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Building a Science Diplomacy Curriculum

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Science diplomacy is a fast-growing field of research, education, and practice dedicated to better understanding and reinforcing the connections between science, technology, and international affairs to tackle national and global challenges. Interest from early career scientists and young diplomats to learn more and engage at the science-diplomacy nexus is growing all around the world. However, as a relatively new and multidisciplinary field, we show that science diplomacy has so far been largely taught through extracurricular courses and workshops, often self-organized by university student groups or international scientific organizations, targeting specific disciplinary and geographic audiences. Given this fragmented landscape, we map and categorize current science diplomacy educational offerings in higher education. Despite some coverage of science diplomacy within general science policy programs or courses focused on an issue area (e.g., water diplomacy or environmental diplomacy), a structured foundational course addressing the commonalities of all the scientific and technological issues relevant to international affairs is still lacking. Hence, we first suggest knowledge and key skills scientists and diplomats can learn from each other to bridge the disciplinary divide and engage in science diplomacy scholarship and practice. Building upon it, we then propose cross-cutting, core concepts that can inform the establishment and consolidation of science diplomacy curricula at universities. These aim to be useful to teach science diplomacy to advanced undergraduate and graduate students of all backgrounds and to be adaptable to a wide range of degree programs and disciplines.

Keywords: science diplomacy, education, transdiciplinary, curriculum-undergrad and postgrad, international relations (IR)

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SCIENCE DIPLOMACY: A GROWING FIELD IN INTERNATIONAL RELATIONS

Science diplomacy is a growing field of study and practice seeking to understand and promote the linkages between science, technology and international affairs to address national and global challenges (Turekian, 2018). As the field matures and expands across the world, there is increasing demand for education and training. Yet higher education institutions offer few opportunities to bridge traditional departmental silos to embed a global policy understanding in science

education, or introduce science, technology and innovation in international affairs curricula[1]. Furthermore, no academic institution offers yet a class solely dedicated to the theory and practice of science diplomacy.

While a clear definition of science diplomacy remains elusive, we consider it here broadly as all the processes that inform or influence international relations in science and technology, noting that "*the scientific and international relations worlds [.] are more and more one*[2]." Hence while the field is more of a "boundary" object (Kaltofen and Acuto, 2018), from a pedagogical standpoint and for simplicity, this article separates the two main components of "science" on one hand and "diplomacy" on the other. Here we define science in its broadest sense, as the general knowledge of natural and social sciences, both basic and applied, including technology and innovation. We approach diplomacy as the art and practice of conducting international relations between governments through dialogue, negotiation, and cooperation (Berridge, 2010). Even though this dichotomy is an over-simplification[3], it reflects the existence of two distinct communities – scientists and diplomats – with different cultures, values, knowledge, and skills. Educating in science diplomacy requires exploring the knowledge and skills the two communities of scientists and diplomats should learn from and about each other to work closer together.

The practice of science diplomacy encompasses a spectrum of roles, organizational configurations and professional profiles that remain fluid and do not align with a traditional career path in science or international relations. Science diplomats conduct a range of activities (also occasionally, part-time or full-time) from promoting international cooperation in science and technology out of an embassy, diplomatic mission or international organization, providing scientific advice to a foreign minister, negotiating a multilateral agreement, or navigating scientific collaborations between countries under political strain. These functions are performed by scientists, diplomats, and other professionals most frequently without specific training and no defined career path, thus limiting their potential impact.

Because scientists and diplomats have been siloed both educationally and professionally for a long time, it is urgent to bridge the divide between current and future professionals by developing common capacity within specialists in each community (Moomaw, 2018).

To bridge the two communities, there is a need for educational opportunities for students and practitioners with backgrounds in science and in diplomacy. Current training offerings, described in section "A Fragmented Landscape of Science Diplomacy Education Around the World," might meet the needs of practitioners, but do not generally target students. This article presents a university-level syllabus to create an introductory class for the new generation of students interested in science diplomacy. It responds to the increasing interest in science diplomacy education and training that the authors have witnessed over the last decade teaching science diplomacy across the world. This demand was recently documented through a needs assessment survey conducted by the European S4D4C research consortium (Croce, 2019). Natural and social sciences students are eager to understand how science, technology, and innovation intersect with foreign policy and global governance to shape and address cross-border challenges. Similarly, international relations students are increasingly attuned to the scientific and technical issues impacting their work, and welcome the addition of science, technology, health, and environmental issues into the toolkits and agendas of 21st century diplomacy (Stanzel, 2018).

