

# Development and Implementation of Education Programs for Strengthening of Nuclear Understanding

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## 1. Introduction

Even after the Fukushima nuclear accident, the imperative to enhance the role of nuclear energy as a pragmatic alternative for addressing fossil energy depletion and global environmental issues remains. In the current reality of our country, heavily reliant on energy imports, the significance of nuclear power is steadily growing as a strategic endeavor aimed at ensuring a sustainable national energy supply and developing future energy sources. To maintain or increase nuclear power generation, it is essential to enhance public support and understanding of nuclear energy among the citizens. The majority of the public's negative perception of nuclear energy arises from inaccurate information about nuclear energy and radiation.

Public perceptions of the risks associated with nuclear energy and radiation are often influenced by psychological evaluations rather than scientific assessments. Stoutenborough et al. presented research findings suggesting that greater knowledge related to nuclear power is associated with increased acceptance of nuclear energy [1]. There is also research indicating observed changes in positive perceptions and attitudes towards radiation following education, where participants were provided with knowledge and information on nuclear power and radiation [2].

Therefore, it is essential to raise awareness among the public about the importance and necessity of nuclear energy by providing accurate information on the subject. Moreover, from the perspective of a feasible and rational national energy mix, it is imperative to expand nuclear understanding education to effectively communicate the importance of nuclear energy, which accounts for approximately 30% of the country's domestic electricity.

The Nuclear Training & Education Center (NTC) of the Korea Atomic Energy Research Institute (KAERI) for the enhancement of the public acceptance of nuclear energy has developed and operated various educational courses to promote understanding of nuclear energy.

This paper provides a comprehensive overview of the outcomes derived from the development and operation

of NTC programs, utilizing the excellent infrastructure for education and training available at KAERI.

## 2. Methods

The NTC has consistently implemented five courses, including job training of secondary school teachers for nuclear energy, seminar on nuclear understanding for teacher, visiting nuclear education for students and general people, atom school for elementary, middle and high school students, and training course on nuclear energy understanding for employees of nuclear-related organizations.

The nuclear understanding program framework consists of 1) analysis of stakeholder involvement, 2) program design, development and implementation, and 3) evaluation and feedback and 4) improvement by introducing the Systematic Education and Training Approach (SAT), an international standard learning model, and ISO 29990, an international standard quality control system.

In addition, satisfaction and nuclear energy awareness of the nuclear understanding education evaluated by developing a questionnaire suitable for each education. Questionnaire survey on satisfaction, nuclear awareness and nuclear knowledge carried.

A 5-point Likert scale from 'not at all' to 'very much' used as the response category. Questionnaire survey on satisfaction, nuclear awareness and nuclear knowledge carried.

## 3. Development and Implementation of Nuclear Understanding Programs

### 3.1. Job-training program for secondary school teachers

Currently, information about nuclear power is only partially covered in the regular curriculum of middle and high schools, specifically in subjects such as science, technology & home economics, social studies, environment subject, integrated science, physics and Korean geography. Consequently, in a situation where opportunities for students to acquire accurate

knowledge and information about nuclear energy are limited, the role of teachers as effective conveyors of correct knowledge on nuclear energy becomes exceedingly crucial.

Therefore, there is a need for professional development courses designed for middle and high school teachers responsible for educating the next generation, fostering accurate and well-balanced nuclear literacy to enhance understanding. To address this, NTC has been conducting an annual program since 2014 specifically designed for middle and high school teachers. The program focuses on enhancing teachers' understanding of nuclear energy through hands-on experiments and practical training.

Table I presents the current status of this program. Through the implementation of this program, teachers' nuclear awareness and knowledge of nuclear energy was increased as shown in Table I. This suggests that this program has a high education effect in terms of cultivating nuclear knowledge and awareness.

It is believed that teachers' participation in this course will contribute to the normalization of school nuclear education, the establishment of a balanced energy perspective for teenagers, and the enhancement of students' nuclear acceptance by transferring the science-based nuclear knowledge they acquired during the training course to students.

