

# An Educational Framework for Decision-Making and Problem-Solving

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## ABSTRACT

Considering the importance of promoting students' critical thinking in environmental education, we focused on developing an educational framework for promoting private decision-making making, in other words, for judgment. First, articles with suggestions for doing so, published in *Environmental Education Research* and the *Journal of Environmental Education* during the last 15 years, were reviewed for worldwide trends. Additionally, those from the *Japanese Journal of Environmental Education* were reviewed for Japanese trends. Treatises with keywords such as *judgment* or *decision-making* were quite limited. Referring to the few treatises related to development of an educational framework for decision-making or judgment, we proposed a framework of five steps: 1) designing alternatives to judge between/among, 2) listing potential perspectives for judging alternatives, 3) organizing and categorizing potential perspectives into a minimum number of perspectives, 4) judging (selecting an alternative) from each perspective, and 5) comprehensive judging (selecting an alternative). Based on this educational framework for judgment, sample teaching materials for judging the necessity of using nuclear power in Japan were developed and tested. These obtained the desired level of usefulness and appropriateness of the teaching material, and involving more samples in future research based on the appropriateness of the framework of this study would confirm these results.

**Keywords:** environmental education, critical thinking, education to promote judgment, use of nuclear power

## 1. INTRODUCTION

Just by its nature, environmental education requires critical thinking. First, established doctrines are often replaced by newer ones. Second, considering the limitations of observation or forecasting, even currently established doctrines or theories often include uncertainty. Many news reports, articles, and rumors related to environmental problems, of course, include more uncertainty. For instance, even the ubiquitously worrisome global warming involves unavoidable uncertainty. Successive reports by the International Panel on Climate Change (IPCC) often modify not only their preciseness, but also their doctrines or certain

perspectives. Indeed, forecasting an environmental problem's effects is always accompanied by uncertainty. Third, environmental perspectives are based on certain values that not everyone shares worldwide. For instance, the concrete direction of sustainable development has a really wide variety, varying from person to person, so environmental students themselves should develop such values. In the ever-changing environmental field, simple transfer of knowledge and skills is highly inadequate for environmental education. Instead of simply believing information presented to them, environmental students must think and judge that information and the situation for themselves. Thus, environmental education requires the critical thinking that many researchers and organizations emphasize.

In light of these three reasons, this research focuses on development of educational methods to promote students' critical thinking, especially development of teaching material. And in light of the need for critical thinking, this research deeply focuses on promoting the ability to judge. Furthermore, as a sample topic, the research employs the issue of nuclear power in Japan, for whether nuclear power is necessary is an important, controversial issue, even more so since the Fukushima Daiichi nuclear power plant disaster on March 11, 2011. This topic presents difficulties for judgment for the following three reasons—first due to its physical features, second to its economic effects, and third to its political environment.

In this manner, we developed and published teaching material<sup>1)</sup> on the necessity for nuclear power as a sample of an educational framework for promoting the ability to judge in general. Through this research, we propose the judgment framework itself and present results of the examination of its effectiveness.

## 2. REVIEW OF ENVIRONMENTAL EDUCATION RESEARCH ON PROMOTING THE ABILITY TO JUDGE

Decision theory can generally be classified into two approaches: normative and descriptive. The normative supports desirable decision-making, and the descriptive helps us understand the decision-making process. Because the purpose of education is to support desirable decision-making, naturally, vision should be discussed mainly through the normative approach. Moreover, this

research focuses on education for private decision-making rather than social decision-making.

In this section, we discuss the genealogy of the educational framework for private decision-making or judgment. The importance of education for the ability to judge in environmental education is discussed in the last section. However, what kinds of education are required is not easy to specify concretely. So first, we need to acquire international knowledge and trends on judging and decision-making in environmental education.

To do so, we reviewed three journals. Two are the best-known international journals in the field of environmental education, *Environmental Education Research* and *The Journal of Environmental Education*. The other is the best-known Japanese journal in the field of environmental education, the *Japanese Journal of Environmental Education*. In journals published from 2002 to 2017, we reviewed categories of articles and reports, but not book reviews or reviews. Publications numbered 708 from *Environmental Education Research*, 285 from the *Journal of Environmental Education*, and 196 from the *Japanese Journal of Environmental Education*—1189 treatises altogether. During this period, the three journals, even though published as print media, could be viewed as digital media, and we extracted treatises with such English search terms as “decision-making,” “judgment,” or “meaning-making” and corresponding Japanese words, discussing educating students in the ability to judge or to make good decisions.

Extracted treatises in English were just seven: six from *Environmental Education Research* and one from the *Journal of Environmental Education*. Among them, Arvai et al.<sup>2)</sup> aimed to create curriculum to develop decision-making skills. They<sup>3)</sup> said that “improving students’ technical knowledge base as means of creating favorable attitudes toward the promotion of better environmental quality” is important to promote more prudent decision-making. However, they<sup>4)</sup> pointed out that “focusing on enhancing technical knowledge without also teaching problem-solving skills will lead to substantial shortcomings with respect to promoting thoughtful decisions.” Thus, enough skill is required to lead from acquired knowledge to proper decisions. Based on these observations, Arvai et al.<sup>5)</sup> noted that a typical structured decision process follows three steps:

- 1) Define the specific decision that has to be made.
- 2) Identify “what matters” in the form of the decision maker’s values expressed as objectives’ in the context of the impending decision and create a set of appealing and purposeful alternatives from them
- 3) Employ the relevant technical information to characterize the consequences of the alternatives carry out an in-depth evolution of the tradeoffs that they entail.

