

# RCA Issue Brief

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## Advancing Nuclear Science and Technology Education in the Asia-Pacific Region

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### Summary

In the Asia-Pacific region, the peaceful applications of nuclear science and technology (NST) are increasingly recognized as critical components of national development strategies. Since 2014, coordinated efforts supported by the International Atomic Energy Agency (IAEA) have driven regional initiatives aimed at expanding NST education. These efforts reflect a strategic vision: to cultivate nuclear literacy from early education, ensuring that societies can fully harness the benefits of nuclear technology in areas such as energy, health care, agriculture, and environmental monitoring. One of the central themes has been inclusivity—ensuring that both advanced and emerging Member States (MS) can participate equally. A regional meeting held in Shenzhen, China in 2024 served as a landmark opportunity to assess progress and shape the agenda for the 2026–2029 technical cooperation cycle. Discussions focused on the evolution of NST education strategies, the rise of digital tools, the role of youth, and the reinforcement of regional networks that have become engines for innovation and capacity building. This paper synthesizes the ongoing evolution of NST education in the Asia-Pacific region, illustrating the seamless continuum of initiatives supported through various IAEA projects and regional cooperation frameworks. ✓

## CONTENTS

1. Strengthening Foundations: Educators and Curricula
2. Youth Engagement and Innovation: From Classrooms to Olympiads
3. Regional Networks and Digital Transformation
4. Policy Alignment and Industry Integration
5. Addressing Challenges: Equity, Resources, and Sustainability
6. Future Directions and Regional Implications
7. Conclusion

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## 1. Strengthening Foundations: Educators and Curricula



During the pandemic, opportunities identified using digital platform in this 2022 Virtual NST Education Exhibition, engaging more than 10,000 visitors from educators and students

The cornerstone of any educational reform is the empowerment of educators. In the Asia-Pacific region, relevant IAEA TC Projects have given priority to teacher training as a means of institutionalizing NST education within school systems. Between 2018 and 2021, over 8,351 teachers were trained through national programs, complemented by 191 educators participating in IAEA regional and interregional training courses. This multiplier model has proven effective, with each teacher impacting an estimated 130 students annually. Countries like Thailand and Sri Lanka are integrating NST topics directly into school curricula, covering subjects from radiation safety to nuclear reactions. Curriculum materials have been tailored to each country's context, such as Oman's Teacher Guide that includes 11 practical lesson plans or Singapore's alignment of NST teaching with its national sustainability roadmap. These advancements were accelerated by the COVID-19 pandemic, which, despite posing immense challenges catalyzed a transition to blended learning. Virtual workshops, webinars, and digital classrooms were launched across multiple countries, ensuring that momentum in teacher engagement and curriculum development was not lost.

## 2. Youth Engagement and Innovation: From Classrooms to Olympiads

One of the most transformative strategies for advancing nuclear science and technology (NST) education in the Asia-Pacific region has been the focus on engaging youth. Early exposure to nuclear science not only fosters awareness and acceptance of the technology but also inspires the next generation of professionals. A particularly notable initiative in this area is the International Nuclear Science

Olympiad (INSO), launched in 2024, marking a significant milestone in integrating nuclear science into mainstream educational and encouraging young minds to explore its vast potential.

The inaugural INSO, held in Clark, Pampanga, Philippines, brought together 55 high school students from 14 countries: Bahrain, Iran, Jordan, Malaysia, Mongolia, Oman, Pakistan, the Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Thailand, and the United Arab Emirates. These students, pre-selected through national competitions, represented the brightest young talents in nuclear science from across the region. Prior to the Olympiad, participants attended local training camps in their respective countries, honing both theoretical and practical skills.



At the closing ceremony of the first International Nuclear Science Olympiad, in the Philippines where 8 high school students were awarded the gold medal for the top 8 highest overall score.