This article lays out the core elements and building blocks of a foundational curriculum to support the next generation of science diplomacy leaders and equip scientists and diplomats with the tools and skills sets to work at the intersection of science and international relations. We first map the current landscape of science diplomacy educational offerings around the world (section "A Fragmented Landscape of Science Diplomacy Education Around the World") and then categorize the types of courses currently available in higher education (section "Current Science Diplomacy Offerings in Higher Education"). We then suggest content-based knowledge and skills useful to help bridge the gap between scientists and diplomats (section "A Content and Skills-Based Framework for Teaching Science Diplomacy"), and propose cross-cutting, core content subjects and topics that can be used in an introductory science diplomacy class offered at the university undergraduate or graduate level, and tailored to a wide range of degree programs and disciplines (section "Building a "Theory and Practice of Science Diplomacy" Course").

A FRAGMENTED LANDSCAPE OF SCIENCE DIPLOMACY EDUCATION AROUND THE WORLD

While science diplomacy has been practiced for centuries, the landmark American Association for the Advancement of Sciences (AAAS)-Royal Society report "New Frontiers in Science Diplomacy" (2010) gave science diplomacy an initial definition and conceptual framework. The report's theoretical approach and practical examples formed the basis of the first trainings to expose early career scientists to the concept, history and practice of science diplomacy. As pointed out by Holford and Nichols (2017), the creators of the first science diplomacy graduate seminar at Rockefeller University[4], graduate

[1]The Science, Technology, and International Affairs (STIA) program at Georgetown University is one of the few educational offerings at the nexus of international policy, science, and technology. Students are trained in the science and technology underpinning key issues in international affairs, such as internet governance, nuclear weapons technology, climate science, biotechnology and artificial intelligence. Interdisciplinary coursework combines training from the natural sciences and engineering with the social sciences and international policy. https://stia.georgetown.edu/academics/major/

[2]Wang, Tom, Science Diplomacy: A State of Mind, 2018, https://medium.com/sciencediplomacy/science-diplomacy-a-state-of-mind-4f724b7e2819

[3]Douglas, Molly and Gruver Barr, Patricia, Fostering Inclusion in Science Diplomacy, 2018, https://medium.com/sciencediplomacy/fostering-inclusion-in-science-diplomacy-618df1b073ca

[4]The Hurford Science Diplomacy Initiative at Rockefeller University http://www.rockefeller.edu/graduate/ScienceDiplomacy

students in the natural sciences work in a highly specialized, narrow field at the frontiers of knowledge, often lacking an understanding of the global issues science and technology are rapidly transforming, such as geopolitics, sustainable development, trade, economics, national security, global health or international law.

Despite some efforts at universities, detailed in section "Current Science Diplomacy Offerings in Higher Education," the majority of science diplomacy training has been conducted by international scientific organizations like the AAAS, The World Academy of Sciences (TWAS), and the International Network of Government Science Advice (INGSA), among others. The AAAS Center for Science Diplomacy, established in 2008, was the first organization to offer dedicated training in science diplomacy in partnership with TWAS. The annual AAAS-TWAS science diplomacy summer course[5] in Trieste (Italy) was launched to expose scientists, policymakers, diplomats and other professionals from the Global South to how science and technology impact international policies, and the different ways the diplomatic system can harness science and technology to advance national and global goals.

More recent programs, such as the AAAS Science Diplomacy & Leadership Workshop[6] or the São Paulo Science and Innovation Diplomacy Summer School, have emphasized knowledge transfer but also skills development (Hobin and Galbraith, 2012), building networks, and designing national or regional science diplomacy strategies[7]. These courses have all been very successful, receiving hundreds or thousands of applications for a few dozen spots, but participation is often restricted to specific disciplinary and geographic audiences. To meet the growing demand, in 2017 AAAS launched the first science diplomacy online course[8] and S4D4C launched a European Science Diplomacy virtual course in 2020[9].

