Lessons for Biosecurity Education from the International Nuclear Security Education Network

Iris Magne[1,2], Olivia Ibbotson[1], Lijun Shang[1], Malcolm Dando[1,3]

[1]Biological Security Research Centre, London Metropolitan University, [2]King's College London, [3]University of Bradford

Abstract

With the rapid advances in technologies and life science, biological security is now at a defining moment. The mandate of the 2022 Biological and Toxin Weapons Convention (BTWC) 9th Review Conference emphasised the urgent need for new tools to strengthen the Convention. This paper reviews the development and work of the International Nuclear Security Education Network (INSEN) in order to draw examples of best practice for the implementation of the newly founded International Biological Security Education Network (IBSEN). Learning from the lessons of the INSEN, the sustainability of the network, through a continuous engagement of its members, is essential to develop global biosecurity education.

Keywords

Security education, Biological and Toxin Weapons Convention (BTWC), Chemical Weapons Convention (CWC), nuclear security education, the International Nuclear Security Education Network (INSEN), International Biological Security Education Network (IBSEN)

0. Introduction

Rapid technical and scientific advances have increased the number and scale of the biosecurity challenges that society faces. [1] These challenges are exacerbated by lack of formal biosecurity training in scientists and policymakers. A similar defining moment took place fifteen years ago in the field of nuclear security. The International Nuclear Security Education Network (INSEN) was then set up to address the absence of trained professionals in nuclear security and enhance global security through the introduction of a formal education network. [2] In this paper, we will explore the history of INSEN and its implementation practices over the past 15 years and the lessons learned especially in the era of advanced science and technology. This would provide very useful implications for our newly established International Biological Security Education Network (IBSEN).

1. History and challenge facing nuclear security

The Nuclear Non-Proliferation treaty was first proposed by Ireland at the meeting of the General Assembly of the United Nations in 1961.[3] A vital element in developing an effective arms control treaty was for non-nuclear states to accede to the treaty. This was a very challenging aspect of the treaty as non-nuclear states had to agree to not receive, attempt to develop, or acquire nuclear weapons. The Nuclear Non-proliferation treaty was subsequently signed in 1968 and entered into force in 1970. Signatories thus agreed to not transfer nuclear weapons and technology. The signatories also agreed to cooperate to develop peaceful nuclear technology and to submit to safeguards against proliferation established by the International Atomic Energy Agency. The treaty originally had a time limit of 25 years, however, was extended indefinitely in 1995.

The 911 attack and its subsequent impact on international security played a significant role in the creation of the INSEN. The international community became increasingly aware of the risks of terrorists obtaining weapons of mass destruction, alongside increasing tensions regarding Iran's nuclear program. This context led to increased awareness amongst the international community, manifested by the amendments of the Convention on the Physical Protection of Nuclear Materials (CPPNM) in 2005. President Obama presented a notable speech on the 5th of April 2009 in Prague, in which he pledged to work towards a nuclear-free world. [4,5] Following this call introducing a new kind of multilateralism, the first Nuclear Security Summit was organised in April 2010.[6]

2. Establishment of the nuclear security education network and recent developments

The 2009 Nuclear Security Plan agreed by the International Atomic Energy Agency (IAEA) Board of Directors emphasized the need to develop educational programs in nuclear security.[7] As a result of the initiative put forward by the IAEA a Master of Science (MSc) program and a certificate program in nuclear security were proposed. [6,8,9] These programs were developed in line with the technical guidance of IAEA Nuclear Security Series No 12 - Educational Programme in Nuclear Security.[10] The MSc and certificate programs aimed to be complementary to academic programmes already implemented in some universities.[7] A workshop organised in March 2010 by the IAEA brought together academics, International Organizations, and governmental representative to discuss this complementarity and to deliberate on the foundations of the Network.[7] The objective of INSEN given by the IAEA is to enhance nuclear security education globally. INSEN defined its mission in 2012 to develop educational materials (peer-reviewed textbooks, online teaching tools and instructional material, including exercises and materials for laboratory work), collaborate internationally at different levels (faculty, academics, and students), quality insurance (consistency with IAEA defined terminology) and assessment mechanisms (assess the effectiveness of nuclear security education via evaluation, coordination, and improvement).[7]