Therefore, it is desirable to continually expand and operate this education program to ensure accurate and balanced enhancement of nuclear understanding and cultivation of nuclear knowledge among teachers. Additionally, considering the level of nuclear knowledge among teachers, it is important to systematically differentiate and operate the program at basic and intermediate levels according to the difficulty of the content.

Table I: Current status of the job training program for secondary school teachers

Title	Job training for secondary school teachers									
Purpose	Improving the understanding of teachers on nuclear energy and radiation through experience and practice									
Yr.	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
No. of times	1	1	1	1	1	1	1	1	1	1
Audience	23	26	40	28	25	30	16	30	25	27
Time, day	3	3	3	3	3	3	3	4	4	4
Program	- Lecture: Nuclear energy and radiation, Nuclear reactor, Radioactive waste management, Radiation basic, Radiation in life, Radiation applications - Experiments: Radiation, Simulator - Nuclear education guidance - Visit KAERI facilities									
Evaluation	- Satisfaction: 4.7 - Nuclear awareness: 3.7 (before) → 4.2 (after) - Nuclear knowledge: 63 (before) → 83 (after)									

### 3.2. Seminar on nuclear understanding for teachers

At a time of energy transition to national low-carbon

energy sources, it is necessary to analyze the nuclear content reflected in elementary, middle, and high school textbooks to provide textbook officials with accurate information on nuclear knowledge in accordance with the textbook reorganization period according to the 2022 revised curriculum. For this purpose, NTC conducted a nuclear understanding seminar for teachers and textbook officials in 2023.

As indicated in Table 2, the content of this seminar included the analysis of nuclear content from the 2015 revised textbooks, understanding radiation right away, and a balanced energy education. After the seminar, the satisfaction level of education was very high at 4.5 points. This suggests this seminar is meaningful in terms of improving nuclear understanding.

It is considered that this program needs to be continuously implemented in each region across the country through the improvement and expansion of educational program to improve teachers' understanding of nuclear energy.

Table II: Current status of the seminar on nuclear understanding for teachers

Title	Seminar on nuclear understanding for teachers
Purpose	Providing accurate information and improving the understanding of teachers
Yr.	'23
No. of times	2
Audience	70
Time, hour	3
Contents	- Analysis of nuclear energy content on the 2015 Revised curriculum textbook - Understanding of radiation right away - Balanced energy education (Nuclear energy, Renewable energy etc.)
Evaluation	- Satisfaction: 4.5

### 3.3. Visiting nuclear education

The decision-makers of future energy, our youth, are acquiring information about nuclear energy and radiation through media and the internet, often without scientific validation. Additionally, the lack of accurate knowledge on safety, coupled with vague fears, makes it challenging them to form scientifically sound judgments about nuclear energy. Therefore, there is a need for education that effectively communicates scientific facts to students and addresses misconceptions and questions about nuclear power from an expert standpoint. To address this, NTC has been conducting nuclear education programs for elementary, middle, and high school students starting in 2024 as part of a nationwide initiative for nuclear communication and understanding enhancement. Table III presents the current status of this program.

As a result of analyzing nuclear awareness among elementary school students, the awareness of the safety of nuclear power (2.3) was relatively lower than that of

energy interest (3.1), nuclear interest (3.2), environmental interest (3.7), and nuclear usefulness (3.8). The results of the nuclear awareness of middle school students showed relatively low scores for safety (3.2) and acceptance (3.4) compared to economic feasibility (3.7), usefulness (3.7), necessity (3.7), and reliability (3.6).

Both elementary and middle school students showed low scores in understanding the safety of nuclear energy. Therefore, the educational content should not only introduce nuclear technology but also emphasize the importance of nuclear safety. It is believed that the hands-on nuclear education experience has a positive impact on enhancing the overall awareness of nuclear energy among elementary and middle school students. Continuous development and implementation of educational content focusing on the usefulness and safety aspects of nuclear energy and radiation are deemed necessary.