Over the last decade, many foreign ministries and diplomatic academies have also recognized the need to incorporate science, technology and innovation in their foreign policy structures (Turekian and Kishi, 2017). While the United States, Japan, Russia, China, or the United Kingdom have a long tradition of science advice to foreign policy, most countries only recently began adopting the concept of science diplomacy. Argentina, Brazil, India, Mexico, Panama, Spain, South Africa, and the European Union are among the countries that have more recently incorporated science, technology and innovation in their diplomatic training structures. This is not only due to the need to understand the diplomatic implications of scientific innovations (Leijten, 2017) such as artificial intelligence (Hone, 2019), cryptocurrencies, or big data, but also to the emergence of multilateral and multi-stakeholder forums such as the Center for the Fourth Industrial Revolution of the World Economic Forum or the United Nations Science, Technology & Innovation Forum for the Sustainable Development Goals. These require skilled professionals capable of navigating the science-diplomacy interface.

CURRENT SCIENCE DIPLOMACY OFFERINGS IN HIGHER EDUCATION

The Science, Technology, and International Affairs (STIA) program at Georgetown University is one of the few university degrees fully dedicated to the nexus of international policy, science, and technology. At the postgraduate level, science diplomacy academic offerings can be classified into three broad categories: (1) issue-area courses exploring the intersection between a specific scientific discipline and diplomacy, (2) seminar series and workshops with invited speakers (mostly practitioners) introducing students to their own area of expertise and career path in science diplomacy, and (3) science policy courses that incorporate elements of science diplomacy when covering international science policy and global governance.

1) Issue-area science diplomacy courses: Given that science diplomacy is a new term that emerged in the early 21st century, it intersects with fields with a long tradition of research and scholarship that already examine the diplomatic dimensions of a particular scientific or technical field within the boundaries of its own discipline. These include environmental diplomacy, energy diplomacy, water diplomacy, health diplomacy, digital diplomacy or nuclear diplomacy, among many others. Notable examples are the "Global Health Diplomacy" course at The George Washington University[10] or the "Science Diplomacy: Environmental Security in the Arctic Ocean" at the Fletcher School of Law and Diplomacy at Tufts University[11].
2) Seminar series: Graduate seminars and workshops expose students to different topics in science diplomacy. They usually consist of guest speaker series offering personal perspectives and career experiences, and do not focus on analyzing, comparing, extracting and highlighting the commonalities across disciplines nor building core science diplomacy knowledge and skills. Some are led by students or early career researchers themselves, such as New York University's "Science Diplomacy: The Role of Science in International Relations and Global Development"[12].

[5]AAAS-TWAS Science Diplomacy Course https://twas.org/science-diplomacy

[6]AAAS Science Diplomacy & Leadership Workshop https://www.aaas.org/news/future-science-diplomats-receive-range-training-aaas

[7]São Paulo Framework of Innovation Diplomacy, 2019 https://2019.innscidsp.com/sao-paulo-framework-of-innovation-diplomacy/

[8]Gual Soler, Marga and Wang, Tom, Introduction to Science Diplomacy online course, 2017 https://www.aaas.org/programs/center-science-diplomacy/introduction

[9]S4D4C European Science Diplomacy online course, 2020 https://www.s4d4c.eu/european-science-diplomacy-online-course-now-ready-for-you/

[10]Global Health Elective Course at The George Washington University https://publichealthonline.gwu.edu/academics/elective-courses/global-health/

[11]Science Diplomacy: Environmental Security in the Arctic Ocean https://fletcher.tufts.edu/academics/courses/divisions/dhp/dhp-p259

[12]Science Diplomacy course at New York University https://nyuscidip.blogspot.com/2017/02/spring-science-diplomacy-course-at-nyu.html

TABLE 1 | A framework for science diplomacy education (content and skills-based) for scientists and diplomats.