The INSEN is, as of 2023, constituted of 204 institutions members from 72 IAEA member states and 13 observers.[11] In order to reach these objectives and promote nuclear security awareness, the INSEN was structured into three working groups (Figure 1).[10] Members of INSEN can participate in multiple groups and group meetings are held either at the annual meeting or working group meetings.[7]

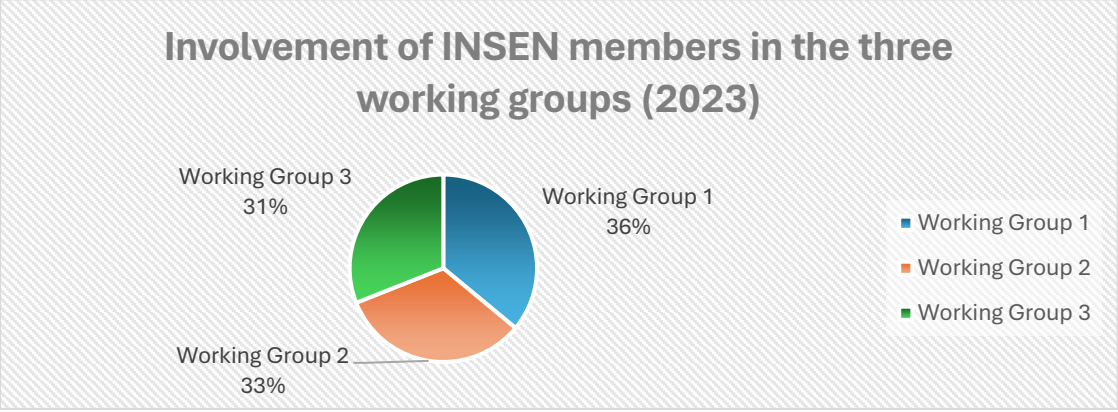

Figure 1 Involvement of INSEN members in the three WGs, "exchange of information and development of teaching materials for nuclear security education" (working group 1),

"Faculty development and cooperation among universities" (working group 2), and "promotion of nuclear security education" (working group 3) [11]

2.1 Overview of the Nuclear Security training developed by INSEN

Training courses were since developed to target students with a range of academic backgrounds and included MSc programmes, two-week schools, and short courses. Below are a few examples.

INSEN played a significant role in the establishment of the Joint ICTP-IAEA International School on Nuclear Security overseen by the IAEA and the International Centre for Theoretical Physics (ICTP). The two-week International School on Nuclear Security provided an overview of contemporary nuclear security and was open to professionals with a various different science and social science backgrounds [10].

King's College London pioneered the development of the Professional Development Courses (PDCs) within the Network. INSEN also provides training in the form of Faculty Development Courses (FDCs). [12]

The MSc programmes are guided by the curriculum put forward by the IAEA Nuclear Security Series No 12 - Educational Programme in Nuclear Security (2010).[10] The guide first suggests that an assessment of nuclear security needs to be at a national level, followed by an analysis of the multidisciplinary aspect of nuclear security. The proposed MSc in Nuclear Security includes 12 required courses which discuss the International/national legal frameworks, methods and instruments for nuclear material, effects of radiation, threat assessment, systems of physical protection, security of nuclear material and the detection, response, and investigation of criminal or unauthorized acts. The elective courses include nuclear material accountancy, import/export and transit control mechanism and regime, nuclear security at major public events, nuclear forensics, and IT/cybersecurity amongst other elective courses. Based on this IAEA guide, the *European MSc in Nuclear Security* was administered by Delft University in the Netherlands and supported by five universities: University of Oslo, Technical University of Vienna, Brandenburg University of Applied Sciences, Dalton Nuclear Institute at the University of Manchester, the National Centre of Scientific Research 'Demokritos' in Greece. [4]

