# Development of Modules and Tools for Public Radiation Literacy by JVET

Japanese Volunteer's Expert Team contributing to international HRD in the field of NST

https://jvet.jp/


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## Activities for Improvement of Radiation Safety Culture of Public

Development of **human resources** is important to improve international and domestic **radiation safety culture**. One of the effective measures is to improve public **radiation literacy** in addition to develop **excellent radiation experts**. In order to discuss safety framework and its countermeasures from the both viewpoints of science/technology and social science, **education of the young generation** and **development of motivated teachers** become the keys as a long-term strategy.

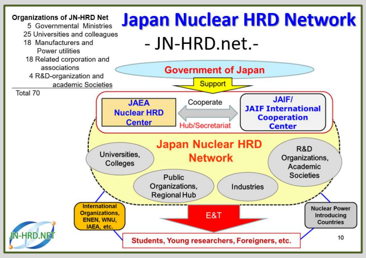
## JVET's Activities Supporting Asian Countries Challenge

**Providing assistance from JVET to Asian Countries in the implementation of the Compendium resources and developed under the Technical Cooperation Programme of IAEA (RAS0065- RAS0079);**

- Participating and assisting the implementation of Radiation workshop for teachers and Radiation Education Programme for Upper Secondary, both based on Japanese module.
- Providing lectures to assist a working group developing/designing instructional teaching and learning methods
- Providing hands-on experiment and DVD/video session to give better understanding about radiation topics
- Reviewing and assisting each country's nuclear education outreach development
- Discussion and exchanging information with teachers, students and nuclear communicators on radiation related nuclear issues.

## Evaluation of the Kick-off Activity at the Time after the each WS

- The activity became one of the triggers to start to really cooperate among relating ministries, agencies and organizations in the human resource development activity focusing on the secondary school education on nuclear science and technology in Asian countries.
- Asian countries have started their first education trials in secondary schools based on the **Japanese module (2-hour Radiation Education Module) in Compendium** developed by IAEA, which are done by participant teachers from 2014. The cooperating activity and movement will continue and accelerate more with strongly supported by IAEA and relating international experts.
- For the early piloting stage, each participant country can import education modules, tools including textbook, movies, PPTs, experimental goods such as **cloud chamber** kits and simple survey-meters (for example, **Mr. Gamma or KIND**) from nuclear advanced countries. However, we believe that the most important point in order to sustain the qualified and effective education is to modify or newly develop their own systematic programs, modules and tools based on the background situation like policy, history and culture. We found out that a lot of experts in each country had already been active with their excellent knowledge, skills and experiences to proceed the mission by themselves.
- National framework or system to support teachers is needed to perform attractive radiation education with **WOW factor**. Radiation experiment in classroom costs. Teachers and schools need funds. Information web platform like RADI operated by Japan Science Foundation in Japan is also effective. **Instruction movies, e-learning systems, teaching materials, model education programs**, etc, could be cost-freely shared among teachers and experts through this website.





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## Education Tools Developed by JVET

科研費 KAKENHI

**Survey Meter /Cloud Chamber/ GM tube**


## Two-hour radiation education programme
### for secondary school students
### *an example*

**Part I Lecture (60 min)**

- **5 min - Program explanation**
- **45 min - Basic radiation lecture**
  - + Radiation and dose surrounding us
  - + Radiation application
  - + Radiation and Radioactivity
  - + Radiation type
  - + Half life
  - + Unit of Bq and Sv
  - + Human effect
  - + Radiation protection
- **10 min - Break time**

**Part II Two Experiments (60 min)**

- **20 min - Cloud chamber observation**
  - + Pouring ethanol; 5 min
  - + Cooling time by dry ice; 5 min
  - + Observation; 10 min
- **30 min - Environmental survey by a radiation detector**
  - + Instruction to use survey-meter; 5min
  - + Surveying activity; 25 min
- **10 min - Conclusion**

## Instruction Movies Assisting Educators/Teachers

### Movies

**Web platform on Radiation Education Information; "RADI"**

**Let's try radiation experiments by yourself !** http://www.radi-edu.jp/

- **5 min** short movie ×6 stories
- Movie instruction manual on experiments
- Preparation for experiment, or showing these movies to students in the class in place of doing experiments
- **English subtitles are ready**. ★ *Let's see example movies.*

**Basic lecture on radiation**

- **20 min** movie
- Q&A attractive talk-show between students and an expert
- Focusing on the radiation keywords in junior high school textbook
- Showing the movie to students in place of teachers' explanation