	Scientists	Diplomats
Content-based knowledge	• An overview of the humanities (history, law, political science) and international relations • Culture, values and timescales of diplomacy • Public policy, foreign policy • A basic understanding of international organizations and international law • International spaces, global commons and transnational issues • International negotiation theory • Distinguishing between scientific advice, advocacy and activism	• An overview of the natural and social sciences, including laboratory practice • Culture, values and timescales of science • Epistemology, the scientific method (basics of observation, experiments and reproducibility) and the research process (peer-reviewed publications, scientific consensus) • Major contemporary issues and trends in science and technology • Research management and funding • Global collaborative science networks (formal and informal)
	• Science as a transnational epistemic community, mobility and collaboration issues • Global scientific governance, international scientific institutions, international science-based agreements • Large international research infrastructures (issues of governance, diplomacy, open access and open science) • Science, technology and innovation and their repercussion onto the economy and society: from blue-sky science to innovation (and vice-versa) • Issues of science capacity building, technology transfer, science as a public good versus private good • Case studies of science as a tool for diplomacy and diplomacy advancing science	
Skills-based knowledge	• Basic negotiation skills (e.g., acquired through simulation games) • Public speaking, communication and outreach • Interpersonal skills, networking, building partnerships and coalitions • Cross-cultural and cross-discipline awareness • International project management • Balancing scientific facts with competing interests and values of diverse sets of stakeholders (political, economic, cultural, religious) • Memo-style writing, policy briefs	• Quantitative and qualitative research methods, basic data analysis skills • Critical thinking skills • Dealing with data biases, incompleteness • Managing scientific uncertainty • Distinguishing between correlation versus causation, inductive and deductive reasoning • Contrasting between legitimate science vs. pseudoscience and accessing reliable sources (journals, citations, repositories) • Identifying and accessing scientific experts in different fields • Risk analysis

These courses often include a capstone field trip to embassies, international institutions or United Nations offices or conferences.

3) Science policy courses: While science policy operates mostly within the national context, university science policy courses increasingly incorporate elements of science diplomacy, as international policies underpinned by science can be a result of science diplomacy processes. Examples of these courses include "Science and Technology in Domestic and International Policy"[13] at the Harvard Kennedy School of Government and "The Practice of Science Policy & Diplomacy"[14] at Dartmouth College.

While these educational opportunities enrich and broaden students' perspectives, they do not fully encompass the cross-cutting, foundational knowledge and skills needed to navigate the many 21st century global challenges underpinned by science and technology. Before we propose core concepts that could be used to develop such a general science diplomacy course at universities (Section "Building a "Theory and Practice of Science Diplomacy" Course"), we first start by exploring the content knowledge and skills that may be lacking in both communities in the next section.

[13]Science and Technology in Domestic and International Policy at Harvard Kennedy School of Government https://www.hks.harvard.edu/courses/science-and-technology-domestic-and-international-policy

[14]The Practice of Science Policy and Diplomacy http://dartmouth.smartcatalogiq.com/current/orc/Departments-Programs-Undergraduate/Environmental-Studies-Program/ENVS-Environmental-Studies/ENVS-80-08

A CONTENT AND SKILLS-BASED FRAMEWORK FOR TEACHING SCIENCE DIPLOMACY

What should scientists know about diplomacy, and vice versa? What skills should they learn to be able to work together? In **Table 1**, we propose a set of science diplomacy knowledge and skills that students or early career professionals in science and in international relations can acquire. We suggest examples of topics and skills for each community to learn about the other and we list common subjects and issues they can explore together.

From a content perspective, scientists should be provided with an overview of the humanities (history, economics, politics, and international relations). They should also develop a basic understanding of multilateral organizations, the principles of international law that govern international spaces and the global commons, and the transnational issues where science plays a key role. For future diplomats, developing an understanding of the epistemic culture of scientific research (Haas, 1992) and its associated methods (publication, peer-review, and funding mechanisms) is necessary to help establish international research collaborations. Understanding how to access and use scientific expertise and facts in international negotiations will also be key. In addition, scientists and diplomats would benefit from joint education in cross-cutting issues, such as a deeper understanding of global scientific governance and the interaction between science, technology, and innovation and its repercussions onto the economy, trade, defense, and geopolitics.

TABLE 2 | Suggested catalog of subjects and topics for an introductory science diplomacy course.

