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NUCLEAR 101

Careers in Nuclear Science and Technology



Nuclear 101

Careers in Nuclear Science and Technology

A Resource Material for Secondary Students and Science Teachers

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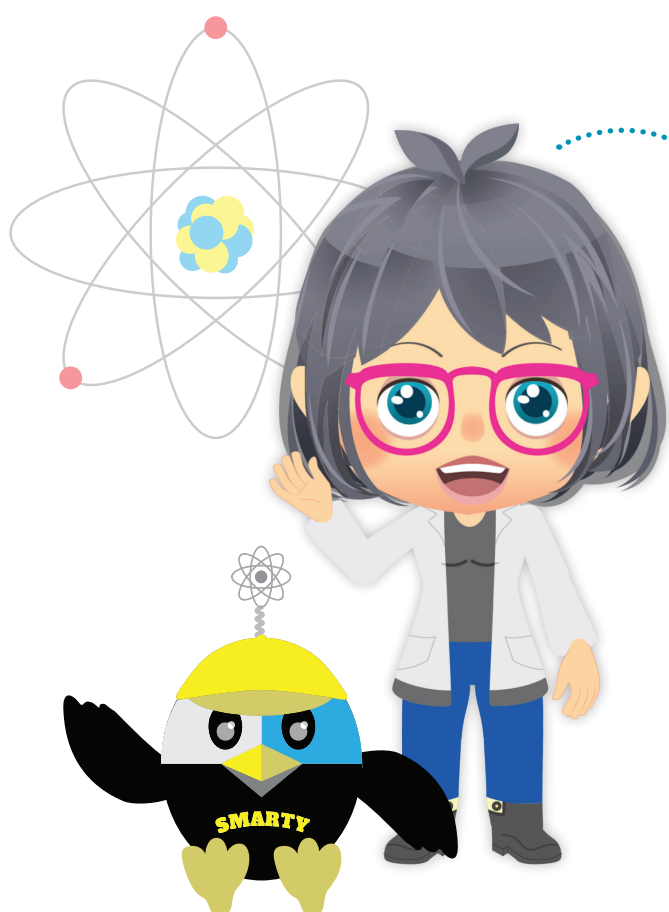
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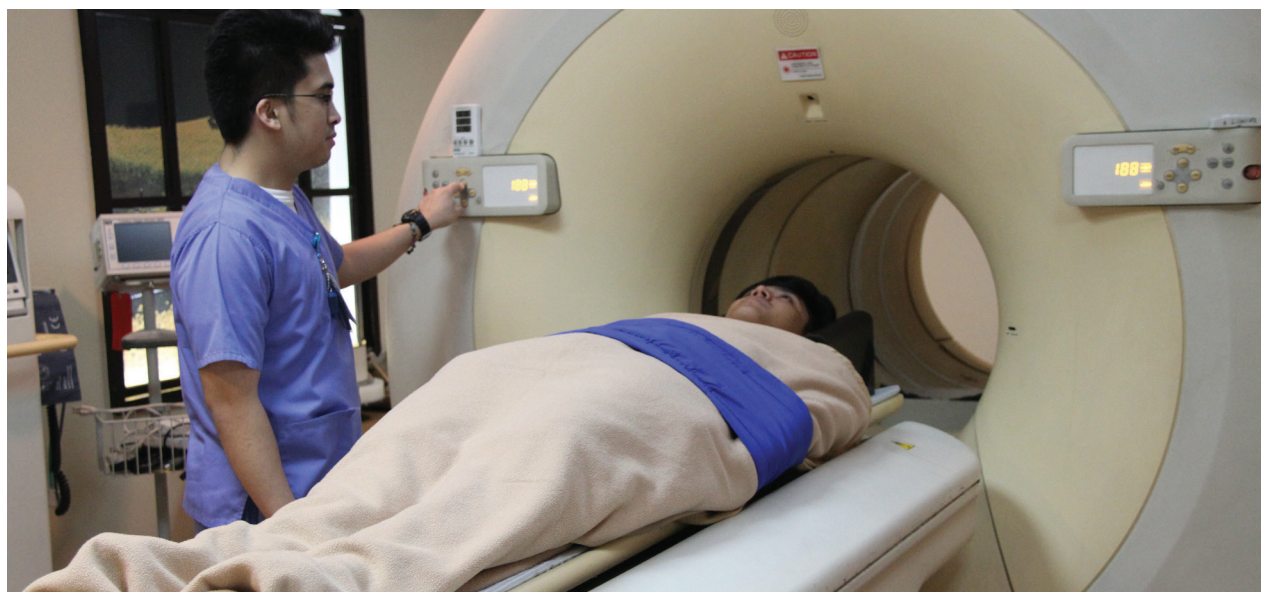
December 2020

