level researchers; administrators in business, government, or non-profit organizations; or secondary school educators.

The decision to pursue STEM studies, as this section has already shown, can be deeply personal. When the influence of parents, close relatives, and other early authority figures weakens, opinions of a partner or spouse may become preeminent. While a mentor or PhD or postdoctoral supervisor should not inquire about a group member's private life, he or she should nevertheless convey empathy and sensitivity when discussing career prospects.

Emerging scholars in all countries can benefit from the mentoring offered by a principal investigator. Such advising can and often does continue even after the completion of formal training. Regardless of where the emerging scholar is employed, the mentor can connect the student to the broad global scientific enterprise by recommending the student as a speaker at conferences, nominating the student for recognition, helping the student write grants, encouraging exploration of various career trajectories, and generally continuing to serve as a listener and a guide. Examples of areas where such advice may be applied range from specifically targeted grants for research collaborations, attending conferences that offer special financial support for emerging scientific regions,[14] or even organizing symposiums and events.

Expanding Collaborative Networks

A major obstacle to career realization for emerging scientists in LMICs is a lack of opportunities when they return home from their international education.[15]

While higher education and research budgets are ultimately the responsibility of each respective country, individual PIs, administrators, and policy makers can nevertheless support students upon their return, including by taking action within scientific NGOs, universities, and institutions.

More specifically, returning graduates may feel they are losing access to the international network with which they were so recently connected, along with its many collaborative opportunities.[16] Here, much can be done on an individual level, including promoting returning researchers as speakers at various events and maintaining relations with collaborators through small mutual research grants. Engaging in reciprocal visits with science-oriented peers is another important option, as is helping organize meetings like the one from which this article emerged. Bilateral grants may well be available, through entities such as the U.S. Agency for International Development, U.S. National Science Foundation, or Swedish International Development Cooperation Agency, among other players. Although sometimes small, these grants are still significant in terms of facilitating collaboration. Diaspora organizations offer yet another outlet. For example, Networks of Diasporas in Engineering and Science, a partnership among the American Association for the Advancement of Science (AAAS; the publisher of *Science & Diplomacy*), the U.S National Academy of Sciences, and U.S. Department of State, supports formation of, and engagement within, diaspora networks.

Other avenues for granting new researchers higher status within their home communities include encouraging their membership—and sometimes nominating them for leadership positions and award opportunities—in international science organizations. Scientific societies such as AAAS, Sigma Xi, The World Academy of Sciences, and the International Union of Pure and Applied Chemistry also support early career researchers from around the world. A particularly interesting initiative is the International Union of Crystallography's Crystallography in Africa program, which organizes lecture series and courses, help supply instruments, sponsor participation in conferences and support the creation of an African Crystallographic Association.[17]

A network gets stronger when nodes connect in all directions. It is thus essential that collaborative links extend from LMICs not only to a few central nodes in Europe, North America, and Asia but also to those in emerging countries. One example of a framework wherein this may be possible is L'Agence Universitaire de la Francophonie, comprising around 850 higher education and research establishments around the world.[18] The Berkeley Global Science Institute is sponsoring another initiative in which the work of chemists has been fostered within several LMICs with the expectation that each independent node collaborate

with the others, including the "mother node," at the University of California, Berkeley.[19]

In these endeavors and others like it, internet access helps scientists who return home to their LMICs stay wired to a broader network. This access helps researchers prosper by enabling deep engagement in all aspects of their research enterprise, including building infrastructure, developing curricula, recruiting talent, interacting with local government representatives, and partnering with local institutions to access talent and equipment, especially in the research startup stage.

As successful as these collaborative approaches seem, one should not underestimate the obstacles faced in successfully executing a research agenda. Unfortunately, examples abound of cooperation failing to meet expectations, and emerging scholars need to be well prepared for various scenarios. The independence of each research group with respect to intellectual freedom and research development is also essential and should be encouraged as an ultimate goal of a fruitful partnership.

In seeking to prevent unnecessary conflict in collaborations, all parties must remember to respect the professionalism of other disciplines, as well as understand everyone's distinct motivations and goals. This means scientists must develop empathy for the experience of other professionals around them. Their gaze must expand outward from the microscope lens for science to be truly integrated into broader society.

Adjusting Expectations at Home

Two principal reasons exist for host countries to fund research for international scientists: either these countries expect to benefit from the talent they attract, either immediately or in the longer term, or they want to provide an educational experience that will benefit a LMIC. For a LMIC country, of course, providing such funding is based on an expectation of accruing benefits on the scholar's return.[15] The barriers to such a return, however, may be quite steep, ranging from personal reasons to the difficulty of securing research resources to the prospect of managing heavy teaching loads. In countries with few advanced-degree holders in the private sector, an overseas PhD can actually be an impediment to nonacademic employment.[15]

Because available financial resources for academic research are likely to be firmly set, it must be stressed that not all research requires expensive equipment.

