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VIEWPOINT

The role of education in nuclear security compliance: the International Nuclear Security Education Network as a good practice

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Abstract

This viewpoint emphasizes the critical role of education in nuclear security compliance, particularly in response to evolving security dynamics post-September 11 attacks. Amidst threats to nuclear and radiological materials in use, storage and transport, the international community has established numerous legal and political instruments mandating national implementation, thereby necessitating state compliance. Domestic institutions are pivotal in this process by enacting legislation and regulations, subsequently implemented by stakeholders. In this context, education is key to accelerating the development of nuclear security culture, especially in the case of newcomer countries, and ensuring the sustainability of national efforts. The viewpoint argues that the International Nuclear Security Education Network (INSEN), operating under the auspices of the International Atomic Energy Agency, serves as a vital platform bringing together researchers and educators in the field of nuclear security. The network facilitates the dissemination of educational programs, modules, and faculty development initiatives, thereby advancing nuclear security education on a global scale. This piece presents INSEN as a model of good practice that has significantly contributed to enhancing state compliance in nuclear security.

Keywords

Education, IAEA, INSEN, nuclear security, state compliance.

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Introduction

The events of September 11, 2001, highlighted the potential for terrorists to obtain weapons of mass destruction, either from inadequately secured facilities or with assistance from state and non-state actors.[1] Existing frameworks or agreements were aligned in a way that they can address these new threats or new ones were introduced.[2]

Attacks to nuclear facilities, including nuclear power plants, medical facilities and research centers, are potential targets for sabotage, theft, or unauthorized access to steal or tamper with nuclear and/or radioactive material. Critical infrastructure, such as energy generation facilities and land and maritime transportation, can also be targeted by terrorists aiming to disperse radioactive material and disrupt international trade of strategic goods.

Terrorist groups may seek to acquire nuclear material, such as highly-enriched uranium or plutonium, to create improvised nuclear devices. Alternatively, they may attempt radiological terrorism by detonating a radiological dispersal device, also known as a "dirty bomb", using acquired nuclear or radiological material, or a radiological exposure device.[3] Incidents of unauthorized possession or criminal activities involving radioactive materials have been reported to the International Atomic Energy Agency (IAEA) Incident and Trafficking Database. The number of such incidents reached its peak around 2000 and remained steadily high during the first decade of the 21st century.[4]

Sabotage scenarios include physical or cyber-attacks that can result in reactor meltdown and radiation release, or one of a "nuclear 9/11" scenario involving an aircraft crash onto the plant's reactor core, spent fuel storage pool, a nuclear fuel fabrication plant, spent fuel storage facility, or waste repository.[5] Nuclear material in liquid form, such as

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[1] Rolf Mowatt-Larssen, *Al Qaeda Weapons of Mass Destruction Threat: Hype or Reality?,* Belfer Center for Science and International Affairs, Harvard Kennedy School, Cambridge, January 2010.

[2] The 2005 Protocol of the Convention for the Suppression of Unlawful Acts Against the Safety of Fixed Platforms Located on the Continental Shelf (SUA), LEG/CONF.15/22, International Maritime Organization, November 1, 2005; United Nations, International Convention for the Suppression of Acts of Nuclear Terrorism, 2005.

[3] Charles D. Ferguson and William C. Potter, *The Four Faces of Nuclear Terrorism* (Monterey, CA: Monterey Institute of International Studies, 2004), p. 3.

[4] IAEA, "IAEA Incident and Trafficking Database (ITDB)", 2023 Fact Sheet, https://www.iaea.org/sites/default/files/22/01/itdb-factsheet.pdf

[5] See George Bunn et al., "Research Reactor Vulnerability to Sabotage by Terrorists," *Science and Global Security* 11, no. 2-3 (2003), pp. 85-107.

plutonium in a reprocessing plant, is particularly susceptible to theft and sabotage.

