Proposing an Education System to Judge the Necessity of Nuclear Power in Japan

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ABSTRACT

In environmental education, the importance of education to promote thinking has been repeatedly emphasized. Further, following the Fukushima Daiichi nuclear power plant incident on March 11, 2011, judging the necessity of nuclear power is a controversial and important issue in Japan. Therefore, it is clear that education to promote thinking and judgment is important, especially as far as the necessity of nuclear power is concerned. In this research, I focus on the development of education to promote making judgments. I developed an easy-to-use education system, designed to enable individual citizens to judge the necessity of nuclear power in Japan. The system is designed to allow people to judge whether "YES" or "NO" regarding the using of nuclear power. First of all, a preliminary judgment is called for from each of a range of nine perspectives. Then, a comprehensive judgment is expected to be made from each of the nine perspectives. For those who cannot make judgments easily, I developed a quantitative system and made it available so that anyone can judge. Through the use of a questionnaire, I was able to make evaluations of the usefulness, appropriateness and neutrality of the education system that I had developed.

Keywords: environmental education, thinking, judgements, education to promote making judgments, the using of nuclear power

1. INTRODUCTION

The importance of education to promote clear thinking is widely recognized in environmental education. The Japanese School Education Law 30(2) notes that "It is important to develop students' ability to think, judge, and express themselves, so an attitude for active learning can be cultivated." The importance is written into the basic policy on environmental initiatives of the National Institute for Educational Policy Research of producing "A person who can not only acquire information but also think for him- or herself, judge fairly, take action, and produce results."

In my daily teaching practice, I am recognizing more and more the importance of an education that promotes thinking. As environmental problems are changing day by day, certain interpretations and evaluations of news items or commonly accepted information and doctrines related to environmental problems have also changed over time and will continue to change. There are no mature standards for the content of instruction for environmental education, unlike other, traditional subjects. Therefore, the content of each class depends on its teacher, causing much variation. Moreover, the aim of environmental education, the promulgation of the value of environmental conservation, includes the formation of an attitude among its students, implying that simple transfer of knowledge and skills is not good enough. For these reasons and because that I teach environmental education, I have always been concerned with and prioritized critical thinking, avoiding allowing my students to simply believe the information given to them blindly. Thus, developing a method of education to promote critical thinking is important.

In contemporary Japan, following the disaster of the Fukushima Daiichi nuclear power plant on March 11, 2011, whether nuclear power is necessary is a controversial and important issue. It is a difficult issue due to several reasons. First, its physical issues, such as radiation, the damage to health by radiation exposure are difficult to understand because they are obscure; second, the economic effects of the usage of nuclear power is ambiguous; and third, the political environment is not easy to discuss. In Japan, discussing the necessity of nuclear power remains a somewhat taboo. Because it is governmental policy and because a hidden but influential majority has a great amount of power, many citizens do not discuss the issue in public. For these reasons, engaging in this issue in class has a great deal of importance.

It is clear that education that promotes the ability to think and judge is important, especially with regard to the necessity of nuclear power. Among types of education that promotes different kinds of thinking, which have not yet been well developed, I focus in this study on the development of education to promote the ability to judge. I develop and propose a workbook[1)], which is a system of education that promotes the ability to judge in general and in particular about the necessity of nuclear power, in concrete terms. I also examine and present the effectiveness of my system for judging concretely.

2. PREPARATORY PHASE FOR CONSTRUCTING A CONCRETE SYSTEM FOR JUDGING THE NECESSITY OF NUCLEAR POWER

First, I prepared alternatives to judge between. One extreme alternative would be to shut down all nuclear power plants tomorrow. Another extreme would be to continue using nuclear power as long as energy sources for it continue to exist, including the employment and implementation of the nuclear fuel cycle. Those who may be proponents of using nuclear power would find that their opinions could thus be limited to just the use of existing

nuclear power plants for their expected lifetimes. Someone may oppose nuclear power entirely, while another may prefer a gradual shift from nuclear power to other sources of energy. Thus, there are many points of view to consider in judging the necessity of nuclear power. To simplify, however, I prepare and use only two alternatives. One is "YES," that is, supporting the use of nuclear power in the long term without considering other options. This alternative would include within it all positions in favor of nuclear energy. The other is "NO," opposing the long-term use of nuclear power regardless of other options. This alternative includes all positions opposed to nuclear energy.