Returning scholars, therefore, might refrain from seeking to recreate their setup from the United States, for example, to avoid a sense of underperformance and frustration. The alternative, carefully considering available resources and local context, might be far more rewarding and cost-effective. Often research thrives because it is connected at the local level. Success in research, such scholars need to be reminded, relies critically on the quality of the participants rather than just equipment and buildings. Restrictions and a lack of resources is obviously an impediment, but it may also foster innovation.

In addition, governments and funding agencies must appreciate that fundamental, curiosity-driven research is critical to economic development in LMICs, as attested by historical examples. In particular, researchers provide expert guidance to government and the private sector, support innovations and investments in local industry, and create and develop local NGOs.[20] Countries must also be prepared to capture opportunities when they appear. For example, in the wake of the 2011 Arab Spring, expatriate researchers returned to Egypt and helped establish the Zewail City of Science and Technology.[21]

Call to Action for Universities

How do we as individual researchers or administrators in universities, research institutions, and scientific organizations advance the idea of equal opportunities and a leveled playing field for global contributions to science? The following summary of recommendations, along with more explicit suggestions, offers a way forward.

- Respect and reciprocal expectations are central to scientific collaboration. A researcher from an LMIC must be treated with as much respect as a researcher from a high-income country. A PhD should be valued irrespective of the status of the granting institution.***
- Principal investigators (PIs) should support emerging researchers in LMICs by visiting, sending students and colleagues to them (as well as welcoming these researchers in their own institutions), encouraging collaborative grant applications, and inviting them to international meetings. PIs also should encourage members of their respective diaspora communities to remain engaged with peers in the home country.

****This does not prevent one from treating each person as an individual and recognizing their particular merit. Nevertheless, pursuing a second PhD because the first is from a less prestigious university is not a sound practice; this devalues the first degree and may complicate rather than foster a future career (bought and fraudulent degrees excluded, obviously).*

- PIs should encourage emerging researchers to take on roles that provide expert advice to government and the private sector, support innovations and investments in local industry, and create and develop local science organizations.
- Whether as individuals or as influencers, well-established PIs should encourage international-scientific-meeting organizing committees to hold more events in LMICs. Science diplomacy and the individuals engaged in this arena could be of significant assistance here.**** Also, to an increasing degree, diplomats and scientists should engage the public when such meetings are held by promoting them in open lectures, visits to schools, press conferences, and so forth.
- PIs and science diplomats should petition funding agencies and universities to insist that a researcher's professional portfolio include global scientific cooperation and engagement, treated with the same seriousness as teaching, research, and service at a home institution.
- Finally, researchers and administrators at all levels should spread and showcase, in wider circles, models of scientific collaboration that transcend national and cultural borders.

As this paper has sought to argue, global engagement should be central to the role of researchers and administrators, integrated into their daily work. Especially at universities, whether predominantly as researchers or administrators, ample opportunity exists to consider and act on these questions. Steering an academic institution has been likened to the proverbial "herding cats," with researchers tending to travel in whatever direction they wish. Instead of being frustrated by this reality, administrators and policy makers would profit by harvesting the tremendous energy and engagement of individual researchers for addressing global questions that prevail in the research community.

Our universities face a daunting but worthwhile task: creating equal opportunities and a leveled playing field for global contributions to science. This should be the fourth mission of universities, and the science diplomacy community can now embrace the task of articulating its contours.

*****The SwedAlex meeting, where these thoughts first took root, could never have happened without the support of the Swedish diplomatic services and the Swedish Institute in Alexandria, Egypt.*

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Endnotes

1. The authors gratefully acknowledge the discussions and input to this article from the other participants to the S*wedAlex Symposium on Scientific, Social & Cultural Sustainability through Chemical Research*, 24th-26th September 2017 at the Swedish Institute in Alexandria, Egypt: Tarek Abdel-Fattah (USA), Ahmed Abdel-Fattah (Egypt), Areej Abuhammad (Jordan), Sameh S. Ali (Egypt/USA), Yousry Botros (USA), Anne-Sophie Castanet (France), Elsayed El-Ashry (Egypt), Anna Falkdalen (Sweden, Diplomatic service), Sherif Kandil (Egypt), Febee Louka (USA), Salah S. Massoud (USA), Masahiro Mikuriya (Japan), Mina Nashed (Egypt), Donna Nelson (USA), Mona Sharaf (Egypt), Sir Fraser Stoddart (USA), Michael Zaworotko (Ireland). The responsibility of the present document remains, however, with the authors. See https://www.facebook.com/SwedAlex/photos/a.139093082804529.20613.138552329525271/1405741466139678/?type=3.
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16. The cost of going to scientific meetings, predominately held in high income countries, is often both relatively, considering available resources, and in absolute money, more expensive from low- and middle-income countries.
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