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Hi there! I'm Radia! In this booklet, you will learn about potential options for employment in the nuclear and radiation-related fields. The unique advantages of nuclear technology, as well as its diverse applications in medicine, power generation, industry, agriculture, environment, research and teaching makes a career in nuclear science a worthwhile choice.



A patient undergoes a PET-CT scan at a nuclear medicine center

CAREERS IN THE MEDICAL FIELD

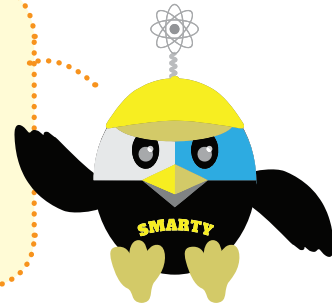


Most people can remember their first encounter with radiation when they had their first chest x-ray. But that was merely the tip of the iceberg. From the operation of imaging equipment to the treatment of various diseases, these applications will mean that hospitals and medical centers will also need medical professionals for these nuclear and radiation applications.

As of 2016, there are around 60 nuclear medicine centers in the Philippines . Doctors can use radiopharmaceuticals along with advanced imaging procedures such as scintigraphy with gamma cameras and Positron Emission Tomography – Computed Tomography (PET-CT) scans to diagnose diseases. In radiation oncology, doctors use radiation sources to treat cancer by killing the malignant cells.

Other medical professionals such as medical technologists and radiation technologists can also assist in performing the medical procedures and tests, while technicians can operate the imaging equipment. Health physicists keep workers safe by ensuring that the people exposed to radiation due to their jobs will not exceed the dose limits set by regulations.

Do you know how many medical cyclotrons are there in the Philippines? The first medical cyclotron in the country was set up in 2001 at St. Luke's Medical Center. As of 2019, the Philippines has a total of 4 medical cyclotrons, most of which are located in the National Capital Region. You might work in one of these too in the future!



CAREER IN FOCUS



Known as the Father of Nuclear Medicine in the Philippines, National Scientist Dr. Paulo Campos established the first Radioisotope Laboratory in the country in 1956, as well as the Thyroid Clinic of the UP-PGH Medical Center in 1960.

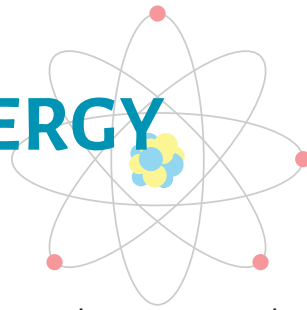
What's a nuclear medicine physician?

A nuclear medicine physician is a highly qualified health professional, with a medical degree in internal medicine, radiology, pathology, family medicine or pediatrics, followed by a highly specialized training in nuclear medicine. Though they work primarily in hospitals and clinics, these physicians can also work in research and development institutes or organizations, universities, and/or government agencies. They diagnose and treat diseases using radioactive materials and techniques. They also collaborate with other health professionals such as nuclear medicine technologists in the preparation, administration and disposition of radionuclides.