The *Model Academic Curriculum in Nuclear Security* released in 2021 included new technical guidance.[13] The updated MSc curriculum introduced new modules and divided the core modules into three categories: protection, detection and response and cross-cutting topics. This new guidance recognised that each university would implement the degree structure differently, based on analysis of the resources and national job market.[13] It is estimated that 2500 undergraduate and postgraduate students have participated in nuclear academic programmes offered by members of the INSEN.

The aforementioned programmes have made considerable contribution to the promotion of the Network and the creation of a new generation of policymakers, scholars, and professionals educated in nuclear security.

2.2 Recent development of the INSEN

The Annual Meeting of the International Nuclear Security Education Network (INSEN) – Chair's Reports 2022 and 2023 highlighted the recent developments in INSEN.[14,15] The reports emphasise the importance of sustainability and flexibility of the Network and illustrate the Network's ability to adapt to consistently changing international and local contexts. The renewed framework for nuclear security education (2022-2025 Nuclear Security Plan) approved during the 2022 annual meeting supported this view. Members at the 2022 annual meeting also discussed the release of the IAEA Nuclear Security Series No. 12-T (Rev.1) and its implementation.

The recently published *Oxford Handbook of Nuclear Security* illustrates the significant role which researchers have played in enhancing nuclear security education within this new framework. The training of early-career professionals is key in creating a sustainable network. The previously mentioned meetings saw members discussing multiple approaches to engage students and young professionals. This focus on young professional engagement was included in the IAEA International Conference on *Nuclear Security: Shaping the Future* (ICONS 2024).

INSEN members have also placed emphasis on their commitment to gender parity within the network and field of nuclear security. This can be seen through the initiatives *Women in Nuclear Security* and the *Marie Sklodowska Curie fellowship programme*.

3. Successes and challenges of INSEN

With its rapid growth, the INSEN had a significant impact on the spread of worldwide nuclear security. This was facilitated by the affiliation and support from the IAEA which plays a significant role in promoting the INSEN by prioritising nuclear security education. The IAEA *Nuclear Security Plans* give high priority to nuclear security education and assist IAEA's member states in establishing educational programmes. [12] It also provides a Secretariat function for the INSEN and hosts the NUSEC (Nuclear Security Information Portal), the coordination platform for the three working groups. These resources enable INSEN to multiply its educational approaches to nuclear security through the design of PDCs and FDCs, summer schools, Master's programs and educational material on the NUSEC platform, with each targeting different audiences. Specific initiatives, such as *Women in Nuclear Security Initiative* (WINSI), foster the participation of women through dedicated events and opportunities. [16] The network also benefits from significant outreach and promotion strategies with members regularly presenting at diverse conferences. [12] INSEN members also promote the network and its research locally which leads to a multiplier effect and a regionally focused approach.

3.1 King's College London as a local INSEN champions in nuclear security education

As a member of INSEN, King's College London (KCL) played a globally and regionally significant role in promoting the network by delivering a cutting-edge training on nuclear security. In partnership with the INSEN, *KCL Centre for Science & Security Studies* launched in 2010 the first professional development course (PDC). During the first three years of King's PDCs, the courses were attended by more than 100 academics from 30 institutions and 15 countries.[17] The PDCs organised by KCL include 6 different workshops, such as *Physical Protection of Nuclear Materials* and *Insider Threat and Preventative Measures* which last between two to six days. These courses and workshops employ an interdisciplinary approach and use different methods to apply theoretical concepts such as case studies, site visits to an operational nuclear power plant or video walk-through of a site containing radiological sources.[17]

