Role for Diplomacy in Advancing Global Science, Technology, Engineering, and Mathematics (STEM) Policies in the Twenty-First Century

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The most daunting challenges that governments face are technologically demanding and global in scope: poverty, lack of access to clean food and water, macroclimate change, inefficient response to disease outbreaks, and the inability to address expanding regional economic opportunities. Addressing these challenges will require nations to harness the knowledge and experience of policymakers and diplomats familiar with science, technology, engineering and mathematics (STEM). Owing to the launch of President Obama's 2012 priorities for STEM education and the 2013 Global Innovation Initiatives[1] articulated by policymakers in the United States and United Kingdom, we discuss these science diplomacy priorities and the UN advancing STEM policies for the next decade. Using science diplomacy as a tool, the US State Department can also encourage the engines of society to address the most pressing STEM challenges of this century.

Science and technological advances are driven, in part, by the necessity to solve national and international problems. Ergo, to remain at the vanguard of science, the US must effectively use STEM in collaboration with other countries to make the world more secure, healthier, and more competitive. The ongoing Ebola crisis, in which the US is assisting West African nations to contain and medically manage the increasing number of infected individuals, is an example of global problems that demand STEM solutions. Science diplomacy is effectively contributing to the most recent initiatives to hasten the development of effective and affordable Ebola vaccines. In addition, STEM scientists are developing advanced ocean-

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mapping technology to chart US continental shelf regions and maritime boundaries, assisting in the reduction of nuclear arms, clearing land mines and unexploded ordinance, and developing security systems that defend against computer hackers.[2] To build on these and other successes, and to remain at the vanguard of discovery, the next generation of scientists and science diplomats must use technology to develop innovative solutions to what have long been intractable international problems: developing and operationalizing alternative energy sources, managing sustainable food sources, and identifying mechanisms for the improvement of the quality of healthcare through biotechnology for the US and developing countries alike.

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DEVELOPING A NEW GENERATION OF STEM SCIENTISTS AND STEM POLICIES

How can we advance the STEM agenda to enhance the quality of life in the US and abroad? Is there a role for diplomacy in this process? STEM experts working in science diplomacy require competencies and skill sets which enable them to effectively inform government officials who are involved in policy development. The stereotype of a STEM scientist as an ivory tower academic, generating theories removed from practical application, is no longer relevant. Science has become exceedingly complex and multidisciplinary, and the scientific enterprise must address the need to collaborate, perhaps through team science efforts, to cure disease through translational or applied approaches (physicists have long recognized this need). Academic medical centers in the US are now promoting interdisciplinary collaborations to address various diseases to a much greater extent than they were in previous decades, with the aim of more quickly converting biological discoveries into marketable products. To internationally market these products, diplomats (e.g. health attachés) who can assist in negotiations involving intellectual-property rights or bilateral agreements and can strengthen collaborations and broker STEM deals between countries. This requires an attaché who can combine the challenges of STEM research with the challenges of science diplomacy.

It is also recognized by academic institutions and the US government alike that the US has fallen behind in crucial areas related to STEM education. If our policymakers are addressing our technological challenges, it is paramount to include in any list of priorities the necessity for better training and exposure of American students to the STEM disciplines. (STEM education and training encompasses curricula and didactic teaching methods used from grades K–12 to graduate/professional schools as well as parent-teacher outreach).

We must utilize the full spectrum of STEM international cooperation from top-down strategic research planning to bottom-up research collaborations. This includes underprivileged countries of the world. Many countries, whether highly industrialized or not, turn to STEM disciplines to advance their quality of life. For example, the development of a better quality of life in the Middle East and North Africa (MENA) region of the world exemplifies some of priorities of national governments, and many science diplomats and health attachés participate in helping countries establish and expand their academic centers. Although these international academic centers face multiple obstacles,[3] government science officials of MENA countries have successfully assisted academic and industry-related recruitment teams to import talent to staff or augment nationals who wish to work in STEM areas.

What drives such cooperation is competition and shared national goals. As science and innovation progress the quality of life should follow suit; global collaborations can advance national agendas. For international science networks to thrive, resources will be vital. Science diplomats can drive robust global STEM policies for the purposes of fostering better healthcare, increasing efficient energy production, ensuring safer food and water supplies, and improving national defense.