**Effective Use of Radiation in Various Fields**

- **30 min** movie, recommended officially by MEXT in 2010
- Secondary school students reports the real situation of radiation usage in industry, medical, agriculture, archaeology, and other fields.
- Radiation-related experiments by experts
- Q&A attractive talk-show between students and an expert
- Showing the movie to students in place of teachers' explanation

# Radiation Education Tools Developed by JVET

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## Japan

### Graphical flip-charts of nuclear and energy-related topics

**A) Purpose and development concept**

- To make students feel the "WOW" factor by seeing radiation tracks in their class.
- For students to enjoy assembling a cloud chamber by themselves, and to see radiation tracks when using it.
- To develop understanding of how the natural materials surrounding us emit radiation anytime.
- To learn how the Nobel Prize relates to NST through the story of the cloud chamber's history.

**B) Overview, design and specifications**

- Container (petri dish, Pyrex, etc.), ethanol, wrapping film, dry ice, sponge tape, black paper, etc.; a radiation source of Petri dish (small) size
- Radioactive ores (e.g., monazite), thorium-containing gas mantles, pencil balloons (electrostatic), granite, dust samplers, uranium glass, thorium-tungsten (welding rods), Crookes tubes, etc.

**C) Standard use**

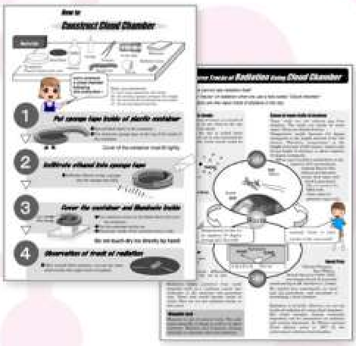
This is an experimental lesson lasting 20–60 minutes that combines the work of assembling a cloud chamber and the observation of radiation tracks. Occasionally, teachers may use instructional videos (www.radi-edu.jp/en/material/) instead of actual laboratory work to give students a taste of the experimental atmosphere. Various radiation tracks can be observed, including alpha and beta radiation, muons and Compton scattering by using this simple tool.

**D) Points to be noted**

- Teachers need to systematically prepare the materials for the cloud chambers and dry ice before the experiment.
- Students need to be given an extra warning about cold burns and the lack of acidity caused by dry ice.
- It looks even better if the evaporated ethanol is sealed so that it does not leave the container, and the lid is fogged and electrostatically charged.
- The time it takes to cool the cloud chamber and the thickness of the supersaturated layer depend on the size of the container. There are differences in the type and amount of radiation that can be observed.

**E) References and remarks**

The material is presented in RADI via: www.radi-edu.jp/en/material/
The information platform supporting radiation education for teachers is operated by Japan Science Foundation/Science Museum www2.jsf.or.jp/




### Peltier cooling cloud chamber with wide window

**A) Purpose and development concept**

- To make students feel the "WOW" factor by seeing radiation tracks in their class.
- To understand that natural materials surrounding us emit radiation anytime.
- To learn how the Nobel Prize is relates to NST through the story of the cloud chamber's history.

The tool does not need dry ice for the experiment to work in class. A development goal for the Peltier cooling cloud chamber was to realize a wide window for observation.

**B) Overview, design and specifications**

- Cooling method: Peltier element cooling
- Observation surface: circular (diameter 75 mm)
- Illumination: 12 high brightness white LEDs
- Size: about W220×D170×H220 mm
- Body weight: about 2kg
- Supply voltage: AC100–120V or AC200–240V
- Power consumption: about 70W, using liquid: Ethanol
- Radiation source: 220Rn supply mantle and ceramic monazite ball

**C) Standard use**

This is a 10–15-minute experimental lesson that seeks to observe radiation tracks. The tracks will start to appear in about three (3) minutes after turning on the power. Five (5) to six (6) students can observe simultaneously. Occasionally, teachers may use instructional videos (www.radi-edu.jp/en/material/) instead of actual laboratory work to give students a taste of the experimental atmosphere.

**D) Points to be noted**

Learning about the cooling mechanism by using Peltier devices also leads to a deeper understanding of science and technology. This device is an example within the Science, Technology, Engineering, Arts and Mathematics (STEAM) educational framework.

**E) References and remarks**

The material can be accessed via https://kiribako-rado.co.jp/e-goods/, and https://academic.oup.com/rpd/article/184/3-4/539/5480505. The tool was developed by RADO LTD, supported by STIF (NPO Science and Technology Information Forum (https://npostif.org/) and The University of Tokyo.