Transportation vehicles—cars, trucks and ships—carrying nuclear and radiological material are vulnerable to interception or to infiltration. Ensuring the security of these materials during transportation is a crucial element of nuclear security. Shipping containers may be especially vulnerable to infiltration in ports, where terrorists may place and detonate nuclear or radioactive material in the container and detonate it close to a mega-port or in a maritime chokepoint to cause contamination, hence disruption of maritime transportation and trade of especially strategic goods, affecting the global economy.[6]

Insider threats also pose significant risks, as disgruntled nuclear facility employees or those in charge of transportation vehicle(s) may collaborate with criminals, steal and sell the material, or provide critical information to terrorists.[7] Cyber threats from hackers seeking economic gain may attack nuclear facilities to cause a nuclear safety incident.

Additionally, activists opposed to nuclear power may exploit security loopholes in power plants to undermine the credibility of the state or energy companies regarding nuclear safety and security.

In response to all these threats, existing frameworks and agreements in the field of nuclear security were adjusted, and new measures were introduced to address these emerging challenges.[8] An example of the former, is the 2005 amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM), which expanded its scope to include nuclear material in use and storage, in addition to during transport.[9]

The IAEA defines 'nuclear security' as "[t]he prevention and detection of, and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive

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[6] See Paul W. Parfomak and John Fritelli, *Maritime Security: Potential Terrorist Attacks and Protection Priorities*, Congressional Research Service Report for Congress, May 14, 2007,
https://digital.library.unt.edu/ark:/67531/metadc462262/m1/1/high_res_d/RL33787_2007May14.pdf

[7] "Preventive and Protective Measures Against Insider Threats", IAEA Nuclear Security Series, 8-G (Rev.1), (2020), pp. 3-6.

[8] The 2005 Protocol of the Convention for the Suppression of Unlawful Acts Against the Safety of Fixed Platforms Located on the Continental Shelf (SUA); International Convention for the Suppression of Acts of Nuclear Terrorism, UN.

[9] Amendment to the Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1/Mod. 1 (Corrected), IAEA, October 18, 2021.

substances or their associated facilities."[10] The international regime on nuclear security is underpinned by several legally and non-legally binding international legal instruments, including UN Security Council Resolutions 1373[11] and 1540,[12] the CPPNM-A, the International Convention on the Suppression of the Acts of Nuclear Terrorism, and the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (1988 SUA Convention) and its 2005 Protocol, IAEA's Nuclear Security Recommendations on Nuclear and Other Radioactive Material Out of Regulatory Control. A regime is formed not only of international law, but also international organizations, agreements, initiatives and even significant individuals.

Although the IAEA was established first and foremost to implement nuclear safeguards to ensure peaceful use, it is also an essential piece of the international nuclear security regime as well. It supports member states in implementing nuclear security related tasks and the Amended CPPNM by a number of means. One primary method is the International Physical Protection Advisory Service (IPPAS) missions, which offer advice and guidance on protecting nuclear and radioactive material, their associated facilities and associated activities. Additionally, the IAEA also assists states to strengthen their national nuclear security regimes by exchanging experience and good international practices in addition to reviewing their security measures during the use and transport or nuclear and radioactive material upon state request.[13] Another significant support method is funding Coordinated Research Projects related to the security of nuclear and radioactive material.[14] The Agency also issues a Nuclear Security Plan based on member states' priorities for their nuclear security activities.[15] Although establishing national nuclear security regimes was a task that dates back to 1970s, September 11 was *the* turning point for the IAEA. In March 2002, the IAEA Board of Governors approved the first comprehensive plan of action to protect against nuclear terrorism, along

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[10] IAEA, "IAEA Nuclear Security Glossary", August 2020, p. 22, https://www.iaea.org/sites/default/files/21/06/nuclear_security_glossary_august_2020.pdf

[11] United Nations Security Council Resolution 1373 (2001), September 28, 2001, S/RES/1373 (2001).

[12] United Nations Security Council Resolution 1540 (2004), April 28, 2004, S/RES/1540 (2004).