Next, I listed various potential perspectives for judging alternatives to the issue of the necessity of nuclear power. Then, I organized and categorized them into 12 perspectives. This was done through brain storming with co-researchers and many workshops with citizens and students. The 12 perspectives are listed in Table.1.

It is desirable to allow students to conduct their own judging procedures and list the required number of perspectives. As the necessity of nuclear power is complicated and difficult, I organized my workbook such that students can omit these processes to concentrate the following ones. In other words, these processes are arbitrary, and the outcome may not be limited to one type; therefore, my implementing these processes in place of the students is important. In this way, presenting 12 concrete alternatives enables students to judge concrete questions.

After the 12 perspectives were developed, 3 were excluded after thorough examination. These are numbers 10, 11, and 12. The process described above is important because one of the aims of this process is to bring up various related ideas in the judgment of alternatives and, at the same time, another is to supply actually necessary perspectives to judge alternatives.

Perspective 10, which concerns the probability of nuclear accidents, was excluded for the following reason. To judge the issue according to this perspective, a precise figure for the probability of the occurrence of nuclear accidents is essential. According to my survey, however, no estimation can avoid certain kinds of assumptions, which implies that some form of bias from either side is unavoidable. As long as the estimated probability is biased, judging the necessity of nuclear power based on the probability of occurrence of nuclear accidents cannot be fair. In other words, it is impossible. Therefore, it is easier and more direct to judge without incorporating the probability of the occurrence of nuclear accidents.

It has become common in Japan to say that we will have insufficient electric power without nuclear power. Judging by considering whether the electric power supply is sufficient or not is perspective 11. Briefly, the easiest counterargument would be to say that we still have enough electric power after all nuclear power plants have been shut down. Nevertheless, it remains an open question whether any insufficiency of power would be covered by increases in price or whether the insufficiency would occur in the necessary minimum demand for energy. These items are to be discussed in relation to perspectives 6, 7, and 12. For the above reasons, I excluded perspective 11 from the necessary perspectives for judging alternatives.

Table 1. 12 perspectives on the issue of the necessity of nuclear power

Perspectives	Contents
1 Effects of radiation exposure	Judging by examining the effects of radiation exposure, including direct effects on health and indirect effects on society (such as suicide and discrimination) and the economy
2 Global warming	Judging by discerning the possible effects of mitigating global warming, gauging the (in)sufficiency of current countermeasures for global warming, and simplifying that the use of nuclear power is a good countermeasure to global warming
3 Nuclear fuel cycle	Judging by considering whether the nuclear fuel cycle is feasible or not
4 Interspatial fairness	Judging by considering whether the building nuclear power plant in your backyard is acceptable, in relation to the importance of nuclear power
5 Intertemporal fairness	Judging by considering whether the present generation should pay all the long-term costs of the nuclear power industry, with or without the perspective of future generations
6 Cheap power supply	Judging by examining which perspective should be focused: nationwide benefit or benefit of electric power industry
7 Economic effects	Judging by how economic effect is examined: less subjects and shorter period or more subjects and longer period
8 Energy security	Judging by considering whether stable energy security is needed
9 Disposition with regard to nuclear weapons	Judging by determining whether a nuclear weapon is necessary, considering necessity of nuclear power to mask the development of a nuclear weapon
10 Probability of the occurrence of nuclear accidents	Judging by considering whether the probability of the occurrence of nuclear accidents is big or small
11 Insufficiency of electric power	Judging by considering whether the electric power supply is sufficient or not sufficient
12 Alternative energies	Judging by considering whether alternative energies are sufficient or not sufficient

Judging by considering whether or not alternative energies are sufficient is perspective 12. However, it can be broken down to the perspectives 2, 6, and 7. Thermal power, one of the most reliable sources, is often dismissed. This is first because it emits more CO_2 than nuclear power. This context falls under perspective 2. Second, it appears more expensive than nuclear power. This context is discussed in perspective 6. Third, it is not an inexhaustible resource. However, the source of power for nuclear

energy, uranium, is also exhaustible. The use of exhaustible resource should be discussed in the perspective of sustainability over the long term. Perspective 7 covers a discussion of the long term; therefore, this part of perspective 12 is found there. For above reasons, I excluded perspective 12 from the necessary perspectives for judging alternatives.