Interested in a career in nuclear medicine? In 2016, it was reported that there were only 95 physicians fully-trained and certified to practice Nuclear Medicine in the Philippines. Aside from a Medical degree, a Bachelor's degree in Radiologic Technology or a Bachelor's degree in Nuclear Medicine Technology offered by a number of universities in the Philippines can jumpstart your career in this field.

CAREERS IN THE ENERGY SECTOR



Engineers are crucial in the establishment of a nuclear power plant anywhere in the world. While a handful of nuclear engineers, physicists and scientists would be in charge of the reactor that will harness the heat of the atom – as well as the shielding and other safety features of the plant – there are many other aspects to deal with when engaging in a nuclear power program.

For example, civil engineers and materials scientists are responsible for the materials and structural design of the building itself, while mechanical engineers are responsible for the turbines and generators which are key in converting the heat via steam into electricity. Electrical and computer engineers are necessary for the efficient operation of the plant and the transmission of the electricity to our cities and provinces.



High school science students and teachers visit the Bataan Nuclear Power Plant in the Philippines

Geologists are also important for the nuclear power plant industry, particularly in the location of natural resources as well as for the safety assessment of the power plant relative to potential earthquake hazards. Mathematicians and statisticians are also involved in the calculation of energy costs and demand.

Interested in becoming a nuclear engineer? In the 1970's, graduate degree programs for atomic energy and nuclear engineering were being offered by the College of Engineering of the University of the Philippines. The last batch of graduates were in 1984 as the program ceased along with the shifting priorities of the government away from nuclear power and the mothballing of the Bataan Nuclear Power Plant in 1986. While it is a challenge to get a Bachelor's degree, MSc or PhD in Nuclear Engineering or Nuclear Physics in the Philippines, the Department of Science and Technology-Science Education Institute (DOST-SEI) through its Foreign Graduate Scholarship, offers full scholarship to MS and PhD students in these fields.

More recently, President Rodrigo Duterte signed Executive Order 116 which aims to study and consider nuclear power for the country. If the Philippines decides to restart its nuclear power program, more opportunities will open for young Filipinos interested in joining the nuclear industry.



CAREER IN FOCUS

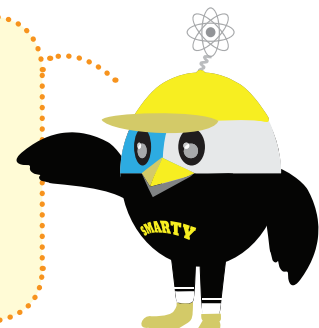
What's a nuclear engineer?

Nuclear engineers research and develop the processes, instruments, and systems used to derive benefits from nuclear energy and radiation. Many of these engineers find industrial and medical uses for radioactive materials—for example, in equipment used in medical diagnosis and treatment and in the design of nuclear reactors in power plants or research institutes. Many others specialize in the development of nuclear power sources for ships or spacecraft. While most nuclear engineers work in the energy sector, a lot of them are also found in research and development institutes or organizations, universities, and/or government agencies.

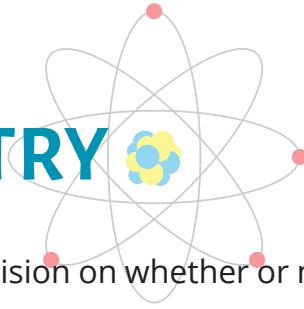


A nuclear engineer inspecting a nuclear fuel assembly.
Source: <https://www.sciencephoto.com/media/342548/view/nuclear-fuel-assembly-russia>

DID YOU KNOW? The Bataan Nuclear Power Plant has sister power plants still in operation today: the KORI-2 in South Korea, the Krško Nuclear Power Plant in Slovenia and the Angra Nuclear Power Plant in Brazil.