[13] International Physical Protection Advisory Service (IPPAS), IAEA, accessed April 19, 2024, https://www.iaea.org/services/review-missions/international-physical-protection-advisory-service-ippas

[14] "Coordinated Research Projects – Security of nuclear and other radioactive material", IAEA, accessed April 21, 2024, https://www.iaea.org/projects/coordinated-research-projects?type=3720&status=5017&topics=3105

[15] Nuclear Security Plan, IAEA, April 21, 2024, https://www.iaea.org/topics/security-of-nuclear-and-other-radioactive-material/nuclear-security-plan

with the Nuclear Security Fund—a voluntary funding mechanism to help implement the Plan.[16]

Another component of the nuclear security regime is the Global Initiative on Combatting Nuclear Terrorism, formed by the United States and Russia in 2006 during the G-8 Summit in Russia. This initiative builds on the CPPNM-A and UN Security Council Resolutions (UNSCRs) 1373 and 1540.[17] Following former US President Barack Obama's 2009 speech in Prague—which underlined nuclear and radiological terrorism as the most important threats to security[18]—Nuclear Security Summits were convened starting from 2010 at head-of-state level to raise awareness and get international support for proposed actions.

In addition to these initiatives, the International Nuclear Security Education Network (INSEN) was established in 2010. [19] It is another vital component of the regime; it promotes education and training in nuclear security, essential for maintaining national nuclear security regimes and ensuring compliance within the international framework. The role and contributions of INSEN will be further discussed below.

The nature of the threat necessitates that responses be developed and strengthened at the national level, ultimately constituting state compliance. A national nuclear security regime includes legislation, regulation, intelligence, assessment of the threat to radioactive material and associated locations and facilities, administrative and technical systems, response capabilities and mitigation activities. Operational procedures must be clearly defined and diligently followed by those in charge. Therefore, effective functioning of the nuclear security regime depends on the people involved, including operators and managers. Public awareness and stakeholder cooperation are crucial in ensuring nuclear security, making the development of a robust nuclear security culture essential.

To enhance the existing nuclear security culture, the human factor must be addressed. To that end, the IAEA endorses a pyramid-like structure for the development of this culture. The foundation is formed by beliefs and

[16] Nuclear Security Plan, IAEA.
[17] Global Initiative to Combat Nuclear Terrorism (GICNT), Nuclear Threat Initiative, accessed April 21, 2024, https://www.nti.org/education-center/treaties-and-regimes/global-initiative-combat-nuclear-terrorism-gicnt/
[18] Remarks by President Barack Obama in Prague as delivered, The White House, April 5, 2009, accessed March 25, 2023, https://obamawhitehouse.archives.gov/the-press-office/remarks-president-barack-obama-prague-delivered
[19] The International Nuclear Security Education Network, IAEA, accessed June 20, 2024, https://www.iaea.org/services/networks/insen

attitudes of actors, based on two main assumptions: first, that credible threat exists, and second, that nuclear security is important. Only with these assumptions in place can principles be developed, which are (a) motivation, (b) leadership, (c) commitment and responsibility, (d) professionalism and competence, and (e) learning and improvement. These principles then lead to well-developed management systems that prioritize security and behaviors that foster more effective nuclear security.[20] Thus, such effectiveness "[…] depends upon the extent to which these beliefs and attitudes are commonly held and manifest themselves in appropriate behavior and practices."[21] Nuclear security should be a concern not only to the facility personnel but also to the public.[22]

The IAEA technical guidance on nuclear security culture self-assessment envisions a 'universal' nuclear security culture as the ultimate goal for all states.[23] However, the definition and perception of threat can vary from state to state, and security and safety cultures may differ. Consequently, international instruments and plans of action for response may prove to be insufficient. Thus, 'compliance' in nuclear security cannot be ensured solely through international efforts; it requires cooperation among all national stakeholders. This involves developing a common belief of the threat, being informed about the actions to take at each stage of the nuclear security plan, and, most importantly, cultivating a nuclear security culture.

