Pedagogical Methods for Nuclear Security and Nonproliferation Policy
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Nuclear proliferation and nuclear security breaches are among the most critical issues facing the world today. Tackling policy challenges to the nonproliferation regime requires communication across disciplinary boundaries, strategies to address evolving threats, and diplomatic capacity for negotiation and independent thought. Without explicit consideration of these attributes, existing approaches for education in nuclear security policy are limited in their effectiveness. This work outlines key characteristics needed to feed the pipeline of experts in nuclear security and nonproliferation policy. Current educational efforts are highlighted and assessed in terms of their strengths and shortcomings with regard to these attributes.

Interdisciplinary Expertise in nuclear security and nonproliferation requires knowledge of political science, international relations, peace and conflict studies, physics, nuclear engineering, and the capabilities and limits of radiation detection and nuclear instrumentation. However, the skills needed for problem solving in the associated policy realm go beyond fundamental academic knowledge to encompass an understanding of the technical complexities and political sensitivities—the "human elements" of conflict resolution and effective diplomacy in an inherently technical domain. The multifaceted nature of the field exists both in terms of the concepts wrestled with and the interactions among players in the nuclear security community. It is often argued that policymakers must complement their training with a deep understanding of technology or that nuclear scientists must be made aware of the policy implications of their technical research. And while this is certainly advantageous, the development and implementation of informed effective nuclear security policy comes not from a single subject-matter expert or silo of experts but instead from a mutually aware cross-functional team with a common goal. It is within this "shared space" that progress towards diplomacy on sensitive nuclear issues lies.

The offerings for formal coursework in nuclear security policy that combine technical and social scientific students and concepts are woefully lacking. While several efforts to train nuclear security policy experts exist at academic institutions across the United States, these are fielded primarily through certificate or degree programs that package an assortment of disparate course offerings plucked from different disciplines. Very few nuclear policy courses[1] are cross-listed and co-taught between technical and social scientific departments. One such example, *Nuclear Security: The Nexus Between Policy and Technology*,[2] is a graduate-level course offered jointly between the Department of Nuclear Engineering and the Goldman School of Public Policy at the University of California, Berkeley. This course places technical and non-technical students in a

[1] For example, *Nuclear Security: The Nexus Between Policy and Technology* is the sole nuclear security policy course in the University of California system.
[2] NE285C, Nuclear Security: The Nexus Between Policy and Technology, https://www.nuc.berkeley.edu/courses/ne-285c

shared learning environment and requires them to collaborate on a semester-long research project addressing a contemporary issue in nuclear security policy—guided by nuclear physics experts and seasoned policy practitioners.

Such an arrangement has several advantages. Students learn the subject matter from a multidisciplinary perspective in a collaborative learning environment while gaining important skills in communicating across disciplines. A *shared language* is developed, important for effective communication both with regard to collective terminology and development of mutual respect in working towards a common goal. Nomenclature is particularly important in this field, as the political terms of art and technical jargon are often derived from disparate semantic fields. For example, 'precision' to a nuclear physicist describes statistical variability, while social scientists consider the term synonymous with accuracy. As words shape perceptions and perception influences decision-making, shared language is crucial to effective action. While a glossary of terms could be useful as a starting point for communication across disciplinary boundaries,[3] language disparities are most effectively broken down through immersive collaboration to achieve common goals. Practiced relations in cross-functional teams pave the way for constructive interaction via conversation, cooperation, and negotiation.

Impediments to making new cross-disciplinary courses available exist within the traditional academic structure adopted by many educational institutions in the United States. The conventional stove piping of disciplines often disincentivizes early career faculty, who are bound to organize their activities towards a successful tenure review, from actively collaborating outside of their academic department. This is because tenure review processes aren't geared towards embracing the multidisciplinary nature of nuclear security issues. For technical scientists, journal publications are expected to be peer-reviewed and in the top journals within the discipline, which encompass narrow, highly specialized subfields.[4] In contrast, nuclear security policy influence is maximized through op-eds, face-to-face interactions with decision makers, and policy briefs in general consumption and online media. Further, the timeline required for the realization of policy recommendations may far surpass the tenure clock. In this regard, the academy functions as an adversarial force towards nuclear security policy education and research by only rewarding work that solidly looks like traditional scholarship.

Experiential Learning Policymaking in nuclear security is inherently interactive. It requires interplay between domestic and international interests; people, government, and the environment; and resources, hardware/software, and institutions. Problem

[3] A multidisciplinary textbook is in preparation based on the lecture notes and lessons learned from the *Nuclear Security: The Nexus Between Policy and Technology* course.

[4] While several peer-reviewed journals exist in the nonproliferation policy field, such as *The Nonproliferation Review* and *International Security*, tenure review processes have historically placed emphasis on the candidate's contributions in a single disciplinary area. See for example: National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2005. *Facilitating Interdisciplinary Research*. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/11153.

solving in this domain benefits from a systems approach that takes into account the interrelationships between entities. "Learning by doing" through hands-on engagement, tabletop exercises, and research projects solving real-world problems provides opportunities to identify connections between the known and unknown, experience the forces that may hinder realization of goals, and develop a nuanced intuition for the complex dynamics that govern nuclear security policy implementation.

