A Study on the Adolescents Perception and Knowledge of Nuclear Energy Issues

Eunjee Jang[a*], Youngmi Nam[a], Kyongwon Han[b]
[a]*Nuclear Training & Education Center, KAERI, 111, Daedeok-daero 989 beon-gil, Youseong-gu, Daejeon*
[b] *Radworks, 503, CTRCC, ETRI, 218, Gajeong-ro, Youseong-gu, Daejeon*
[*]*Corresponding author:eunjee@kaeri.re.kr*

1. Introduction

The issue of public acceptance on the use of nuclear energy is receiving more attention by the nuclear community particularly due to the Fukushima accident. However, unbalanced information through media is widespread and nuclear education is not involved in the regular education curriculum in schools.

The decreasing interest in nuclear energy in young people and a lack of basic understanding of it result in a negative influence on the formation of opinions and policy decision making regarding nuclear energy as a future energy source for a long-term view.

International organizations including the International Atomic Energy Agency (IAEA) and countries dealing with nuclear related programs are promoting nuclear outreach to younger generations, in terms of an integrated, innovative, and sustainable approach [1, 2, 3]. The same goes with the Korean nuclear community where diverse extra-curricular educational programs are being developed and provided to primary and middle school students, and to school teachers as well [4]. Taking advantage of its unique research resources including experts and facilities, as a part of an adolescent and teacher's Nuclear Outreach project, KAERI-NTC (Nuclear Training and Education Center) is developing a education and training based nuclear outreach program is being developed, using the SAT (Systematic Approach Training) model.

Systematic Approach to Training: the SAT model provides logical processes for developing and implementing education and training courses.

KAERI-NTC has not only identified the nuclear education environment by conducting interviews with teachers, but has also collected opinions related to the development of a Nuclear Outreach program through expert consultation since last July.

Based on this, KAERI-NTC developed a survey questionnaire to grasp the perception and the education demands of young students on nuclear energy and conducted a survey for 1,200 students a national scale.

2. Review of Previous Studies

After the accident at the Fukushima NPP, the number of domestic researches on nuclear awareness as increased. (17 studies in '11~'14, 9 studies in '05~'10), which mainly deals with 'crisis management', 'risk communication', 'risk perception', 'conflict', etc. as a main topic.

As research on the perception and knowledge of nuclear energy, Girondi [5] used 44 questions regarding faith in science and technology, health and safety, the need for nuclear power, and trust in government. Calhoun and Shrigley [6] also used 20 questions on radiation, safety, the relative risks of other form of energy, and social benefits, which shows that nuclear recognition can be explained by 'Safety' and 'Usefulness'.

Jang and Woo [7] developed four categories for measuring the attitude toward nuclear energy; technology, management, usefulness, and safety.

A recent study focused on how the recognition and knowledge of nuclear energy can affect the attitude and the acceptance of the youth. The lower level of nuclear knowledge that the students have the more negative they are on the nuclear accidents [8]. The lower the levels of knowledge students have, the lower their level of consciousness and attitude [9].

More men than women have a positive attitude on nuclear power generation. In addition the more highly educated and aged they are, the more positive they are. Another study shows that nuclear reliability is more important than nuclear knowledge.

Accordingly, there have been studies that evaluate subjective knowledge such as 'perceived knowledge' [10, 11] rather than using the method of identifying the rate of correct answers.

Our research mainly approaches the perception of nuclear energy and radiation to determine the state and the current level of knowledge rather than study how the awareness affects the attitude and which attitude we should have toward nuclear acceptance.

Perceived knowledge and perception can be measured, but it is difficult to measure the level of objective nuclear knowledge in way mentioned above.

In this study, we made an effort to supplement the gap of previous studies. As a result, nuclear recognition is defined as five different categories. We set the level of expectation about nuclear energy. To identify the current level exactly, we developed questions to measure knowledge on nuclear energy.

3. Contents of Research

3.1 Objective of Survey

The survey aims to identify the nuclear perception (concern, usefulness, trust, acceptance), and nuclear

education demand for elementary, middle, and high school students.

We identify the level of expectation of nuclear knowledge through expert consultation. After surveying the level of nuclear knowledge by each grade, we also identify the differences and reduce them as the ultimate goal.

3.2 Contents of Survey

A survey targeting 1,200 students was conducted. The result of 309 data and the information of the survey target are as shown in Table 1.