States with previous exposure to nuclear technology and operational challenges of nuclear facilities are likely to have already developed such a culture. However, this presents a challenge particularly for newcomer countries in the nuclear industry. The nuclear energy élite—comprising bureaucracy, academics and technical personnel in the industry—are typically well-informed, but other stakeholders require professional training and education to bridge the gap.

Education and training in nuclear security, however, are often understudied topics for the development, maintenance and strengthening of both national and international efforts to counter threats to nuclear and radiological materials, whether from state or non-state actors. This viewpoint piece emphasizes the vital role of education and training in ensuring nuclear security. Specifically, it sheds light on the INSEN as a professional network of nuclear security educators and researchers, and

[20] Nuclear Security Culture, IAEA Nuclear Security Series, No.7, IAEA, 2008, p.18.
[21] Nuclear Security Culture, IAEA, pp.4, 19.
[22] Nuclear Security Culture, IAEA, p.20.
[23] Self-assessment of Nuclear Security Culture in Facilities and Activities, IAEA Nuclear Security Series No. 28-T, IAEA (2017), 3, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1761_web.pdf

their activities contributing to raising awareness and human resource development. It is another vital component of the regime; it promotes education and training in nuclear security, essential for maintaining national nuclear security regimes and ensuring compliance within the international framework. It is essentially a platform (for nuclear professionals or states) to exchange experiences. The role and contributions of INSEN will be further discussed below in more detail. Education and training in nuclear security are essential for the maintenance of national nuclear security regimes, which is part of compliance within the international nuclear security regime.

National nuclear security regime and education

An international regime is established upon principles that serve as the foundation for rules, decision-making procedures, and norms on a specific issue, around which states align their national interests.[24] States are expected to develop national nuclear security regimes to fortify the international regime—as outlined in the UNSCR 1540[25]—and particularly emphasized as a fundamental goal in the CPPNM-A.[26] UNSCR 1540 and the Amended Convention mandate that states adopt domestic legislation and foster stakeholder cooperation in developing a national nuclear security regime.

The underlying assumption is that individual country efforts and compliance will maintain and strengthen the international regime. The IAEA's 2020 Nuclear Security Conference highlighted the importance of "identification of national needs through the development of an Integrated Nuclear Security Support Plan", with participants focusing on its benefits, such as applying a comprehensive approach to strengthening their nuclear security regimes. This is essential for enhancing coordination among relevant competent authorities.[27]

The international regime on nuclear security is only "as strong as the weakest link in the chain."[28] This is because the threat is assumed to originate from non-state actors, necessitating action at the domestic level

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[24] Stephen D. Krasner, "Structural Causes and Regime Consequences: Regimes as Intervening Variables," *International Organization*, Vol. 36, No. 2, Spring 1982, p. 186.
[25] United Nations Security Council Resolution 1540, S/RES/1540 (2004), April 28, 2004.
[26] Amendment to the Convention on the Physical Protection of Nuclear Material.
[27] "International Conference on Nuclear Security: Sustaining and Strengthening Efforts", IAEA,
Vienna, Austria, February 10-14, 2020, p. 27.
[28] "NTI Nuclear Materials Security Index: Building a Framework for Assurance, Accountability and Action", the Nuclear Threat Initiative, January 2012, p.3.

as required by the amended Convention. The nuclear security regime adopts a 'bottom-up' approach. Ensuring nuclear security involves prevention, detection and response stages,[29] which require coordination among various departments and agencies within a state, including the regulatory authority, facility operators, ministries of energy, interior, health, transportation, national defense, departments of security and law enforcement, coast guard, intelligence agencies, media, and local communities.