DIPLOMACY CAN INFLUENCE STEM RESEARCH: ROLE OF THE US STATE DEPARTMENT

American leadership in science and technology can be used as a diplomatic tool to enhance international STEM development, thereby improving economic prosperity. The Foreign Relations Authorization Act of 1979 states that the US Department of State is the lead federal agency responsible for guiding the development of global science and technology

agreements.[4] As stated by D. D. Shine in a Congressional Research Service Report for Congress, the State Department has effectively applied science, technology, and innovation in the conduct of foreign relations. Ergo, the State Department clearly has a role in developing policy at a global level. It works to create global scientific enterprises that increase social and economic prosperity and provides innovative solutions to global challenges.

In the twenty-first century, we recognize that knowledge-based societies must interact in an interconnected global arena. As such, we have seen the State Department engage foreign governments such as the UK and China to address issues such as climate change, national security, and public health. Science and technology advances our global partnerships, and the State Department has facilitated these endeavors by emphasizing democracy, transparency, and the sharing of information.[5] STEM cooperation can strengthen our global relationships because these disciplines are based on values that transcend politics, borders, and cultures. STEM partnerships outside of government-to-government mechanisms can bridge differences between nations, advance STEM innovative ideas, and often work in a collaborative spirit amid strained geo-political relationships.

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US agencies have determined that it is important to ensure a baseline of STEM literacy within the State Department to ensure the US implements successful international STEM diplomacy efforts and global leadership initiatives. To achieve this goal, the National Academies sponsor the Jefferson Science Fellows program, placing prominent STEM experts in the State Department or in the US Agency for International Development. Annually, ten to fifteen Jefferson Science Fellows are selected through a rigorous, competitive process. The fellows inform and shape top State Department priorities; their scientific guidance helps to ensure that US foreign policy objectives advance US interests.[6]

In 2009, President Obama announced in Cairo, Egypt, several international STEM diplomacy programs in the MENA and South East Asia region that include funds for technological development in these countries.[7] These resources would be used to establish centers of scientific excellence and support new science envoys. The president stated that the US government would launch a new front to support technological development to assist

in the transfer of innovative ideas to the marketplace, thus creating more jobs. Hence, American leadership and the STEM fields can be used as diplomatic tools to enhance economic development at home and abroad. This recently has been re-emphasized by the State Department, which also provides policy direction for US international STEM diplomacy. The State Department works with other federal agencies to develop key diplomatic strategies in order to encourage science and technology cooperation to advance knowledge in food and water management, promote the sharing of knowledge in international scientific communities, strengthen international collaborations on energy technology (such as biofuels, clean coal power generation, and wind power), assist in research development to foster sustainable natural resource use and conservation, and support scientific applications to increase agricultural productivity and food availability. The State Department also uses a variety of tools to implement these strategies, such as crafting formal multilateral science and technology cooperation agreements that facilitate international collaboration, scientist and student exchange programs, workshops, conferences, and providing seed funding for the production of STEM educational materials.

INNOVATIVE US APPROACHES TO GLOBAL STEM INITIATIVES: DOMESTIC CHALLENGES AND OPPORTUNITIES

The US has begun to place greater emphasis on global STEM education. Diplomats, STEM experts, and US national leaders understand the direct correlation between US global leadership in STEM research, economic development, and US international relations. Undoubtedly, STEM research in the US can lead our world into a new era of prosperity. Notwithstanding its largest percentage of premier academic institutions, the US ranks poorly compared to its global partners in STEM, placing twenty-fifth in math and seventeenth in science out of thirty-one countries profiled by the Organization for Economic Cooperation and Development (OECD). And although the US produces the most STEM undergraduates among OECD countries (348,484 in 2008), it ranks twenty-seventh in the proportion of STEM degrees compared to all undergraduate degrees (15 percent compared to the 21-percent OECD average in 2008). In response to this trend, the US government has elected to fund the development, recruitment, and retention of 100,000 STEM teachers over the next ten years.

This includes the training of an additional 1,000,000 students in this field. The funding also appropriately includes resources to be targeted at under-represented minorities and women. In addition, non-profit organizations such as Change the Equation[8] and state-based programs like New York's STEM Education Collaborative[9] are working to improve and sustain the national STEM effort.