Theory and practice of science diplomacy	

Science policy and diplomacy fundamentals	• Science and public policy fundamentals
	  ○ Overview of the sciences (natural and social) and the scientific method
	  ○ Basic and applied science, innovation and the economy
	  ○ Case studies in science policy (e.g., science funding, health, environmental, energy policies in various countries)
	• Science advice vs advocacy: why, who, how?
	  ○ The nexus of science, society, politics, economics, values and religion
	  ○ Influence of politics and society on science (and vice-versa)
	  ○ Scientific advice to government
	• Science diplomacy fundamentals
	  ○ The nexus of science, international relations and global governance
	  ○ History and evolution of science diplomacy
	  ○ Current frameworks of science and technology in international relations, evolving theories and definitions of science diplomacy
	  ○ An overview of the ecosystem of actors in science diplomacy
	  . Ministries of foreign affairs, embassies and consulates
	  . Multilateral organizations, international scientific organizations
	  . Academies of sciences, scientific formal and informal networks
	  . Non-profit organizations and foundations in science
	  . Businesses and transnational technology companies

International engagement in science and technology	• Major contemporary issues and trends in science, technology and innovation • Issue areas of science diplomacy, overview of scientific drivers in diplomacy (e.g., global health, nuclear, environment, oceans, cyber, biomedical, trade, security) • Nation-states, diplomacy and global governance • International scientific institutions, networks and governance • International spaces and international treaties (environmental, science-driven), global commons, transnational/transboundary issues and shared resources • Treaty-based international scientific organizations, Big Science and international large research infrastructures (membership, open science and access issues) • International scientific collaborations: diplomatic successes and challenges • Science in the United Nations system, the role of science, technology and innovation for the Sustainable Development Goals • International scientific development and capacity issues, technology transfer, scientific mobility and circulation

Science diplomacy in practice	• National approaches to science diplomacy, strategies and implementation
	• Interfaces and mechanisms enabling international policy and diplomacy exposure (science advisors in foreign ministries, science attachés, fellowships)
	• International approaches to science diplomacy, transnational and global challenges
	• Science-intensive international negotiations
	• Science and technology cooperation under political strain
	• "Political" versus "Economic" framework (with role-play simulations and case studies)
	  ○ "Political" science diplomacy
	  . Science in foreign policy, public diplomacy and soft power
	  . High-level science and technology networks and fora
	  . Influencing and agenda setting in international scientific organizations
	  . Large international research infrastructures
	  ○ "Science, Technology and Innovation" diplomacy: economic repercussions
	  . Ministries (foreign affairs/economy/science) and economic interests
	  . Technological watch, horizon scanning and technology disruption
	  . Innovation consulates and startup incubators
	  . Technology giants as transnational and geopolitical actors
	• Developing science diplomacy skills and competencies (see **Table 1**) through experiential learning (e.g., via role-play simulations)

Teaching approaches must include not only theory but also skills development. There has surprisingly been little published on science diplomacy skills, despite the field now being a decade old. Gual Soler et al. (2017) and Bednarek et al. (2018) describe science diplomats as "boundary-spanning professionals" acting as expert intermediaries between the worlds of science and international affairs. In order for science diplomats to perform their functions effectively, skills development (Paschke and Zurgilgen, 2019) can in fact prove even more important than content knowledge.

For scientists, these skills include negotiation, communication and leadership skills, navigating protocol, building coalitions, partnerships, and networking, and heightened cross-cultural, cross-disciplinary awareness in dealing with counterparts from different cultures and backgrounds. Another crucial aspect is to be able to distinguish science advice from advocacy when dealing with policymakers (Gluckman, 2016). For diplomats, key skills include data analysis, critical thinking, risk analysis, understanding and navigating scientific uncertainty, and identifying and accessing experts.

The cultures and values of science and diplomacy can be so different that they might seem opposite at first, as noted by Copeland (2009): while science is rooted in transparent experimentation, promotes objective discussions

and value-neutral propositions, diplomacy is about balancing power, negotiating and influencing others, all the while operating in a highly hierarchical structure, often in secret. Hence the best way to bridge the two cultures and practices is to train scientists and diplomats together using experiential learning methods such as role play simulations and interactive case studies to understand how the intersection between science and diplomacy plays out in the real world (Stokes and Selin, 2016).