Accordingly, states are expected to establish relevant divisions, enact and implement laws, develop a nuclear security culture, and cultivate human resources. Awareness and an accurate assessment of the threat are necessary for the sustainability of national nuclear security regimes. Merely having laws and regulations in place does not guarantee successful implementation. Often, achieving nuclear security goals across different agencies and institutions poses a challenge. For starters, energy and security bureaucracies need to work together and develop standard operating procedures, pushing beyond their comfort zones to address nuclear security comprehensively. Moreover, nuclear security is unsuited to compartmentalization and requires a basic knowledge of all its facets, including the technical aspects of nuclear energy generation, radiation protection, design basis threat, physical protection, cyber security, threat assessment, forensics and insider threats. That is why, professional training in nuclear security designed for particular stakeholders (agencies/institutions involved in ensuring nuclear security) reinforces this divide and each one will continue to 'speak its own bureaucratic language' when a case arises. To break this vicious circle, either educators/experts on nuclear security should provide such education during professional development or training programs which are particularly designed for a certain profession, or a new generation of nuclear security experts should be raised so that the national nuclear security regime will be sustainable.

Education serves several purposes in the development of national nuclear security regimes. Firstly, it raises and maintains awareness on nuclear security-related threats and challenges. Secondly, it fosters the development of human resources and a new generation of nuclear security experts. Thirdly, it helps embed nuclear security culture within the government, industry and academia.

The amended CPPNM determines the development of nuclear security culture as a fundamental element. More specifically, it requires the development of nuclear security culture at all levels of operation

[29] IAEA Nuclear Security Glossary, IAEA, (August 2020), p. 22.

(managers, operators, and personnel) and its dissemination to stakeholders. The core belief that 'nuclear security is important' must be ingrained within institutions and individuals, facilitated by informed decision-making. Bureaucratic cultures may hinder the assimilation of new information and the roadmap for nuclear security goals. To address this, education and training are essential, particularly in newcomer countries in the nuclear industry where there is a limited number of professionals who are experienced to work in the nuclear energy sector. Education and training orient the stakeholders towards threat assessment, and definition of threat and understanding their responsibilities in the stages of nuclear security (prevention, detection and response), and building a nuclear security culture, thereby fostering proactive rather than reactive behavior by stakeholders in nuclear security-related scenarios. Education in nuclear security also ensures a continuous supply of human resources to serve in civilian and military bureaucracies with a sound understanding of nuclear security principles, contributing to the regime's sustainability. Next section focuses on INSEN as a good practice on the contributions of education.

INSEN as a good practice

Established in 2010, INSEN serves as a link between the IAEA and educational institutions, whereby it contributes with teaching material, curriculum and faculty development, and faculty exchange opportunities through its working groups. The added value of such an international infrastructure to support education efforts is linked with the philosophy of having an international organization to coordinate international efforts for cooperation towards the resolution of a certain issue: in this case, nuclear security. Education is part of these efforts under the nuclear security division aiming to inform and raise awareness in the wider public with accurate information on the threats, scenarios and responses. The network operates through three working groups: Working Group I focuses on curriculum development; Working Group II focuses on faculty development and exchange; Working Group III works on the promotion of nuclear security education and INSEN.

Since its establishment, INSEN's membership has grown significantly. The eligibility criteria are the offering of nuclear security related courses, teaching modules or graduate programs. One of the network's key contributions is that through its working groups and leadership meetings, researchers and scholars of nuclear security have assumed the "identity" of being the "academic piece" of the developing international nuclear

security regime.[30] This makes the network an indispensable part of their academic status both at home and abroad. Thereby, through networking, they also contribute to nuclear security education activities within their respective institutions.

INSEN is significant not only because it helps states at the national level but also because it has a multiplier effect at the international level by bringing together academics and researchers from around the world. The main contribution and impact of INSEN on nuclear security is to raise awareness by equipping and supporting faculty in educating students and professionals. INSEN has been instrumental in facilitating the development and implementation of nuclear security education through several means:

- *Annual meetings and working group sessions:* these are held at the IAEA headquarters in Vienna, where scholars and researchers from INSEN institutions share their programs and progress in teaching nuclear security. This includes degree programs, modules, curricula, and faculty development courses, which serve as a good practice.
- *Teaching materials*: INSEN provides teaching materials developed by subject matter experts, which members can use in their courses.
- *Faculty exchange and development opportunities*: members can organize or develop faculty exchange opportunities or faculty development courses to enhance their expertise and serve with newly acquired knowledge in their particular institutions.