Arvai et al.<sup>6)</sup> also noted that students “must learn the skills that can help them to make higher-quality choices.” These researchers’ proposals and ideas are significative for designing an educational framework for judgment.

All other treatises reviewed, however, just mention the relationship with environmental education rather than attempting to establish any concrete educational framework for judgment,

even though they do mention the importance of decision-making or judgment. For instance, Boreholz<sup>7)</sup> emphasizes the importance of “nature experience,” and asks, “How does nature experience relate to the social justice dimension of sustainable development?” She carefully discusses the important relationship between individual decision-making and sustainable development or affinity for nature. This discussion is suggestive, but does not attempt to establish a concrete educational framework for judgment.

From the *Japanese Journal of Environmental Education*, we extracted 20 treatises in Japanese. However, most addressed only the importance of the ability to think and to judge, but did not discuss a concrete educational framework to help students do so. But two treatises were exceptions. One was by Hasumi,<sup>8)</sup> who not only emphasized the importance of the ability to think and to judge, but also reported on the practice of his actual lessons. Although he did not actually propose a concrete educational framework for judgment, his report might contain hints for developing one. The other treatise was by Kusumi,<sup>9)</sup> who, because he is one of the authors, shares recognition of the need for and proposed a basis for a framework of four items:

- 1) Organizing concrete alternatives to judge between
- 2) Organizing perspectives or judging alternatives
- 3) Judging from each perspective
- 4) Comprehensive judgment

His proposal was a prototype of the educational framework for judgment that we employ here.

As explained, previous discussion about designing an educational framework for judgment is extremely limited. At least within the range of this treatise’s review, no such framework has been established.

### 3. PROPOSAL OF EDUCATIONAL FRAMEWORK FOR JUDGMENT

Based on Kusumi’s proposal,<sup>10)</sup> we propose the following educational framework for judgment in general:

- STEP 1: Designing alternatives to judge between/among
- STEP 2: Listing potential perspectives for judging alternatives
- STEP 3: Organizing and categorizing potential perspectives into a minimum amount of perspectives
- STEP 4: Judging (selecting an alternative) from each perspective
- STEP 5: Comprehensive judging (selecting an alternative)

Concerning STEP 1, the simplest case has only two alternatives, for instance, YES or NO. But alternatives can number more than two, and the more the alternatives, the more difficult is the judgment. Therefore, to judge realistically, including only selected, feasible alternatives is best because this process cannot have a “right answer.” Rather than a science, this process is an art.

In STEP 2, to understand the whole picture, one should first list all potential perspectives. Then, in STEP 3, having a minimum amount of perspectives is important for the same reason as in STEP 1. Thus, to reduce the number of potential perspectives from STEP 2, one should organize and categorize similar

perspectives, uniting them as much as possible. Perspectives of little importance should be omitted. Again, such a process is like art. For objectivity, one should discuss with others, although this step has no single right answer either.

In STEP 4, what one should do is simple. Having a limited amount of alternatives and perspectives, from each perspective, one should select an alternative, independent from other perspectives. Next, one continues to select an alternative from each perspective. Finally, a list of judgments, one from each perspective, emerges.

In STEP 5, one judges comprehensively. If all perspectives have the same weightage, a simple arithmetic sum of each judgment in STEP 4 may lead to comprehensive judgment. Usually, however, each perspective has a different weight, according to its nature. Thus, one considers the weight of each perspective. If qualitatively considering such weight is difficult, paired comparisons can be applied to reach comprehensive judgment quantitatively.

With these five steps, students can make decisions systematically. The next section presents a concrete sample, and the succeeding section examines its relevance and effectiveness.

#### 4. OUTLINE OF A CONCRETE SAMPLE EDUCATIONAL FRAMEWORK FOR JUDGMENT: JUDGING THE NECESSITY OF NUCLEAR POWER

A generally proposed educational framework for judgment can be used in different ways. For actual practice, however, having a relatively more concrete system or teaching materials would be best. We developed such a sample system, employing the theme of judging the necessity of nuclear power in Japan. Kusumi then discussed the system's explanation and evaluated it.<sup>11)</sup> Following is a description of the system's outline and a meta-explanation of the system in general.

First, in STEP 1 we asked whether we need nuclear power in Japan or not, using only two alternatives and omitting minor differences. One of the alternatives is "YES." This alternative supports the usage of nuclear power in the long run and includes all views in favor of nuclear energy. "No" is the other alternative that is in favor of opposing long-term usage of nuclear power and includes all views opposed to nuclear energy.