KCL had to adapt to both the variety of backgrounds of its students and the interdisciplinarity of nuclear security concepts. The courses taught at KCL were focused on both analysing nuclear security issues and on teaching methods and case studies. For this first half of the course, introductory e-learning with videos explaining the key concepts of nuclear security

were sent to students prior to the classes. The assessment mechanisms of these courses were also adapted to include short answer exercises and open-ended policy questions. Based on the principles of a 'learning paradigm' in nuclear security education outlined by Professor Christopher Hobbs, KCL developed efficient educational tools as part of its INSEN membership.[18] Furthermore, between 2014 and 2016, KCL organised some courses locally in Sub-Saharan and North Africa, the Middle East, and Southeast Asia which focused on regional nuclear security education. The last KCL PDC was organised in 2017.

KCL also developed a Master of Arts (MA) in Science and International Security programme. The program focused on the policy aspects of nuclear security, but interestingly also included classes on biological security. There were around 25 students per cohort coming from interdisciplinary backgrounds. However, due to a lack of funding and other internal decisions, the MA program was discontinued after the 2023-2024 academic year. The modules of the MA program are now offered as optional courses to the students of the thirteen master's courses of the KCL Department of War Studies.

KCL established itself as a hub for nuclear security education in the INSEN thanks to the variety of programs offered and the diversity of empirical methods used and adapted to the different student backgrounds.

3.2 Challenges faced by the INSEN: how to build a sustainable network.

3.2.1 Coordinating members from different backgrounds

Due to its interdisciplinary nature combining social sciences and nuclear science, nuclear security is still facing difficulty in being recognised as an individual/separate educational field.[8] This is particularly the case for social scientists compared to life scientists. There are also challenges arising from this discrepancy of subject backgrounds with students from the field of social sciences when paired with trainers from the field of natural sciences and vice versa.[4]

Although the Network has been constantly welcoming new members since its creation, it was also faced with the difficulty of involving institutions from all continents. The geographical distribution of the INSEN members below highlights that only 3% of members are from Latin America. However, this region has a significant role to play in nuclear security.[19] One of the only members in Latin America is Brazil which joined the Network very recently. Although the

INSEN is willing to expand the participation of Latin American States, there seem to be few answers to this call. This raises questions regarding the efficiency of the INSEN outreach strategy in the region especially in those regions with different geographical and cultural backgrounds. There are also registered members who are inactive, with only an estimated 25% of the INSEN members who are regularly participating and engaging locally with the educational material. While providing numerous opportunities for transnational collaboration, the significant number of members also can lead to coordination challenges within the INSEN.

Furthermore, an issue of unbalanced digital infrastructure access among the various areas of the world was highlighted by the COVID-19 pandemic. [14] Some countries and regions had difficulties to access online resources and receive reliable information due to a lack of digital infrastructure. A few members also faced difficulties in attending the INSEN annual meetings remotely in 2021 and 2022 due to a restricted of internet access.[14] These differences must be considered by the network to prevent an inequitable spread of nuclear security educational materials due to the ability of the digital access of countries and members.

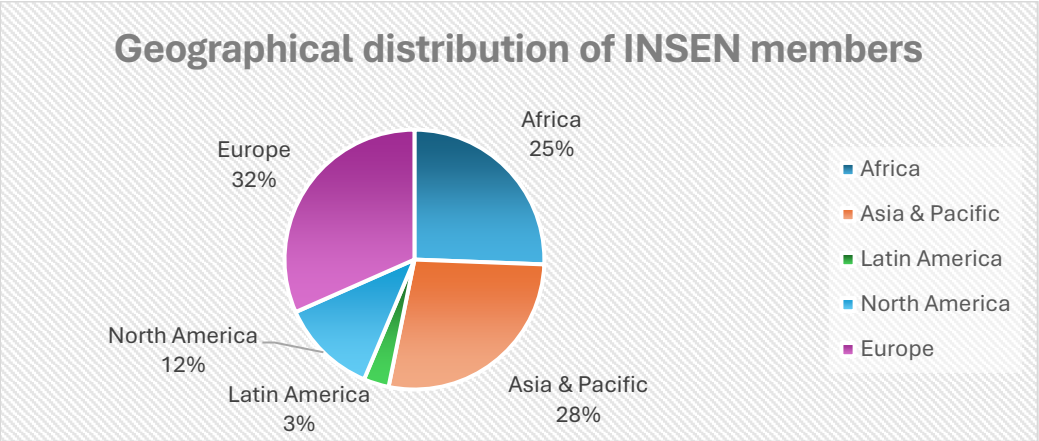

Figure 2 Geographical distribution of INSEN members, as of 2023. [20]