Table III: Current status of the visiting nuclear education

Title	Visiting nuclear education					
Purpose	Cultivating students' correct knowledge of nuclear energy and radiation					
Yr.	'18	'19	'20	'21	'22	'23
No. of times	10	3	1	1	5	18
Audience	443	619	52	17	362	708
Time, hour	1~3	1.5~3	2	2	1~2	1
Contents	- Lecture: Nuclear energy and radiation,					
Evaluation	- Nuclear awareness (in 2018) • elementary school student: 3.4/5.0 • Middle school student: 3.5/5.0					

### 3.4. Atom school (Youth nuclear exploration classroom)

In the current educational curriculum, nuclear education content tailored to the developmental stages of elementary, middle, and high school students is not systematically incorporated. Therefore, systematic nuclear education for students' fundamental nuclear literacy is practically impossible within schools. The nuclear awareness and values held by adolescents are influenced by the content and experiential activities of nuclear education learned during their school years.

Consequently, the implementation of nuclear understanding-enhancing education organized by nuclear institutions is crucial to supplement insufficient school-based nuclear education.

To address this issue, the NTC has been operating a youth nuclear exploration classroom program since 2014. In this program, students have the opportunity to directly visit research facilities, acquire foundational knowledge about nuclear energy and radiation, and enhance their understanding of nuclear energy through tours of research facilities.

Table IV presents the current status of this program. Through the implementation of this program, students' awareness of nuclear energy was increased from 3.3 points before education to 4.0 points after education. This suggests that this program has a high education effect in terms of cultivating nuclear knowledge and awareness.

It is considered that this program needs to be continuously implemented through the improvement and expansion of educational program.

Table IV: Current status of the atom school

Title	Atom school									
Purpose	Improving the understanding of youths on nuclear energy and radiation through experience and practice									
Yr.	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
No. of times	1	2	2	2	2	2	-	-	1	1
Audience	20	40	57	53	48	50	-	-	17	30
Time, hour	3	3	3	3	3	3	-	-	3.5	2
Program	- Lecture: Nuclear energy and radiation - Experiments: Radiation - Visit KAERI facilities : HANARO, Robot lab., Super conductor lab.									
Evaluation	- Nuclear awareness: 3.3 (before) → 4.0 (after)									

### 3.5. Training course on nuclear energy understanding for public institutions

It is very necessary to conduct education on key research projects of the KAERI necessary for performing duties for employees of nuclear-related institutions to improve nuclear understanding.

To this end, the NTC has developed and operated a curriculum to promote nuclear understanding for public institutions that reflects recent key research projects and field training on major nuclear facilities for employees of nuclear-related organizations to understand and smoothly promote nuclear R&D projects since 2014, as shown in Table V.

The average education satisfaction for 9 years was 4.6 points, which was very high. This suggests this education is meaningful in terms of improving nuclear understanding.

Table V: Current status of training course on nuclear energy understanding for employees of nuclear-related institutions

Title	Training course on nuclear energy understanding for employees of nuclear-related institutions									
Purpose	Improving the understanding of nuclear energy for employees of nuclear-related institutions									
Yr.	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
No. of times	1	1	1	1	1	1	1	1	-	1
Audience	18	7	14	16	11	5	11	9	-	9
Time, hour	5	5	5	5	5	5	5	5	-	5
Program	- Lecture: Key status of future reactor technology (SFR, SMART, VHTR). The role of nuclear technology - Visit KAERI facilities: HANARO, Robot lab etc.									
Evaluation	- Satisfaction: 4.6									

#### **4. Conclusions**

The people's trust in nuclear energy is an important factor in determining the direction of the country's energy policy and support for the policy. Education is an important means of strengthening nuclear energy for the public. The NTC has consistently implemented five courses, including job training of secondary school teachers, seminar on nuclear understanding for teachers, visiting nuclear education for students, atom school for students, and training course on nuclear energy understanding for employees of nuclear-related organizations.

Through the implementation of the nuclear understanding programs, the people's awareness and acceptance of nuclear energy, such as teachers, students and employees of nuclear-related organizations has been enhanced. It can be seen that the effectiveness of this program has been proven.

In the future, various nuclear understanding education should be continuously implemented to eliminate excessive public fear of nuclear energy and radiation and to relieve anxiety about nuclear power plant accidents.

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