INSO was not just a competition but a platform for fostering academic collaboration and cultural exchange. Students connect with peers from diverse backgrounds, share ideas, and gain exposure to cutting-edge nuclear technology. The competition itself was rigorous, consisting of both theoretical and experimental components. Over the course of 8.5 hours, students were tested on their understanding of complex topics such as reactor physics, isotope applications, and radiation safety, at a level equivalent to post-secondary education standards. Challenges include calculating the absorbed radiation dose required to sterilize male mosquitoes, highlighting the critical balance needed to ensure sterility without compromising the insects' mating competitiveness, while another required students to analyze and compare the immense energy yield of nuclear fission and fusion reactions relative to that of conventional fossil fuels such as coal, highlighting the superior efficiency and potential of nuclear processes in addressing global energy demands.

The IAEA ensured regional/global equity by supporting participation from developing countries like Mongolia and Sri Lanka in the Olympiad. Beyond fostering youth interest nuclear science careers, contributed to reshaping public perceptions of nuclear technology, highlighting its role in addressing global challenges such as climate change, healthcare, and food security. Participants shared their enthusiasm and newfound understanding. Neil Kyle Olaer Maniquis, a

gold medalist, emphasized how INSO exposed him to nuclear science's benefits in agriculture and medicine and inspired him to educate others. The top scorer, Mohammad Nur Casib from the Philippines, was named "Nuclear Science Olympiad Ambassador" and mentored future participants while promoting nuclear science understanding among educators and the public.

The success of the inaugural Olympiad has already paved the way for broader participation in future editions. More than 178 IAEA Member States recognized the successful conduct of the first INSO at the plenary of the 68th IAEA General Conference in Vienna, Austria. In a resolution adopted on September 20, 2024, IAEA acknowledged INSO as among the notable examples of its efforts "to better disseminate to general public, especially the youth, the ideals of the peaceful uses of atomic energy in research and education, particularly its support for research projects and initiatives".

The second edition of INSO, held in Bangi, Malaysia from 31 July to 5 August 2025, introduced several enhancements that strengthened its educational and collaborative impact. A hands-on experimental component, primarily chemistry-based, assessed essential experimental skills, including data collection, measurement, and analysis; a practical alternative to full nuclear experiments constrained by safety, equipment, and regulatory limitations. Physical experiments were particularly valuable, and future editions should aim to provide students with opportunities to handle actual equipment such as radiation detectors, data acquisition electronics, and analysis software, leveraging innovative ideas shared among member countries.



**INSO 2025 Experiment 1: Gamma vs. Vitamin C, Students tested how gamma radiation affects Vitamin C, combining hands-on titrations with data analysis to map its stability.**

The INSO 2025 competition featured 14 participating countries, including new participants from Syria and Japan, alongside four observing countries from China, Turkiye, Lao, and Indonesia, who are seriously considering competing in future editions. The theoretical challenges covered cancer detection, radiation applications in space, nuclear fission, environmental radioactivity, and fuel utilization. Statistical analysis of the results confirmed that nearly all questions met the expected standards for such competitions. Maintaining this rigor while incorporating real-life applications of Nuclear Science and

Technology (NST) will be essential. Expanding the syllabus to include areas such as nuclear chemistry, radiation biology, and radioactive material dispersion, alongside clarification of vague concepts like ionizing versus non-ionizing radiation, will make future exams more engaging and challenging.

INSO 2025 also underscored the importance of national-level organization. Establishing a core national entity requires coordination among institutions aligned with national nuclear science policies and relevant ministries. Learning from countries with established INSO frameworks and adapting approaches to local contexts is recommended. The IAEA aim to continue play its role to support prospective participants by collecting and sharing best practices, providing guidance, and facilitating syllabus and regulation revisions, particularly for the examination. Targeting students who may later contribute as problem developers will help sustain interest and capacity in NST.

A special award introduced in INSO 2025 was the Outstanding Female Participant Award by Women in Nuclear (WiN) IAEA, which was presented to Yuzuka Sasaki from Japan. She commented, "Although nuclear science is not widely covered in school, this Olympiad made me realize its majesty and its potential for a peaceful and sustainable world. I hope this Olympiad inspires more girls to pursue this field." This award reflects the ongoing commitment to promote diversity and gender equity in nuclear science education.