The 9 organized and categorized perspectives should be independent from each other. While we do not have a good way to itemize perfectly independent alternatives, qualitative examinations were conducted as much as possible. The validity of these processes should be judged by others. If the 9 perspectives are not approved by any student, then he or she can develop his or her own based on this framework. In this paper, I propose this framework, first, and the concrete system, second.

The concrete system developed allows students to judge each of the 9 perspectives and comprehensively judge by considering the 9 judgments. The next chapter introduces their structures.

3. OUTLINE OF THE CONCRETE SYSTEM TO JUDGE NECESSITY OF NUCLEAR POWER

3.1 outline of the system of the YES/NO chart

As shown in the last chapter, the perspectives according to which the necessity of nuclear power could be judged were 9 in total. In the workbook, for each of the 9 perspectives, a brief but comprehensive explanation of approximately 2–4 pages is given. The students study the perspectives through these descriptions and proceed to next process, the YES/NO chart.

This is a system where students read yes or no questions and answer them, proceeding according to the answer to the next question or conclusion. Depending on the perspective, there are one or two questions. After responding to all these, students are led to a conclusion, either ○, △, or ×. These signs express the students' conclusions, as follows.

○ : We should use nuclear power

× : We should never use nuclear power

△ : Indifferent to the use of nuclear power. This is a weak opinion, and we can ignore this perspective.

As a sample, YES/NO chart of perspective 4 is presented in Fig.1.

In this sample, there are two questions. Depends how you answer, you face to one or two questions and will be led to △ or ×.

In making these YES/NO charts, the following was carefully considered.

In the discussion of the necessity of nuclear power, first, there are strong positive reasons on the proponents' side and strong negative ones on the opponents' side. And people on the other side are denying such reasons. This means that the proponents have strong positive reasons for using nuclear power, and their opponents have weak negative reasons against using nuclear power. In the same way, opponent side has strong negative reasons for never using nuclear power, and the proponents have only weak positive reasons for not denying the use of nuclear power. Thus, nuance and strength are different between the reasoning of

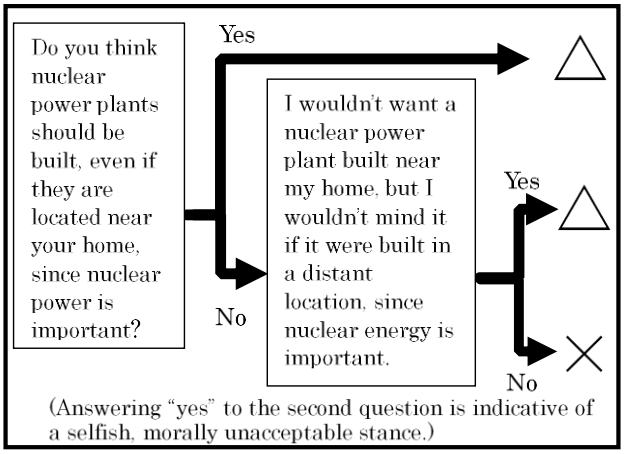

Fig. 1. Sample YES/NO Flowchart (Perspective 4)

the proponents and opponents, and the reasons put forward to deny these strong reasons. The proponent reasons and opponent reasons vary in their strength.

Even among proponents, there may be ○ proponents (with strong reasons), and △ proponents (without strong reasons). Although both are proponents, the strength of reasons is different between ○ and △.

The same logic applies to opponents. This is shown in Fig. 2.