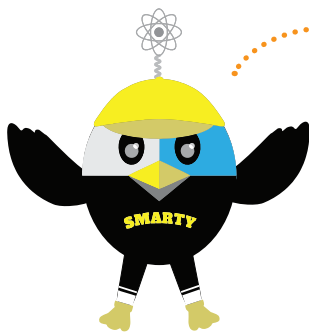


CAREERS IN INDUSTRY



While the Philippines has yet to arrive at a decision on whether or not to establish a nuclear power plant, there are other opportunities in the industrial sector which also use nuclear technology.

Many factories, refineries and production plants use nuclear technology to improve their production and keep their operations efficient. Engineers and technicians use radioactive tracers to measure the flowrate and residence time of liquids in pipes, while gamma column scanning can monitor process vessels in refineries without stopping the operation. Operators of gauges are also needed in various industries to determine the thickness, density, location and composition of materials and products.



DID YOU KNOW? Filipino non-destructive testing (NDT) engineers and technicians/inspectors are in-demand not only in the Philippines but also abroad! Because NDT is present in so many industries, it has become one of the fastest-growing jobs and is expected to become a 21.2 billion industry by 2024!

CAREER IN FOCUS

What's an NDT Technician?

A non-destructive testing technician, aka NDT technician or NDT inspector, utilizes a wide range of non-destructive technologies and techniques to inspect products and manufactured materials for structural flaws without ever taking the materials apart. These techniques include among others radiographic testing, ultrasonic testing, magnetic particle testing, eddy current testing, and permeability testing. Technicians perform these tests on many products to make sure that they are working correctly and meet all safety standards. They work in industries such as oil & gas, energy, aerospace, automotive and defense.

Technicians who are trained in radiographic testing among other non-destructive testing methods use these techniques for testing welds in pipelines, joints and castings. These techniques are also used by many aircraft maintenance engineers and technicians here and abroad.

Operators of processing facilities engage in a more straightforward industrial application of radiation in decontaminating food, spices and raw materials as well as sterilization of medical products. With the private sector already starting to invest in these facilities, one can look forward to job opportunities during the establishment and operation of such radiation facilities.



Gamma column scanning at a petrochemical plant

Interested in becoming an NDT technician/inspector? While having just a high school diploma qualifies one to undergo training and certification for NDT, most companies prefer to hire candidates with an associate's degree or higher. The Technological University of the Philippines is the only university in the Philippines that currently offers a degree in Bachelor of Engineering Technology major in Non-Destructive Testing Technology, so far.



CAREERS IN AGRICULTURE



“Magtanim ay hindi biro” says the age-old adage. But agricultural research and development will go a long way in ensuring a better harvest for Filipino farmers, especially when equipped with radiation and isotope-based technologies.

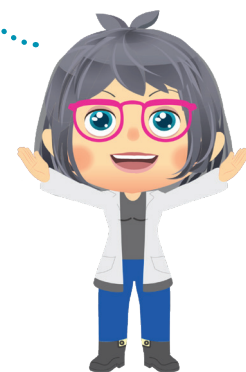
Agriculturists and biologists develop new varieties of staple food crops as well as ornamentals. One way of doing this is through mutation breeding, where radiation is used to induce mutations to plants in order to obtain improvements and new characteristics.



A researcher with samples of putative mutant plants in a tissue culture laboratory

Chemists can also cooperate with agriculturists for isotope-based analyses of soil fertility, nutrient and water use efficiency of different plants in different environments. Meanwhile, entomologists can develop measures against insects and pests that threaten crops without causing damage to the environment. These include radiation quarantine treatments for fruits and sterilization of insects to reduce pest populations.

Interested in becoming a Science Research Specialist? You will need a Bachelor's degree in any of the basic or applied sciences to start. A number of universities in the Philippines are offering a plethora of specializations in the sciences such as agriculture, biotechnology, data science, environmental studies, food technology, forensics, marine biology, materials science, radiation chemistry, and a lot more! Check with your school's career counselors for more information!





CAREERS IN ENVIRONMENTAL STUDIES

With raised awareness in the fight against pollution and the effects of climate change, chemists using isotope-based techniques play an increasing role in the field of environmental studies. These include research on air and water pollution, groundwater resource management, and remediation of typhoon-affected areas, to name a few.