Table 1. Survey List

unit	Residence section				Total
	A	*B*	*C*	*D*	
elementary	30	30	30	30	120
middle	0	50	49	0	99
high	0	30	30	30	90
Total	30	110	109	60	309

*A: capital (Seoul), B: Chungcheong-do,
C: Gyeongsang-do, D: Jeolla-do

3.3 Questionnaire Configuration

The questionnaire was composed of four parts. The first part is 'nuclear recognition' and interest, usefulness, reliability, safety, and acceptance, which is composed of 10 questions. It was measured with a 5-point Litert scale.

The second part is 'Nuclear knowledge' with 20 questions on the principle of nuclear, radiation characteristics and use and nuclear power generation and use. Nuclear knowledge is measured using three choices: 'Yes', 'No' and 'I do not know'.

The third part consists of 24 questions on educational contents and the teaching method and is about 'educational demand'.

In the last part, we make three questions on age, gender, and residence, and add 10 questions more on science grade, interest, and questions related to nuclear energy as a basic statistical survey.

4. Research Method

4.1 Nuclear Recognition of Adolescents

Recognition is the process of reflecting the objective reality to human consciousness theoretically and the degree of seriousness, which is mainly defined as interest on an object and psychological tendencies.

Recognition was designated as the 'recognition for what' rather than making the subordinate concept to identify the 'recognition' in the previous studies.

Nuclear recognition identifies nuclear interest, usefulness, reliability, and acceptance, and the factors in each category are as follows:

- Nuclear interest: interest in energy, and the electricity generation principles,
- Nuclear usefulness: the usefulness of technology, and radiation,
- Nuclear reliability: reliability on technology, and management,
- Nuclear acceptance: for my health, for my community, for my country

4.2 Nuclear Knowledge of Adolescents

We implemented a Focus Group Interview by experts for identifying the level of expectation of nuclear knowledge and derived questions according to the categories below:

- Nuclear principle, i.e. composition of the atom, nuclear reaction principle, academic values, radiation definition, and unit of Radiation,
- Radiation characteristics/use, i.e. radiation characteristics, environmental radiation, radiation protection, and radiation use,
- Nuclear power generation/use, i.e. electricity generation principle, environment friendliness, economics, utilization of energy, technology compactness, and nuclear operation and waste safety.

4.3 Educational Demands of Adolescents

We surveyed nuclear educational demands in the two categories of educational contents and methods. The educational contents are composed of the nuclear principle, the characteristics and use of nuclear radiation, and social issues.

We developed specific questions regarding the contents mentioned.

The educational methods were divided into three (lecture, experience, and play) types and let the respondents choose among them. If there was no preferable method, the respondents could write their own opinion.

5. Research Result

5.1 Nuclear Recognition of Adolescents

The survey result, which is shown in Table 2, provides findings as follows:

- Nuclear interest (2.99), safety (2.95), acceptance (3.13) is low regardless of gender and grade, while relative usefulness (3.48) is high.
- Reliability of nuclear declines as the grade (age) is higher (95% probability level of significance),
- Interest in nuclear, usefulness, reliability, and acceptance are affected by the place of residence (95% probability level of significance). Nuclear recognition of Gyeongsang-do (Gyeongju) and capital is lower than Jeolla-do and Chungcheong-do,
- Gender is irrelevant to the nuclear acceptance, but residence and grade (age) indicate a significant difference,
- Students will use radiation therapy for their medical checkup, but they do not accept the construction of nuclear power plants in their neighborhood,
- Students have the highest interest in environmental

conservation (3.68), followed by views that the use of radiation helps their lives (3.95), living near radioactive waste disposal site is dangerous (-2.10), and they don't agree with the construction of a nuclear power station in their area (-2.6).

Jeolla-do>Chungcheong-do>Gyungsang-do>Capital

An important conclusion from the findings is that the level of students' perception on nuclear energy is low (3.14) on average, while the level of usefulness of nuclear energy is the highest (3.48) compared to that of credibility (3.27), acceptance (3.13), interest (2.99), and safety (2.95).

Another meaningful finding is younger students less interest they have in nuclear issues, while a more favorable perception in terms of usefulness, safety, credibility, and acceptance.