BUILDING A "THEORY AND PRACTICE OF SCIENCE DIPLOMACY" COURSE

In **Table 2** we present a catalog of cross-cutting subjects and topics that, combined, cover the knowledge and skills framework described in **Table 1**. These can be incorporated into a general introductory science diplomacy course delivered as a stand-alone class or as part of a specialized degree in one of the issue areas (e.g., nuclear diplomacy, environmental diplomacy or global health diplomacy). The course would be most useful at a late undergraduate or early graduate level for students from STEM and international relations programs, taken separately or together. Instructors should design the syllabus depending on their academic home and prior course requirements to avoid redundancy and overlap with existing knowledge, although some overlap will be inevitable in a mixed-background class (with students from natural and social sciences as well as arts and humanities).

A "Theory and Practice of Science Diplomacy" course would be structured in three modules: (1) Science policy and diplomacy fundamentals; (2) International engagement in science and technology; and (3) Science diplomacy in practice. These are meant to be sequential, yet exploratory and adaptable in duration and depth. Skills development (as identified in **Table 1**) should happen throughout these modules, particularly the last two, via experiential learning.

The syllabus will include (and give more emphasis to) different elements depending on students' backgrounds and academic itineraries. In principle, it should begin with a general overview of science policy, science advice, science advocacy and science diplomacy as distinct domains within the general science-policy-society nexus to ensure an understanding of the boundaries, however diffuse, of these concepts and activities. It should introduce the diverse set of actors of a science diplomacy ecosystem and the broader political, economic, and societal context in which they operate (major contemporary science and technology issues and the current global governance framework). It is also important to cover prominent topics in the field such as science, technology and innovation for the sustainable development goals, science advice to governments or scientific capacity building and technology transfer issues. An important component is to demonstrate how science diplomacy is designed and implemented in practice through examples and case studies, which is done both at the high-level around scientific and technical issues of political importance, but also through "technology" and "innovation" diplomacy that focus on horizon-scanning activities and national economic priorities (Ittelson and Mauduit, 2019).

Finally, we consider necessary to equip the students with practical skills such as the ones described in the last row of **Table 1**. These will be dependent on the instructor, the context and academic home of the course, and the background of the students. However, it is important to note that these skills benefit from constant practice and as such will not necessarily appear redundant. Practical science diplomacy skills such as negotiation, cross-cultural awareness, data analysis, and communication can be acquired or honed through experiential learning methods, including role play simulations or mock briefings involving scientific uncertainty and pressure for rapid decision-making. Simulations of science-intensive negotiations (for example water and environmental negotiations[15]) allow participants to identify points of friction between science and diplomacy. Scientists may experience first-hand the nuances between advising, advocacy, and activism, or balancing scientific and political considerations. Diplomats and other non-scientists are confronted with assessing the credibility and legitimacy of various sources of technical information and how to deal with issues of uncertainty in science. All participants experience different value systems and perspectives and get to understand how to best reconcile them.

CONCLUSION

As science, technology and innovation become increasingly intertwined with international relations on cross-border issues such as climate change or global pandemics, there is an immediate need to bridge the gap between the scientific and diplomatic communities. Yet, science diplomacy still lacks a formal educational path and training opportunities remain limited. A first step is to consider what knowledge and skills each community can learn from the other, as described in the first part of this paper. The next step is to work toward better preparing the next generation of scientists, diplomats, and boundary-spanning professionals for global challenges requiring multidisciplinary collaboration. A quick landscape analysis of the current educational offerings in science diplomacy shows that little is currently available at the university level. We propose knowledge and skills modules that could be part of a "Theory and Practice of Science Diplomacy" course at the graduate or undergraduate level that can be adapted by any university and academic program in the world. As an important point of comparison, we anticipate that science diplomacy as a field will consolidate its educational offerings and pathways similar to the evolution of science policy as a field over the last decades[16]. We hope that the framework presented there will spark further thinking and new developments at universities and higher

[15]Indopotamia: Negotiating Boundary-Crossing Water Conflicts, https://www.pon.harvard.edu/shop/indopotamia-negotiating-boundary-crossing-water-conflicts/

[16]Science Policy Course Syllabi, http://www.science-engage.org/science-policy-course-syllabi.html

education institutions interested in offering science diplomacy education across the world.

AUTHOR CONTRIBUTIONS

J-CM led the writing, wrote the first draft, created the content of the core two tables, and led the rewriting of the subsequent drafts. MG provided comments and insights to the initial draft, provided initial edits, and contributed to the writing and editing throughout. Both authors contributed to the combined writings of most sections.