The IAEA has developed the Nuclear Security Series-12 in 2010 and its updated version, NSS 12-T (Rev. 1) Model Academic Curriculum in Nuclear Security, in 2021, to guide educators for developing course content and degree programs.[31]

In the Nuclear Security Series 28-T, the "Self-Assessment of Nuclear Security Culture" assumes that all members should achieve a similar level of nuclear security culture.[32] Therefore, they need to acquire a general knowledge of nuclear security, related scenarios, threats, and actors.

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[30] Şebnem Udum, "INSEN As Part and Propellant of Nuclear Security Regime: An Insider's View," *International Journal of Nuclear Security*, Vol. 6, No. 2 (Special Issue), 2020.
[31] Model Academic Curriculum in Nuclear Security, IAEA Nuclear Security Series No. 12-T (Rev. 1), IAEA, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1930_web.pdf
[32] Self-assessment of Nuclear Security Culture in Facilities and Activities, IAEA Nuclear Security Series No. 28-T, IAEA (2017), p. 3, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1761_web.pdf

INSEN member activities, including Professional Development Courses (PDCs), help to achieve this goal. These courses are not just offered in English: to overcome language barriers and focus on regional needs, PDCs were organized in Africa in French and Arabic, and in Latin America in Spanish.

The author has witnessed significant mutual contributions between the members and the network, benefiting individual academics and researchers in their teaching and research. Firstly, INSEN has developed a unique "nuclear security education community". Members maintain constant contact beyond the annual or working group meetings, facilitated by their active participation in working groups and the networking opportunities provided during their time at IAEA headquarters and leisure time in Vienna. This sustained interaction over fourteen years created a sense of 'befriended colleagues', which has facilitated the organization of various activities. Secondly, the lockdowns and the shift to virtual meetings due to the Covid-19 pandemic have increased opportunities for engagement, supplementing the once-in-a-year annual meetings. This transition has enabled members to interact more frequently and effectively. Lastly, the leadership structure of INSEN, characterized by a system of trinity (former, current and vice chairs) and the continuing involvement of former network chairs, ensure the transmission of "network memory and experience" to incoming chairs and vice chairs of working groups, as well as to new members. This continuity supports the development of nuclear security education and the enhancement of national nuclear security regimes.

In the next section, the author will share personal experience of teaching nuclear security, illustrating how INSEN has contributed to the success and development of their instructional methods.

Education and training in nuclear security

Teaching nuclear security is challenging at both national and global levels. Few disciplines receive training in policy and lack a comprehensive understanding of nuclear security risks and threats across technical, political, and international dimensions. Furthermore, the links between academia and government may be weak. Language poses another problem, particularly regarding terminology in local language at the national level. The type of audience also impacts how information is received. Table 1 outlines audience expectations depending on whether the instructor is in a teaching environment or training professionals or professors.

Audience/Properties	**Students**	**Professionals**	**Professors**
Background	Limited	Focused	Academic
Expectation	Jobs	Career development	Progress in teaching
Attention	Limited	Need-based	Forward-looking

Figure 1 Characteristics and expectations of different audiences in nuclear security education

The first group is students who are intelligent but usually uninformed about nuclear security, and their main focus is on securing jobs. Therefore, their attention is limited, as they are still developing their foundational knowledge. The second group is composed of professionals with focused backgrounds, mainly related to their specific roles and are interested in career development and promotion. Their attention is need-based, concentrating on information that is relevant for their job performance and career growth. The final group are professors who are advantaged in having academic backgrounds with a comprehensive understanding of the subject matter. They have a wider understanding of the issue, seek progress in teaching and are forward-looking, often interested in the latest developments and research in the field.

An outstanding issue in teaching nuclear security is the discrepancy between the backgrounds of the educators and students, as nuclear security straddles both natural and social sciences, most notably, physics, nuclear engineering, forensics, political science, international relations, and psychology. INSEN has contributed to the author's academic progress by fostering an interdisciplinary approach. With a background in International Relations and nearly two decades of experience in studying and teaching nuclear non-proliferation, the author is informed about the basics of nuclear technology.