Isotope-based techniques shine best in these situations since the presence and proportion of isotopes in different materials allow researchers to better pinpoint where it came from, how old it is, and what it is composed of, among other information, compared to conventional techniques. Engineers could also be involved in the design, establishment and operation of radiation facilities that can be used for treatment of sewage water, desalination and disinfection of various wastes.

CAREER IN FOCUS



Water samples being analyzed with an isotope ratio-mass spectrometer to determine its characteristics

What's a Science Research Specialist?

Research Specialists are responsible for designing, undertaking and analyzing information from controlled laboratory-based investigations, experiments and trials. They can work for government laboratories, environmental and other specialist research organizations, universities, and research and development units in various industries. These industries include but are not limited to food, materials, consumer products, pharmaceuticals and chemical products. Depending on the sector they are in, research specialists may need to further their studies to an MSc or a PhD.

CAREERS IN OTHER RESEARCH FIELDS AND THE ACADEME



While the applications are the most visible aspect of science, working behind the scenes through research and development is always an option for a long-term career, following in the footsteps of great minds like Einstein, Bohr and Curie, among others.

All science professionals – be it physicists, chemists, biologists – are engaged in basic and applied research. By themselves, the results of these research projects are valuable contributions to the body of knowledge in a particular field of study, especially when published in internationally-recognized journals and other publications.

Since the results of the researcher’s studies are also intellectual property, he or she may earn royalties from people and companies who use these results via the registration of patents and utility models.



Aside from studying nuclear reactions and neutron sources, physicists also study the properties of various materials

CAREER IN FOCUS



What's a Medical Physicist?

A medical physicist (also called health physicist) is a highly qualified health professional, with an advanced university degree, such as an MSc or a PhD, followed by a specialized clinical training in one or more medical physics disciplines. These disciplines include among others radiation oncology, diagnostic and interventional radiology, nuclear medicine and radiation protection. They can work in hospitals, research and development institutes or organizations, universities, government agencies, diagnostic or medical instrumentation manufacturers, and/or other facilities using radiation sources such as medical cyclotrons and nuclear power plants. In addition to their core tasks, medical physicists ensure that regulatory requirements relating to radiation protection are fulfilled, thus avoiding potential radiation accidents.

In addition, many companies can hire scientists and researchers as part of their R&D team, which will develop new proprietary technologies that will help keep their company's edge over other competitors. In either case, applying nuclear and radiation principles to your research will give your projects a unique advantage over many others which rely on conventional methods.

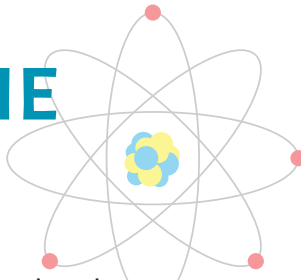
If a science professional is prolific enough with his or her journal articles and scientific publications, he or she may also have greater chances to be part of the tenured faculty of a university or college. Academic support and funding for research projects will allow for a career that is exclusively focused on research and development.



Interested in becoming a medical physicist? The University of Santo Tomas is the only university in the Philippines that is currently offering a Master's Degree in Applied Physics major in Medical Physics, so far. One such alumni from the said program is Ms. Karen Ibasco, who reigned as Miss Philippines – Earth in 2017.



CAREERS IN THE GOVERNMENT



The Department of Science and Technology (DOST) as well as other government agencies reliant on research and development are also in need of professional talent in the sciences. While working for the government usually requires passing the Civil Service Examination, scientists and researchers with at least three years of continuous experience in research or teaching in their respective fields, or those with master's or doctorate degrees in the sciences, are exempted from taking the exam by virtue of Presidential Decree 997.

Aside from the security of tenure and other benefits given to all civil servants, scientists and researchers working for the government also receive benefits and privileges through Republic Act 8439, or the Magna Carta for Science Workers Act.