3.2.2 Diverging approaches to nuclear security education

The IAEA had a different approach to educational materials compared to some INSEN members. The IAEA did not recognise the variations showed between the training courses provided by the international organisation and those developed by INSEN. This can be illustrated by the reliance on the IAEA Nuclear Security Series No 12 for the structure of a MSc program in Nuclear Security.[10] However, this MSc structure is broad and does not take into consideration regional challenges and resources available. The approach of implementing

a single MSc structure in Nuclear Security would not be efficient for the development of different local nuclear security education projects.

Some members also have different views about the approach to the type of educational programs INSEN should develop. Indeed, the two weeks summer schools are considered by sone to be more sustainable than the Master programs. This is due to the difficulties in recruiting Master students interested in the subject. Moreover, the Network needs to ensures that the universities where the Master program is developed have experts with the appropriate knowledge and infrastructures. This was a criticism made of the *European MSc in Nuclear Security* because it was implemented in five different universities some of which were not necessarily specialised in nuclear security. However, the summer schools and the Master programs target different audiences and answer different needs for nuclear security education. The INSEN seemed to face the difficulty of finding a balance between these different deliverables.

Despite these difficulties, developing nuclear security education is an ongoing process. The INSEN adapted to these challenges and has proven to be an essential tool in enhancing excellent global education in the field.

4. Implications for biological security education

Although biological security education, defined as 'the prevention of natural, accidental, and deliberate disease in humans, animals, and plants', has been advocated for decades, it is still overlooked in life science curriculum.[21] The necessity of including biosecurity education within the framework of the Biological and Toxin Weapons Convention (BTWC) was highlighted during the Side Event *From the Tianjin Biosecurity Guidelines to an International Biosecurity Education Network* organised at the 2023 Meeting of BTWC State Parties. Current efforts in the field have been fragmented and geographically limited.[22] Initiatives previously developed in biosecurity education include the resources and methodologies designed by The Bradford Disarmament Research Centre, University of Broadford (UK), the postgraduate courses in biosecurity education at National Defence Medical College in Japan, the joint projects on fostering the biosecurity norm with the Landau Network Centre Volta in Italy and the work of the Biological Security Research Centre, London Metropolitan University (UK). [9] Although each such initiative developed good practices, they were also limited due to the difficulty to coordinate their actions and share adapted resources in biosecurity education.

Other resources, such as newly published book *Essentials of Biological Security: A Global Perspective* (Shang, Zhang, Dando, 2024), aim to fill this gap in available tools for stakeholders.[21] These resources are important and could be the first step for a network which would raise awareness of the urgency for biosecurity education and help at implementing the mandate of the 2022 BWC 9th Review Conference to strengthen the Convention.

Founded in February 2024 by the London Metropolitan University's *Biological Security Research Centre* (BSRC), the International Biological Security Education Network (IBSEN) aims to help raise awareness of risks of dual-use research in the life sciences and to initiative lasting changes in implementing widespread biosecurity education. This unique initiative, supported by *the Joseph Rowntree Charitable Trust* (JRCT), provides a platform to facilitate the exchange and creation of biosecurity education resources.

It is essential that the IBSEN learns from the experience and expertise of the INSEN. This analysis of INSEN led to six key lessons for IBSEN (table 1).