Having completed two successful iterations, INSO has established a strong framework for international nuclear science education and competition. Future editions can build on this foundation by expanding participation, refining the syllabus, and incorporating hands-on experimental experiences that engage students with real-world equipment and applications. Strategic investment in teacher training, laboratory infrastructure, student enrichment, and partnerships among academic institutions, government agencies, and technical organizations will amplify INSO's educational value. National and local Nuclear Science Olympiads can nurture talent and strengthen national capacity, while INSO itself can evolve into a premier platform that inspires young scientists, fosters international collaboration, and highlights the peaceful and sustainable applications of nuclear science. As the competition grows, it will continue to provide invaluable opportunities for students to develop both their technical skills and ethical understanding of nuclear science, cultivating a generation of thinkers poised to shape the future of nuclear technology and its peaceful applications.

### 3. Regional Networks and Digital Transformation

Networks such as the Asian Network for Education in Nuclear Technology (ANENT), the International Nuclear Science and Technology Academy (INSTA), and INSO have become pillars of regional cooperation. ANENT's Learning Management System has grown significantly, attracting over 175,000 visits and enabling content sharing among educators and institutions. INSTA launched the Executive Programme for Educators (INSTA-EPE), a hybrid platform that provides training on nuclear fundamentals and modern pedagogy. Digital transformation plays a key role in sustaining and scaling these networks. Indonesia's development of Augmented Reality (AR) applications offers students 3D visualization of complex nuclear processes like fission and radiotracer movement. Several countries are developing AI-driven platforms for adaptive learning. Philippines' 'Curie's Class' initiative and the 'Metaverse Go Nuclear' project envision virtual nuclear labs where students can simulate experiments and interact with avatars of scientists. These efforts, reinforced by IAEA-ANENT webinars and resource-sharing, reflect a shift from traditional pedagogy to interactive, learner-centered education.

### 4. Policy Alignment and Industry Integration



Exhibition by industry on nuclear science techniques & application during INSTA and ANENT Meeting in Shenzhen, China in August 2024, fostering Academia – industry interaction

NST education is no longer confined to the classroom; it is increasingly embedded in national policies and industry partnerships. Malaysia's Universiti Kebangsaan Malaysia (UKM) is collaborating with national regulators to develop a new Master's degree programme focused on the 3S principles—nuclear safety, security, and safeguards. Such collaborations ensure that academic content aligns with regulatory standards and job market needs. Across 11 Member States, Memoranda of Understanding have been signed to promote industry-education partnerships. Indonesia's BRIN has partnered with 15 schools, offering

internships, science fairs, and public outreach campaigns. This not only enhances learning outcomes but also builds pipelines for future employment in nuclear sectors, including reactor operations, radiation protection, medical imaging, and food irradiation. Moreover, some Member States are integrating NST modules with broader policy frameworks—aligning educational initiatives with national goals such as climate neutrality, health innovation, and smart agriculture.

### 5. Addressing Challenges: Equity, Resources, and Sustainability

While the advancements in nuclear science and technology (NST) education across the Asia-Pacific region are commendable, several deep-rooted challenges remain that hinder the full realization of NST's potential. Resource limitations, disparities in educational infrastructure, brain drain, and digital inequalities present significant barriers, particularly in emerging nuclear states and low-income communities. These challenges must be addressed to ensure that the benefits of nuclear science can be effectively harnessed by all nations, regardless of their development status.

One of the most pressing issues is the scarcity of essential resources, particularly in equipment such as dosimeters, radiation detectors, and laboratory tools required for hands-on training in NST. Many countries, especially those with limited financial resources, struggle to provide students and educators with access to modern educational tools and facilities. The lack of proper equipment limits students' ability to experience practical, real-world applications of the theoretical knowledge they gain in the classroom, resulting in a skills gap. This lack of practical training is especially evident in countries with nascent nuclear programs or those that lack operating reactors and radiation facilities.

In response to this, the IAEA has undertaken several corrective measures. Notably, following a 2019 regional review, the IAEA distributed 288 radiation kits to underserved schools, helping bridge the gap in equipment availability. Furthermore, the IAEA has set up monitoring frameworks, which include regular surveys and defined key performance indicators (KPIs), to assess progress in NST education and provide guidance for targeted interventions. This data-driven approach enables the IAEA to allocate resources more effectively, ensuring that they reach the area most in need.