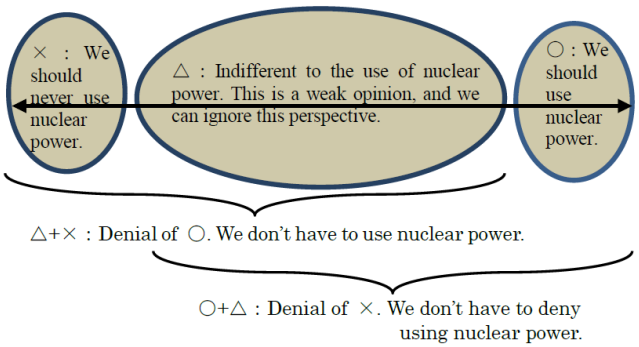

Fig. 2. Range and concept of the signs ○, △, and × expressing a positive or negative stance with regard to the use nuclear power

Above, I classified 9 perspectives with regard to two groups: those who have strong positive reasons to use nuclear power and strong negative reasons against using nuclear power. For former reasons, when they are agreed with, I marked them as ○, and when they are disagreed with, they were designated as △. In the same way, for the latter reasons, when they were agreed with, I designated them as × and, when they were disagreed with, I designated them as △.

I paid careful attention to the creation of concrete sentences as questions for the YES/NO chart. Focusing on the essence of the perspective, a minimum number of sentences were made into questions and then elaborated. For instance, regarding the point of view of proponents, I designed the sentences such that YES led to ○, (not △) and NO led to △ (not ×). If the designed sentence

did not have the proper nuance, YES might lead to △ and NO might lead to ×. Attention was paid to avoid confusion. In addition, careful attention was paid to maintaining neutrality, such that the students could not be led to either side by biased expressions. The final expressions were finally reached through examinations.

3.2 outline of the comprehensive assessment system

The comprehensive assessment system leads students, even those with no opinion for this issue, to give concrete judgment either that YES, we should use nuclear power or NO, we should never use nuclear power.

The first process is shown in Fig. 3. First, students re-write 〇 or △ or × according to their own judgment, for each perspective in the table. This way, students can see all the judgments they made for each perspective. If students falls into pattern 1 or 2, their self-description is easy: it is clear that they are proponents or opponents. If students fall into pattern 3, they should proceed to next process.

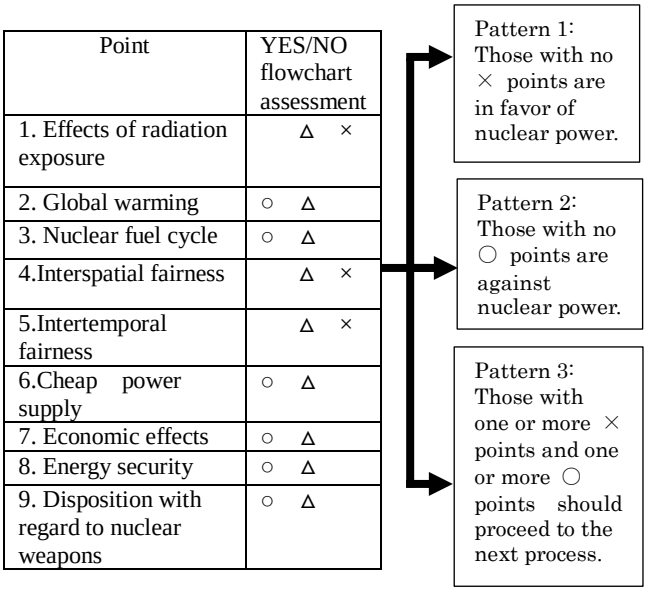

Fig. 3. Part of comprehensive assessment flowchart

The next process is composed of three steps. In the first step, the students simply organize and itemize the strong reasons they have. In the second step, they review their path to reach 〇 or ×, to understand what factors you value. In the third step, they are asked to comprehensively judge the necessity of nuclear power. If any student cannot judge yet, he or she proceeds to an additional process.

3.3 outline of "Quantitative Assessment" system to support comprehensive assessment

The comprehensive assessment system is easy to use. Because it is built to promote comprehensive judgment among students, it is rather slapdash. However, because it avoids too much complexity, it is easy to use.

A precise quantitative assessment system was made, but it is supplied as an appendix, because it may be rather cumbersome to use.