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REFERENCES

Bednarek, A. T., Wyborn, C., Cvitanovic, C., Meyer, R., Colvin, R. M., Addison, P. F. E., et al. (2018). Boundary spanning at the science–policy interface: the practitioners' perspectives. *Sustain. Sci.* 13:1175. doi: 10.1007/s11625-018-0550-9

Berridge, G. (2010). *Diplomacy: Theory and Practice*, 4th Edn. Houndmills: PalgraveMacmillan.

Copeland, D. (2009). *Guerrilla Diplomacy: Rethinking International Relations*. Boulder: Lynne Rienner Publishers.

Croce, M. (2019). What it takes to do science diplomacy: Baseline analysis and needs assessment. *S4D4C project*

Gluckman, P. (2016). *Science Advice to Governments: An Emerging Dimension of Science Diplomacy*. Available online at: https://www.sciencediplomacy.org/article/2016/science-advice-governments

Gual Soler, M., Robinson, C. R., and Wang, T. C. (2017). *Connecting Scientists to Policy Around the World*. Washington, DC: American Association for the Advancement of Science. Available online at: https://www.aaas.org/sites/default/files/International-Landscape-Analyis-ExecSumm-02162017.pdf

Haas, P. M. (1992). Introduction: epistemic communities and international policy coordination. *Int. Organ.* 46, 1–35. doi: 10.1017/s0020818300001442

Hobin, J. A., and Galbraith, R. A. (2012). Engaging basic scientists in translational research. *FASEB J.* 26, 2227–2230. doi: 10.1096/fj.12-0601ufm

Holford, M., and Nichols, R. W. (2017). The challenge of building science diplomacy capabilities for early career academic investigators. *Sci. Diplomacy* Available online at: https://www.sciencediplomacy.org/perspective/2018/EACIs

Hone, K. (2019). The impact of artificial intelligence on diplomacy. *DiploFoundation*

Ittelson, P., and Mauduit, J. C. (2019). *Science & Diplomacy: How Countries Interact with the Boston Innovation Ecosystem*. Washington, DC: American Association for the Advancement of Science. Available online at: https://www.aaas.org/sites/default/files/2019-06/Boston_Science_Diplomacy_AAAS_Diplo_June2019.pdf

Kaltofen, C., and Acuto, M. (2018). Science diplomacy: introduction to a boundary problem. *Glob. Policy* 9, 8–14. doi: 10.1111/1758-5899.12621

Leijten, J. (2017). Exploring the future of innovation diplomacy. *Eur. J. Futures Res.* 5:20. doi: 10.1007/s40309-017-0122-8

Moomaw, W. R. (2018). Scientist diplomats or diplomat scientists: who makes science diplomacy effective? *Glob. Policy* 9, 78–80. doi: 10.1111/1758-5899.12520

Paschke, M., and Zurgilgen, K. (2019). Science-policy boundary work by early-stage researchers: recommendations for teaching, internships and knowledge transfer. *GAIA Ecol. Perspect. Sci. Soc.* 28, 310–315. doi: 10.14512/gaia.28.3.13

Stanzel, V. (2018). *New Realities in Foreign Affairs: Diplomacy in the 21st Century*. Baden-Baden: Nomos Verlagsgesellschaft, 72.

Stokes, L. C., and Selin, N. E. (2016). The mercury game: evaluating a negotiation simulation that teaches students about science-policy interactions. *J. Environ. Stud. Sci.* 6, 597–605. doi: 10.1007/s13412-014-0183-y

Turekian, V. (2018). The evolution of science diplomacy. *Glob. Policy* 9, 5–7. doi: 10.1111/1758-5899.12622

Turekian, V., and Kishi, T. (2017). Science and technology advising in today's foreign Policy. *Sci. Diplomacy* Available online at: https://www.sciencediplomacy.org/perspective/2017/science-and-technology-advising-in-todays-foreign-policy

"New Frontiers in Science Diplomacy" (2010). *The Royal Society & the American Association for the Advancement of Science*. Available online at: https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2010/4294969468.pdf (accessed July 8, 2020).

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