The National Nuclear Security Administration's (NNSA) Office of Defense Nuclear Nonproliferation Research and Development[5] recently established three large consortia of universities to train the next generation of nuclear security experts in collaboration with Department of Energy National Laboratories while engaging in research and development in support of the nation's nuclear nonproliferation mission. These consortia are primarily focused on building scientific experts through training in the core technical disciplines required to support the nation's nuclear security agenda, though nuclear security policy elements are also incorporated as a component of the curricula. For example, the Nuclear Policy Working Group (NPWG)[6] is a research-based educational programming effort supported through the NNSA's Nuclear Science and Security Consortium[7] that brings together undergraduate and graduate students and postdoctoral scholars from the technical and social sciences to collaboratively explore issues in nuclear security policy. Within the NPWG, scholars are exposed to current events in nuclear security and nonproliferation and guided in the development of policy-relevant publications. Participants have the opportunity to present their research at policy-relevant venues and serve as rapporteurs at workshops and review conferences. Through such an arrangement, students learn what it means to "do research," how to ask the right questions, communication tactics, troubleshooting, and flexible implementation strategies—valuable skills for problem solving within an evolving threat landscape.

Just as tabletop exercises illuminate knowledge gaps and potential failure modes, experiential learning supports improved policies by best preparing future experts to perform in an actual situation. The future of nuclear security policy education requires a transition from traditional methodology to cultivating academic, research, and professional skills in the next generation—from professional development to developing the profession.

Independent Thought An education that provides balanced viewpoints drives independent thought—stretching the boundaries of perception opens the space within which vision and realism thrive. Yet, the balance between education and indoctrination is often blurred in nuclear security policy through the ideals of the individual or the organization sponsoring the work. Apart from a handful of formal courses and programs,

[5] National Nuclear Security Administration, Nonproliferation, https://nnsa.energy.gov/aboutus/ourprograms/nonproliferation
[6] Nuclear Policy Working Group, http://npwg.berkeley.edu/
[7] Nuclear Science and Security Consortium, http://nssc.berkeley.edu/

nuclear security policy is primarily explored in the academic environment through one-off lectures, seminars, workshops, and films, each filtered through the political lens of the presenter. As a result, the two main schools of thought—deterrence and disarmament doctrines—are often imparted to the next generation in an independent and disconnected fashion, which may imbue a specific partisan or biased perspective that can hinder innovation and limit careful consideration of options in crisis scenarios.

By presenting both sides of an issue and opening space for active learning, students are encouraged to question assumptions and draw their own conclusions. For example, the Public Policy and Nuclear Threats (PPNT) Boot Camp,[8] is an annual workshop-in-residence dedicated to providing non-partisan instruction and showcasing contrasting points of view. Offered through the Institute on Global Conflict and Cooperation at UC San Diego, the program is designed to expose graduate students and early-career professionals to the historical, legal, technical, and policy aspects of nuclear nonproliferation. Leading lights in the field are brought in to present on topics such as the nonproliferation regime, arms control, safeguards and verification, and nuclear terrorism. Small group work is also performed in the form of a simulation exercise, where participants provide recommendations for action in a nuclear security crisis scenario.

In the expert speaker sessions, at least half of the time is dedicated to discussion, encouraging participants to think on their own about the concepts and providing opportunities for them to learn from one another. As an example of opposing viewpoints in context, a session on the Iran Deal features prepared remarks by proponents and opponents of the initiative followed by a question-and-answer session with participants. The session is structured not as a debate, but as a forum to expose participants to practitioners who strongly (but civilly) hold certain views. By offering a balanced perspective, students are encouraged to question conventions and think independently, thereby paving the way for innovative thought.

How do we attract students to the field?

While this question is often posed when examining nuclear security policy education, it is the wrong question to ask. We don't need to *attract* students to the field; we need to *expose* them to it and then offer opportunities for *immersion*. Bright students are already deeply interested in challenging and complex issues and are readily drawn to nuclear security policy as a result. In many cases, these students don't have a forum for discussion or a community within which to learn. By providing exposure to students at the undergraduate and graduate levels, passionate thinkers are drawn to nonproliferation and nuclear security policy—to work towards solving one of the biggest existential risks to humanity.

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[8] The Public Policy and Nuclear Threats Training Program, https://igcc.ucsd.edu/research-and-programs/research/international-security/nuclear-security/public-policy-nuclear-threats.html

Recommendations

The findings from this brief are summarized in the form of recommendations provided to enable and facilitate effective education in nuclear security and nonproliferation policy:

Recommendation 1. Nuclear security policy education should be delivered to technical and non-technical students jointly by subject matter experts and policy practitioners from across disciplines.

Recommendation 2. Shared language should be developed through a targeted mixing of students from technical and non-technical backgrounds.[9]

Recommendation 3. Incentivize early career faculty through government and private foundation funding opportunities that allow for the development of works within traditional scholarship boundaries while simultaneously supporting nuclear security policy education, research, and training through the integration of technical and policy experts. At the same time, encourage academic institutions to change how early-career faculty are reviewed and evaluated with the goal of rewarding works outside of the boundaries defined by traditional scholarship. This could be accomplished by promoting the use of joint faculty appointments in technical and non-technical disciplines through fellowship programs.

Recommendation 4. Enable the development and sustenance of educational frameworks and modules that include research experience, simulations, and/or tabletop exercises to enhance student preparedness through experiential learning in relevant nuclear security policy scenarios via federal and private foundation educational programming grants.

Recommendation 5. Shift cultural perspectives by rewarding non-partisan educational courses and programs dedicated to providing a balanced perspective on nuclear security issues. Release public statements of support for non-biased nonproliferation policy education. Enhance federal and foundation funding support for expanded non-partisan nuclear security policy courses and modules to allow adequate time to bring in experts with different agendas and cover differing points of view.

[9] Just as foreign language immersion approaches tend to produce improved proficiency, nuclear security policy "language immersion" through shared interaction is key to achieving communication with influence, tact and finesse. Placing emphasis on collaboration and unity around a common goal rather than vocabulary memorization or textbooks yields both a communication bridge and a shared culture.

Recommendation 6. Provide opportunities for student exposure to nuclear security policy issues in the early stages of higher education.