This system is made of "paired comparisons". First, the number of 〇 and × has to be determined. Then, the student subjectively judges the importance between a 〇 perspective and a × perspective and chooses one of 5-point scale (−2, −1, 0, +1, +2). Each denotes the following:

−2 : the × perspective is much more important than the ○ perspective
−1 : the × perspective is somewhat more important than the ○ perspective
0 : indifferent
+1 : the ○ perspective is somewhat more important than the × perspective
+2 : the ○ perspective is much more important than the × perspective

The student simply repeats paired comparison between all 〇 perspectives and × perspectives. After making all the comparisons, the average of all is taken. In this way, the student's judgment can be made quantitatively, even if he or she is unsure of his or her preferences.

4. EVALUATION OF THE USEFULNESS, APPROPRIATENESS AND NEUTRALITY OF THE SYSTEM

The usefulness, appropriateness and neutrality were evaluated. A questionnaire targeting 103 students of Chukyo University showed the usefulness of the system, with around 70% of the respondents stating that it had these qualities. In addition, 60% of the respondents expressed its appropriateness. Only 14% of the respondents denied its neutrality.The results of the questionnaire are shown in Fig.4. Consequently, the usefulness, appropriateness and a certain level of neutrality of the system were shown.

The actual use of the whole system by students in my classes has shown that few students require the use of the quantitative assessment system.

5. SUMMARY

I developed an easy-to-use educational system designed to enable individual citizens to judge the necessity of nuclear power in Japan. This system is designed for students to decide for or against the ongoing use of nuclear power. Judgment is expected first individually from 9 alternatives. Then, comprehensive judgment is expected considering each judgment for each of the 9 alternatives. For those who cannot judge easily, a quantitative system is supplied to assist them.

This is a system for educating judgement that is decision making. As this is a simplified model, it has several limitations. For instance, it is impossible to be perfectly rational, as is well known. This system should be considered as a model that operates within

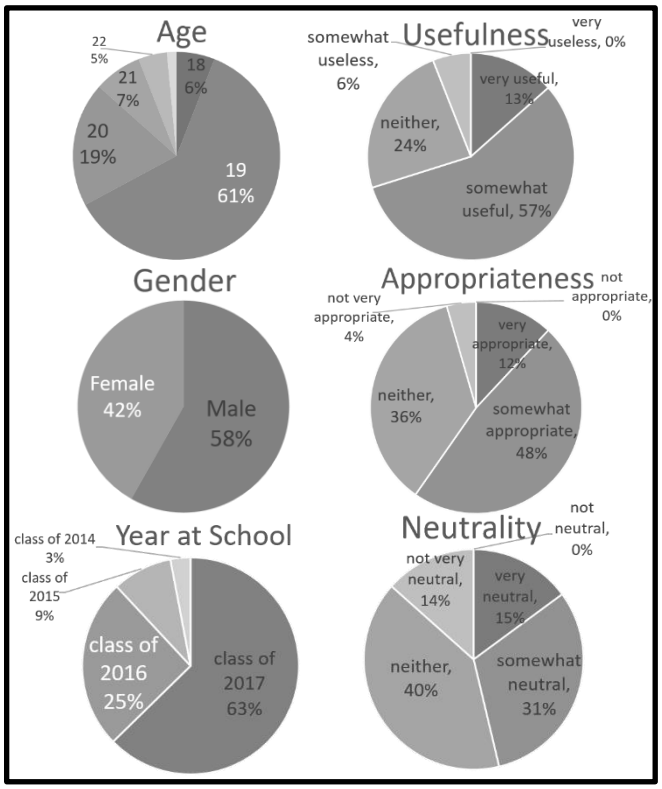

Fig.4. The result of the questionnaire

limited rationality. Further, our private decision making can be influenced by others or others' decisions. This system is designed on the assumption that one is not influenced in this way. In other words, this system simply models the decision making of an independent person. Regarding these matters, the development of a system for educating that type of decision making that is influenced by others should be discussed in future studies. The validity of this system's framework will also be discussed in a later paper.

Using a questionnaire, I evaluated the usefulness, appropriateness and neutrality of the education system I developed.

ACKNOWLEDGMENTS

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REFERENCE

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