Another major challenge faced by many developing countries is the migration of nuclear experts to more developed countries in search of better opportunities. This "brain drain" leaves a gap in the local expertise required for effective mentoring, capacity-building, and the continued growth of the nuclear sector. Countries with well-established

nuclear programs tend to attract and retain talent, creating a disparity in the availability of skilled professionals between advanced and emerging nuclear nations. To combat this, the IAEA has emphasized long-term strategies to build local expertise and reduce reliance on external experts. These strategies include establishing alumni networks and providing incentives for educators to specialize in nuclear science and technology. Additionally, the IAEA is working to create more sustainable, locally driven nuclear education ecosystems that can function independently of international expertise over time.

The COVID-19 pandemic highlighted the digital divide that exists in many parts of the Asia-Pacific region. Rural and low-income schools often lack the necessary infrastructure to participate in online learning, limiting students' ability to access e-learning resources. While e-learning offers an opportunity to overcome geographical and logistical barriers, cultural preferences for face-to-face education, as well as concerns about gender equality in digital spaces, have hampered the widespread adoption of digital tools. The IAEA has responded by promoting hybrid learning solutions that combine the flexibility of e-learning with the advantages of traditional, in-person education. These hybrid models allow for hands-on training in local contexts, such as through interactive workshops or local demonstrations, while also utilizing digital resources to complement learning. For instance, virtual nuclear labs and online training courses can provide students in remote areas with access to resources they otherwise wouldn't be able to access.

## 6. Future Directions and Regional Implications

To address these challenges comprehensively, an ambitious project for the 2026–2027 Technical Cooperation (TC) cycle is being developed, aimed at enhancing NST education through both formal and informal channels. This proposed project builds on past efforts while broadening its scope to include a wider range of education platforms, especially for underserved populations, including those in Least Developed Countries (LDCs). Its overarching goal is to create a skilled workforce and raise public awareness of the benefits of NST, particularly in critical areas such as energy, healthcare, agriculture, and environmental sustainability. To achieve this, the project will target both formal education and informal education platforms. Informal platforms, such as science museums, nuclear research centers, and community outreach programs, will engage broader audiences, particularly children, families, and community groups. Interactive exhibits and educational programs will help to break down the barriers faced by LDCs and reach non-traditional audiences, inspiring interest in nuclear science from a young age.

For formal education, the project will focus on increasing the participation of women and girls in NST fields, offering enrichment programs for talented students, and encouraging youth participation through competitions and outreach initiatives. By collaborating with regional networks such as ANENT, INSTA, and INSO, the project aims to ensure that resources are accessible and that high-quality training opportunities are available to educators and students alike. It also aims to include solutions to the logistical challenges posed by the region's vast geographic spread and high transportation costs. By integrating hands-on training with innovative e-learning solutions, the project will mitigate the need for expensive in-person training sessions and provide access to world-class educational materials without the need for extensive travel.

As NST education becomes a strategic pillar for sustainable development, the Regional Cooperative Agreement (RCA) and RCA Regional Office (RCARO) are well-positioned to amplify these efforts. RCA's framework for multilateral cooperation, combined with RCARO's outreach capabilities, can enhance coordination between Member States, share successful educational models, and scale up innovation. Through its network of designated institutes, RCARO could serve as a hub for regional teacher training, youth competitions, and digital learning tools. As we move into the 2026–2029 cycle, stronger integration of RCA members into NST education initiatives—such as INSTA and INSO—can ensure broader participation, equitable access, and sustained momentum toward a nuclear-literate Asia-Pacific.

## 7. Conclusion

The Asia-Pacific region is undergoing a quiet transformation in how nuclear science and technology is understood, taught, and applied. Driven by a combination of national policy initiatives, IAEA support, regional collaboration through entities like RCARO, and digital innovation, the education landscape is becoming more inclusive, resilient, and future-ready. By framing NST as a tool for peace and development, and by investing in the next generation of nuclear professionals, the region is positioning itself as a global leader in the responsible and sustainable use of nuclear technology. Continued investment in educators, infrastructure, and youth engagement will be key to unlocking the full potential of nuclear technology as a tool for peace and progress. ✓

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