### GM tube for classroom assembly practice

**A) Purpose and development concept**

A GM counter is a simple radiation detector which helps in developing understanding of radiation properties such as half-life, penetration power and the inverse square law. Experiments on shielding and the inverse square law can also show students how the radiological protection concept of "as low as reasonably achievable" (ALARA) can be achieved through shielding and distance from source. A handmade air GM counter for radiation education in secondary schools helps students to understand the structure of the GM tube and allows them to experiment with half-lives, as the composition of the gas in the GM tube can be changed at will. This device has the capability to illustrate radiation counts qualitatively through sound and quantitatively through counting. It can be an effective tool at various levels of education: exploiting the sense of hearing at the primary level and counting aspects at the secondary level.

**B) Overview, design and specifications**

- A 0.3 mm-thick cathode made of 300 kΩ black drawing paper encased in a 55 mm long clear case cylinder of diameter 50 mm with a removable cover that serves as the end window.
- Anode made of stainless steel (SUS) wire of diameter 0.23 mm, folded and twisted.
- Air as active gas with 10–30% butane (or alcohol) as quench gas.
- Optimal operating voltage of 5000–5500 V, customized for the tube with a plug-in safety feature for connecting to the GM tube.

**C) Standard use**

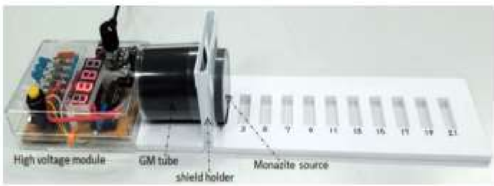
This is an experimental class lasting about 30–60 minutes combines the work of assembling a GM tube with doing experiments on inverse square law, shielding effect and radioactive decay.

**D) Points to be noted**

- Thoron gas from a lantern mantle is often used for the practical observation of radioactive alpha decay. Detecting mostly beta particles in the distance experiments and low energy gamma rays in the shielding experiments are also unique.
- GM detects all alpha, beta and gamma (low energy) rays, so particular care must be taken in the choice of shielding materials.
- While handmade GM tubes can be made at an overwhelmingly low cost when compared to commercial GM tubes, the high-voltage power supply unit requires about ten (10) times higher-voltage.

**E) References and remarks**

The material can be accessed via https://academic.oup.com/rpd/article/184/3-4/535/5480487 and https://www.jstage.jst.go.jp/article/jhps/54/4/54_206/_pdf/-char/ja
The tool was developed by Japan Science Foundation/ Science Museum (www2.jsf.or.jp/), supported by the University of Tokyo.


### KIND series

(portable environmental gamma dosimeter)

**A) Purpose and development concept**

To make students understand the existence and variation of environmental radiation and feel the "WOW" factor in monitoring radiation. The combination of source and shielding allows attenuation and shielding experiments to be carried out and the three principles of reducing external exposure to radiation to be studied. The calibration kit provided allows for simplified calibration.

**B) Overview, design and specifications**

<KIND-pro>

- CsI (Tl) scintillator size (mm): 12 x 12 x 5,
- Sensitivity: over 1,000 CPM/uSv/h
- Measuring time interval 10/30/60 sec, moving average: 60 sec (10 sec update)
- Weight (g): 100, Size (mm): 95 x 60 x 17

<KIND-mini>

- Plastic scintillator size (mm): 12 x 12 x 5
- Sensitivity: over 300 CPM/uSv/h
- Measuring time interval 10/30/60 sec, moving average: 60 sec (10 sec update),
- Weight (g): 100, Size (mm): 95 x 60 x 17

**C) Standard use**

After the presence and distribution of radiation in the natural environment has been explained to the class, students can use this instrument to measure the radiation around them. The students can then be given the opportunity to measure the surface doses of different materials, to recognize the diversity of radiation fields in different objects and places, and to investigate the causes. Twenty (20) minutes to one hour of practical work is suitable for this.

**D) Points to be noted**

The KIND series are designed to be small and lightweight so that even young children can easily measure environmental radiation dose rates by simply pressing a switch on the front panel. KIND-pro has high sensitivity and is designed for deployment in information and communication technology (ITC) education, allowing measurement data to be recorded internally and output to a PC or other device. The KIND-mini is less sensitive to gamma rays, but more sensitive to X-rays, making it useful for detecting X-rays emitted from Crookes tubes.

**E) References and remarks**

The material can be accessed via www2.jsf.or.jp/en/pdf/KIND_pro_manual.pdf, and www2.jsf.or.jp/en/pdf/KIND_mini_manual.pdf

The tool was developed by Japan Science Foundation/Science Museum (www2.jsf.or.jp/), supported by the University of Tokyo and others.