Lessons for IBSEN from the INSEN experience	
1. *Affiliation*	An organisational affiliation can provide support and sustainability, but it could also impose restrictions according to the organisation's mandate.
2. *Participation*	Worldwide participation is desirable but could also cause problems in co-ordination.
3. *Interdisciplinarity*	Security education is difficult as it requires natural science and social science teaching expertise and equally broad interest in the students.
4. *Focus*	Security education needs to be implemented in different ways, but too broad a range of activities risks loss of focus on key elements.
5. *International structure and regional application*	Centralised control of activities is desirable but risks lack of adaptation to diverse local circumstances.
6. *Evaluation*	The importance of clear evaluation targets and methods.

Since its foundation, the IBSEN had to answer significant structural questions. Contrary to the INSEN, the IBSEN is not directly affiliated with an international organisation. Although this can lead to significant challenges such as the difficulty of finding sustainable funding, it can on the other hand limit bureaucratic constraints, which is evidenced in INSEN from the IAEA. This organisational independence enables IBSEN to rely on a horizontal and bottom-up organizational approach in order to ensure a broad engagement of its members. The nature of academic initiative could greatly help in improving biological security education. It is essential to strengthen the engagement of international and regional actors in developing educational tools and methods adapted to their needs. Learning from the difficulties faced by the INSEN in continuously involving members from all continents and backgrounds, one of the first actions of IBSEN was to constitute a database of interested stakeholders, from high school, universities, to continuing professionals in biological security, including local champions. To achieve this global reach, the resources and IBSEN communication are available in three languages English, French and Spanish and aim to reach a linguistic plurality as the network expands.

As the difficulty to find appropriate resources in biosecurity education limits its development, IBSEN created a freely accessible website similar to the NUSEC portal of the INSEN. However, the IBSEN will encounter challenges which are specific to the field of biological security. These include the bioscience revolution and the interrelation of biological and chemical research. The IBSEN will therefore need to have a broad view on biosecurity, integrating common issues from the BTWC and the Chemical Weapons Convention (CWC). The interdisciplinarity of IBSEN was a factor considered since its foundation. The Network is developed to include actors from the life, physical, chemical, computing, materials, and social sciences. This is directly related to the complexity of dual use in the life and associated sciences. As biological and chemical weapons are a direct consequence of dual use, IBSEN will help the scientific community in understanding prevention of dual use concerns. Biosecurity needs to have different approaches as research is conducted in commercial and academic laboratories instead of nuclear research sites which are relatively limited to governmental infrastructures.[23] These aspects add complexity to the challenges already identified from the lessons learnt through the study of INSEN.

5. Conclusion

Similarly, to nuclear security education in 2010, biosecurity education is now at a defining moment. The rapid advances in life science and technologies require sustainable biosecurity education to meet the developing challenges. Learning from both the INSEN's successes and challenges, the newly founded initiative IBSEN aims to have a lasting and global impact on biosecurity education. It will adapt the characteristics of INSEN and integrate other initiatives and collaborations such as with the Advisory Board on Education and Outreach (ABEO) of the Organisation for the Prohibition of Chemical Weapons (OPCW) and WHO's Global Framework. Biosecurity education cannot be implemented as a 'one-size-fits-all' framework. The IBSEN will therefore have the significant responsibility of connecting relevant actors in biosecurity education to help them developing educational tools adapted to local circumstances. This is reflected in the report of our recent Policy Workshop.[24] The challenges identified for IBSEN will be the focus of research for our IBSEN in the next two years in the initial project. The materials to be produced and the implementation tools and methodologies to be tested will allow a thorough evaluation and assessment of how IBSEN should and could be sustainable in the long terms.

Acknowledgement

We would like to thank the constructive discussions with Dr Matteo Gerlini, former Chair of the International Nuclear Security Education Network (INSEN) and Professor Christopher Hobbs, Professor of Science and International Security at King's College London where they shared their expertise on the INSEN. IBSEN is supported by the *Joseph Rowntree Charitable Trust* (JRCT).

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