Agriculturists from the Philippine Nuclear Research Institute were conferred the rank of Scientist by the Civil Service Commission

The best scientists in the civil service can push their career even higher by joining the Scientific Career System. Once awarded, the applicant is conferred the official rank of a Career Scientist, giving them higher pay grades and allowing them to progress in their careers unhindered by the regular promotion process.

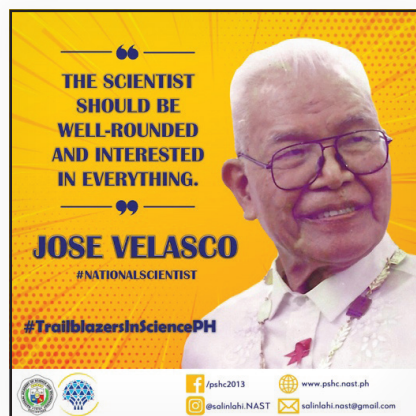
There are currently five Career Scientists who are experts in nuclear and radiation-related projects and technologies.

Interested in becoming a Career Scientist? Enroll in a STEAM (Science, Technology, Engineering, Agriculture and Mathematics) related course now!

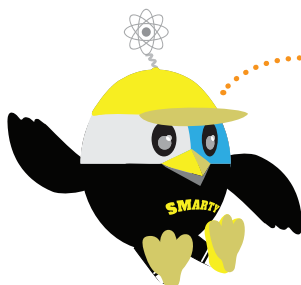


CAREER IN FOCUS

What's a Career Scientist?



A Career Scientist is a rank conferred to qualified scientific personnel in the government service with at least a master's degree and/or doctorate degree. It can also be conferred to qualified non-faculty full-time researchers from the State Universities and Colleges (SUCS) in the Philippines. The Scientific Career System is a system designed for recruitment, career progression, recognition and reward of scientists in the public service as a means of developing a pool of highly qualified and productive scientific personnel in the country. It is one of the many modalities of government support to the Filipino scientific community.



DID YOU KNOW? Presidential Decree No. 997 grants special civil service eligibility to science and technology specialists with at least a Bachelor's Degree in various science courses, exempting them from taking the Civil Service Examinations

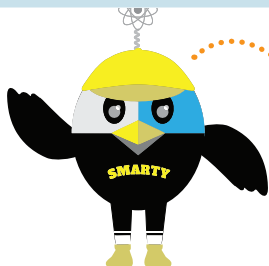
SKILLS FOR YOUR CAREER JOURNEY



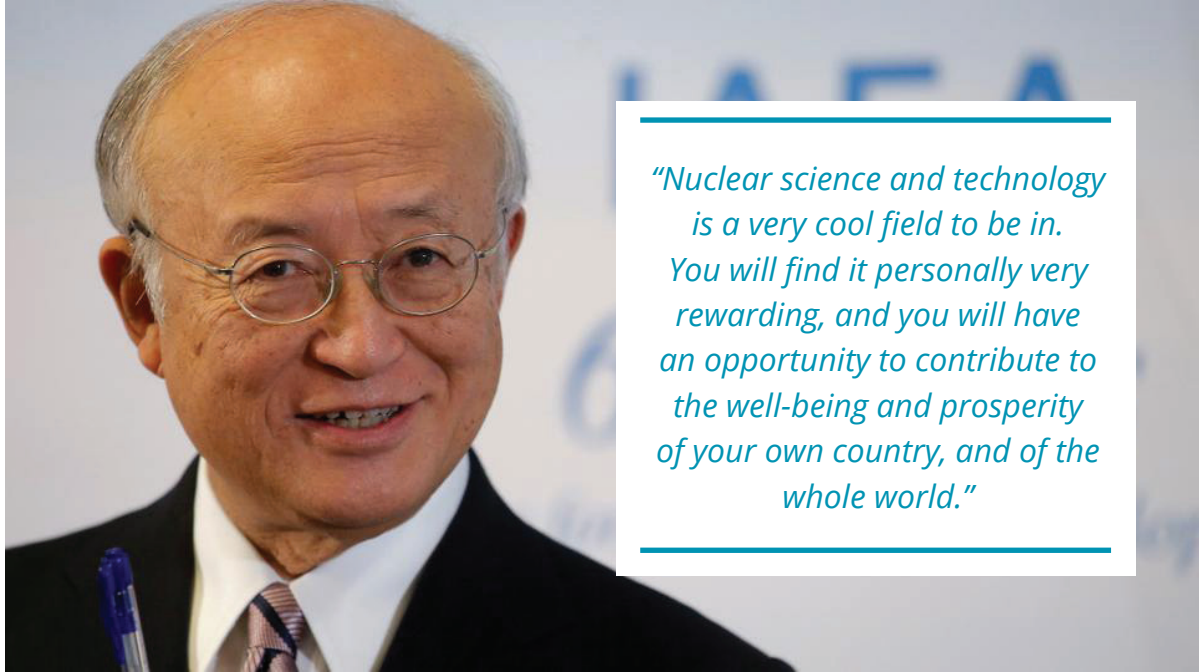
Studies in psychology revealed that there are three basic factors that lead to happy employees – autonomy, competence and purpose. The ideal career is one where you are so good at what you do that you have control over what you do and how you do it. Keep this in mind as you think about your career plans.