At the professional level, the State Department's Global Innovation Initiative also fosters the international exchange of students and faculty who have developed scientific skill-sets. This initiative will encourage international academic collaborations with the potential of forming business linkages and multinational bases for the exchange of scientific discoveries.[10] The Bureau of Educational and Cultural Affairs in the State Department, as well as the Institute of International Education, foster mutual understanding between the US and other countries by means of STEM-based educational and cultural exchanges. As laudable as these efforts are, more consideration should be given to exposing STEM-focused graduate students to the art of science diplomacy. We believe it is necessary to offer fellowships that teach post-graduate students how to implement team science approaches for developing and implementing innovative research projects with international collaborators. It can be argued that team science can advance scientific discovery with alacrity, and once graduate students have mastered the scientific approach for problem solving in their own research, they can soon learn to effectively and skillfully collaborate with global partners. Science attachés may be able to assist in this endeavor.

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We also reason that, through international exchange and science diplomacy, the training of a whole new generation of STEM innovators and researchers can be successfully achieved. A major challenge will be to harness the innovative talent that exists globally in STEM areas, which can lead to the discovery of cures for disease, improvements in food and water supplies, improvements to our climate, and production of sufficient sustainable energy. The use of science and health agreements by our global partners in the service of foreign policy interests confirms a positive role that these interests can have in bringing STEM experts together to advance a global health agenda in many areas, including management of climate

change and the combatting of global epidemics, such as MERS, SARS, AIDS, avian influenza, and Ebola.

Finally, the globalization of science is now recognized as an important goal for the future of the advancement of STEM areas. The US has benefitted from collaboration with UNESCO, the OECD, the InterAcademy Council, and the International Council for Science in shaping science policy.[11] Still, policymakers in the US must assess what globalization implies. It is imperative to expand STEM diplomacy in the US to drive global competition and scientific advances, notwithstanding any hesitation due to concerns involving economic competition or the brain drain phenomenon that the US and other countries have experienced. STEM experts are essential to the advancement of global interests and the management of global challenges, while also building robust international collaborations. Our science diplomats must be skillful in developing these global relationships to effectively address global challenges. Undoubtedly, continued training and support in STEM education will only heighten their abilities to address societal needs in the future.

Notes

[1] Global Innovation Initiative, http://global-innovation-initiative.org.
[2] "How Does Diplomacy Affect STEM Research?" Discover Diplomacy, US Diplomacy Center at the US Department of State, http://diplomacy.state.gov/discoverdiplomacy/diplomacy101/issues/224641.htm.
[3] David P. Hajjar et al., "Prospects for Policy Advances in Science and Technology in the Gulf Arab States: The Role for International Partnerships," International Journal of Higher Education 3, no. 3 (2014): 45–57.
[4] "An Act to Authorize Appropriations for Fiscal Year 1979 for the Department of State, the International Communication Agency, and the Board for International Broadcasting, to Make Changes in the Laws Relating to Those Agencies, to Make Changes in the Foreign Service Personnel System, to Establish Policies and Responsibilities with Respect to Science, Technology, and American Diplomacy, and for Other Purposes," Public Law 95-426, US Statutes at Large 92 (1978): 963–995.
[5] Deborah D. Stine, Science, Technology, and American Diplomacy: Background and Issues for Congress, CRS Report no. RL34503 (Washington, DC: Congressional Research Service, 2009), http://fas.org/sgp/crs/misc/RL34503.pdf.
[6] "Jefferson Science Fellowship Program," The National Academies, http://sites.nationalacademies.org/pga/jefferson/.
[7] Barack Obama, "A New Beginning," (speech delivered at Cairo University, Egypt, June 4, 2009), accessed at http://www.nytimes.com/2009/06/04/us/politics/04obama.text.html?pagewanted=all&_r=0.
[8] "Change the Equation," Change the Equation, http://www.changetheequation.org/.
[9] "Welcome to the New York State STEM Education Collaborative," New York State STEM Education Collaborative, http://www.nysstemeducation.org/.
[10] "Global Innovation Initiative," Institute of International Education, http://www.iie.org/Programs/Global-Innovation-Initiative.
[11] See, for example, "Revised Field of Science and Technology (FOS) Classification in the Frascati Manual, Organization for Economic Co-operation and Development, Directorate for Science, Technology, and Industry, Committee for Scientific and Technological Policy, Working Party of National Experts on Science and Technology Indicators, February 26, 2007, http://www.oecd.org/science/inno/38235147.pdf; and "Responsible Conduct in the Global Research Enterprise: A Policy Report," InterAcademy Council and IAP—The Global Network of Science Academies, October 17, 2012, http://www.interacademycouncil.net/File.aspx?id=28283.