Teaching nuclear security involves four probabilities of instructor/student interaction. Two scenarios occur when the instructor is from a STEM (Science, Technology, Engineering and Mathematics) field and students are from social or technical sciences. The other two scenarios occur when the instructor has a social science background, and students are from either social or technical sciences. Since becoming an INSEN member, the author has taught to both audiences, identifying which allowed her to detect issues that arise when a STEM instructor teaches about nuclear issues to an audience with a social science background.

For compliance training in nuclear security, the audience is not usually students, but typically professionals from different government departments. In this case, the main roadblock is the bureaucratic culture and the people's receptivity to "new information." Each bureaucracy tends to receive (learn) or give attention to the topics they find related or relevant

to their specific department. However, nuclear security is a topic that requires basic information on all facets, including safety and security, so that a nuclear security culture can be developed, hence a sustainable compliance for the particular state.

The instructor should pay attention to the audience and underline the message that the training is not for a certain bureaucracy or department, (such as security or energy, or nuclear safety, nuclear security, physical protection, legal affairs, operations, etc.), but it is an essential part of compliance with international legal commitments of their state. The purpose of the training is to prepare the stakeholders to structure their respective roles as per the stages of nuclear security and strengthen their capabilities. Thus, they need to learn about the basics of nuclear and radiological material, radiation protection, scenarios of theft, sabotage, unauthorized access; means of detection, strengthening security measures, adopting layered defense, how to cope with insider threats and cyber threats, to cooperate with the public in detecting intentions and to respond to incidents. The audience in nuclear security education and training would include most notably students of social science, physics and nuclear engineering, government officials from relevant agencies and departments, and professionals, who will be or are working in nuclear facilities or those including nuclear and radioactive material.

Conclusion

Following September 11 attacks, vulnerability of nuclear and radiological material in use and storage (in facilities) and transport (in vehicles and vessels) to malicious intent raised concerns for their security against scenarios of theft, sabotage or unauthorized access to the material or the facility. An ensuing nuclear safety failure, disruption of land or maritime trade and transportation routes or mass panic and anxiety would create a nuclear and/or radioactive September 11. Hence a new international regime on nuclear security has been developing.

The nature of the threat requires that responses be developed and strengthened at the national level-which constitutes state compliance. The effective functioning of a national nuclear security regime depends not only on facility personnel but also stakeholder harmony that would eventually result in the development of nuclear security culture. The latter is a fundamental element foreseen in the amended CPPNM that upholds the regime.

Education emerges as a linchpin in this endeavor, serving to raise awareness, cultivate expertise, and instill a culture of security across government, industry and the academia. Last but not least, the

development of operational level safety and security culture would contribute to the harmony of stakeholders and their active involvement in nuclear security related tasks. Through INSEN, collaborative efforts among scholars and professionals further amplify the impact of such educational endeavors, fostering a robust community dedicated to advancing nuclear security.

This article focused on INSEN as a good practice for nuclear security education to contribute to the development of national nuclear security regimes. It argued that it had a multiplier effect at the international level by bringing together academics and researchers from around the world. The main contribution and impact of INSEN on nuclear security is to raise awareness through equipping and supporting faculty to educate primarily students but also professionals by developing training materials, designing and implementing courses and curricula, and engaging in advocacy and outreach on the value of promoting nuclear security competence among relevant practitioners.

INSEN has developed a unique 'nuclear security education community'. Throughout the working groups and leadership meetings, researchers and scholars of nuclear security have assumed the "identity" of being the "academic piece" of the developing international nuclear security regime.[33] This makes the network an indispensable part of their academic status at home and abroad. Thereby, by networking, they also contribute to nuclear security education activities in their institutions. In sum, collective engagement enriches individual professional development in the realm of nuclear security. Through concerted educational efforts and collaborative networks, we can cope with nuclear security challenges now and in the future.

[33] Udum, "INSEN As Part and Propellant of Nuclear Security Regime."