Not only that, also consider the skills employers value most. Employers want people who think critically and creatively and has the ability to work with others effectively to solve problems; who learn from mistakes and welcome criticisms because they know that this will produce the best solution to a problem. They also want people who are honest and can communicate effectively, both in person and on paper. Do you think you have one of these skills? Do the skills self-inventory below:

ESSENTIAL SKILL	I STILL HAVE TO DEVELOP THIS SKILLSET	I NEED TO IMPROVE THIS SKILL	I AM SATISFIED WITH MY PRESENT ABILITY LEVEL FOR THIS SKILL
Problem Solving			
Communication			
Team Player			
Honesty			
Critical Thinking			
Learning from Mistakes			
Creativity			
Using Technology			
Data Analysis			
Working Safely			



The above skills can be developed in classes, school activities, civic activities or other experiences. Where do you think you may best develop each of these skill sets?

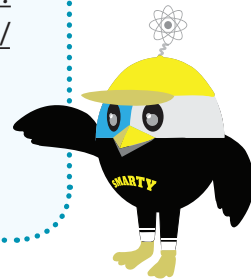


“Nuclear science and technology is a very cool field to be in. You will find it personally very rewarding, and you will have an opportunity to contribute to the well-being and prosperity of your own country, and of the whole world.”

- IAEA Director General **Yukiya Amano** during the 1st Philippine Nuclear Youth Summit in 2015



Read his full speech during the Philippine Nuclear Youth Summit in 2015: <https://www.iaea.org/newscenter/statements/iaea-director-general-yukiya-amanos-remarks-philippine-nuclear-youth-summit>



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Notes:

Job descriptions and salary approximations were sourced from PayScale (<https://www.payscale.com/>) and Salary Explorer (<http://www.salaryexplorer.com/>)

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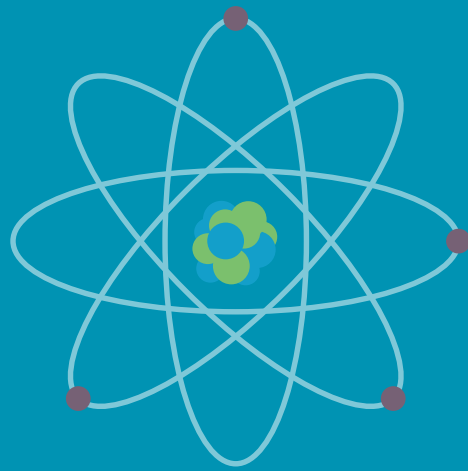


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