Table 2. Nuclear recognition

Unit		Interest	Usefulness	Safety
Elementary	M	2.91	3.56	3.05
	S.D.	.96	.75	.64
Middle	M	2.99	3.41	3.03
	S.D.	1.00	1.56	2.20
High	M	3.11	3.44	2.75
	S.D.	.93	.55	.61
Unit		Reliability	Acceptance	Total
Elementary	M	3.48	3.23	3.24
	S.D.	.66	.77	.61
Middle	M	3.23	3.02	3.07
	S.D.	.90	.87	.94
High	M	3.04	3.12	3.09
	S.D.	.75	.77	.49

* Cronbach a 0.80, $p<0.05$

5.2 Nuclear Knowledge of Adolescents

Major findings on nuclear knowledge of adolescents from the survey result, which is shown in Table 3, are as follows:

- High school students have the highest level of knowledge on nuclear, followed by middle school and elementary school students,
- The number of correct answers is 5.9 (elementary school), 8.17 (middle school), and 8.79 (high school) out of 20 (standard deviation: 4.38),
- Elementary school students have the highest rate of answering "I don't know" followed by middle school and high school students,
- Students who intend to take natural sciences have a higher knowledge of nuclear energy,
- Gender and residency do not affect the results,
- Students, who are interested in energy issues including nuclear energy, have a high knowledge of nuclear energy.

Table 3. Nuclear knowledge

Unit		a	b	c	d	e
Elementary	M	.30	.29	.34	5.90	10.3
	S.D.	.28	.26	.27	4.15	5.68
Middle	M	.45	.39	.46	8.17	7.37
	S.D.	.31	.29	.31	4.85	6.39
High	M	.51	.38	.51	8.76	6.42
	S.D.	.30	.24	.26	3.46	4.76
Total	M	.41	.35	.43	7.46	8.23
	N	308	308	308	308	309
	S.D.	.31	.27	.29	4.38	5.91

* a: Nuclear principle
b: radiation characteristics & use
c: Nuclear power generation & use
d: correct answer frequency
e: I don't know frequency

5.3 Nuclear Educational Demands of Adolescents

The survey result on nuclear educational demands of adolescents is summarized as follows:

- Educational wants of recent nuclear issues is the highest. A similar aspect appeared for each grade.
  recent issues > radiation characteristics & use > nuclear power & use > nuclear principles
- Based on their individual rank, interest in North Korea's nuclear weapons and our safety is the highest (total average of 3.90). On the issue elementary school students' showed the highest interest (4.11),
- In terms of the educational method, elementary and middle school students have shown their interest in the order of play, experience and lecture. While, for high school students' it was in the order of experience, play and lecture

5.4 Other Remarkable Findings

In addition to the aforementioned findings, some more information has been gained from the survey, which is remarkable as follows:

- The more the students are interested in energy and environment, the lower interest they have,
- Having a similar experience of a technical tour to a nuclear power plant and the Korea Atomic Energy Research Institute for all three kinds of schools,
- Difficulty of comparison of the level of recognition and interest of nuclear issues with the level of knowledge,
- The very high rate of choice "I don't know" indicates that the level of nuclear knowledge is very low.

5. Conclusion

There is an increasing need for nuclear outreach to younger generations particularly due to the Fukushima NPP accident. Addressing this need by developing a SAT Model based educational nuclear outreach program, a survey on school students was conducted as part of a needs analysis.

The survey show that the level of students' perception on nuclear issues is low, indicating 3.14 out of on average, while the level on usefulness of nuclear energy is the highest (3.48) compared to that on credibility (3.27), acceptance (3.13), interest (2.99) and safety (2.95). Another meaningful finding is students have less interest on nuclear issues the younger they are, but have a more favorable perception in terms of usefulness, safety, credibility and acceptance.

The level of students' knowledge on nuclear energy is found to be quite low on average (7.46 out of 20 with a standard deviation of 4.38), while it increases along with the student's grade, i.e., 5.9 for primary school students, 8.17 for middle school students, and 8.76 for high school students. In terms of knowledge area, students' knowledge on radiation characteristics is less than that on nuclear principles and nuclear power.

The demands of students for learning have turned out to be a subject on current nuclear issues with top priority, which is followed by radiation and its application, nuclear power generation, and nuclear principles in a decreasing order. With respect to the learning method, the preference of primary and middle school students is shown to be play, which is followed by experience and lecture, while that of high school students to be experiencing, play, and lecture in a decreasing order.

These results reflect the overall identification of outreach program demands, which will then be transformed into a set of requirements for the design and development of the program.

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