First, one of the current authors undertook STEP 2. Next, through many workshops with citizens, lessons with students, and brainstorming with co-researchers, the author listed perspectives.

STEP 3 was undertaken in the same way as STEP 2. Many potential perspectives were organized and categorized into only 12, but, notably, these 12 were the thoroughly organized and itemized outcome of STEP 3. Later, however, three perspectives were excluded because we recognized that, logically, those three could be reorganized into the other nine, even though the three are generally regarded as important and independent perspectives. Conducting this process was important to show the transparency of perspective categorization because we have no way to itemize independent alternatives perfectly. In a sense, students should undertake STEP 3 by themselves in case practitioners value this

step more. On the other hand, some cases might prefer to employ an easy-to-use system, and STEP 3 can be undertaken differently, depending on such needs.

Once alternatives are selected and perspectives for judgment are established, undertaking STEP 4 is generally simple. In the necessity-of-nuclear-power issue, each perspective is complicated by physical, economic, and political aspects. Thus, one current author prepared a brief, but comprehensive explanation of two to four pages for each perspective, along with a YES/NO chart. As shown in Fig. 1, a YES/NO chart directs one to either YES or NO through answers to certain questions. The idea of supplying some explanatory pages with a YES/NO chart was to help the students to judge more easily. Designing and supplying good teaching material through ingenuity or innovation might lead to easier judgment.

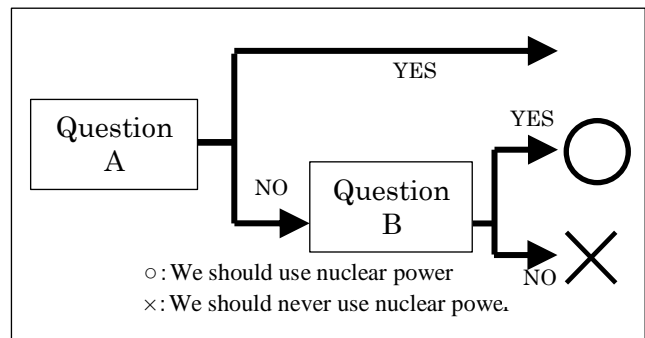


Fig. 1. Image of a YES/NO Flowchart

STEP 5 requires comprehensive judgment; the judgment should be based on each previous judgment of each perspective as in STEP 4. However, STEP 4 is not as simple as just arithmetically adding all judgments. Even if one has more YES than NO answers, one might conclude NO as a comprehensive judgment, and vice versa. YES or NO from each perspective has its own weight, and judging comprehensively by considering each perspective's weight is important. The sample teaching material was made to provide first a qualitative system in order to implement STEP 5. Concretely, we created a system to guide students to list YES and NO answers and to record reasons for those answers. Then, comprehensive judgment is promoted. One author implemented and practiced this sample framework in many different classrooms. Always, more than 90% of students could make comprehensive judgments.

This qualitative system is, however, rather coarse. Therefore, we constructed an auxiliary quantitative comprehensive judgment system from the stance that teaching materials are important, especially for students who have difficulty in judging using the qualitative comprehensive judgment using STEP 1 through 5. This auxiliary system is based on "paired comparison" that asks which of two opposing elements (in this case, perspectives) is more important and allows students to judge quantitatively. In the nuclear power sample, first, the number of ○s and ×s have to be counted. Then, students judge between an ○

perspective and an × perspective, choosing one rating on a 5-point scale (-2, -1, 0, +1, +2), as follows:<sup>12)</sup>

- 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.

In general, such subjective judgments inevitably have bias, but by repeating paired comparisons between many pairs of elements, the bias can be reduced to a negligible level. Paired comparisons are known as part of the Analytical Hierarchy Process (AHP) and are employed by Baracho et al.,<sup>13)</sup> for instance, as a means of decision-making in the conference of the International Institute of Informatics and Systemics.

In determination of simple matters, using pair comparisons is simply troublesome. In contrast, for esoteric problems, this method is effective.

In the teaching materials we developed, more than 90% of students did not need this quantitative system, but preparing such an auxiliary quantitative system would likely be helpful in some cases.

### 5. EVALUATION OF THE USEFULNESS AND APPROPRIATENESS OF THE SYSTEM

The usefulness and appropriateness of the educational framework for judgment were evaluated. A questionnaire targeting 103 Chukyo University students showed the framework’s usefulness. Although 45% of respondents did not explicitly mention usefulness, only 1% were negative. Similarly, nearly 50% of respondents appreciated the framework’s appropriateness, while only 5% denied its appropriateness. Fig. 2 illustrates the questionnaire’s results.

Results of a similar questionnaire targeting the same students about the usefulness and appropriateness of the system itself, concerning the necessity of nuclear power, showed higher figures both for usefulness and appropriateness.<sup>14)</sup> Students’ vague image of the general educational framework for judgment might have drawn somewhat lower appreciation.

The quantitative assessment system’s usefulness and appropriateness were not well evaluated because only a few students needed to use the system. Therefore, respondents were limited only to twelve. For both usefulness and appropriateness, five respondents were positive, and seven were indifferent.

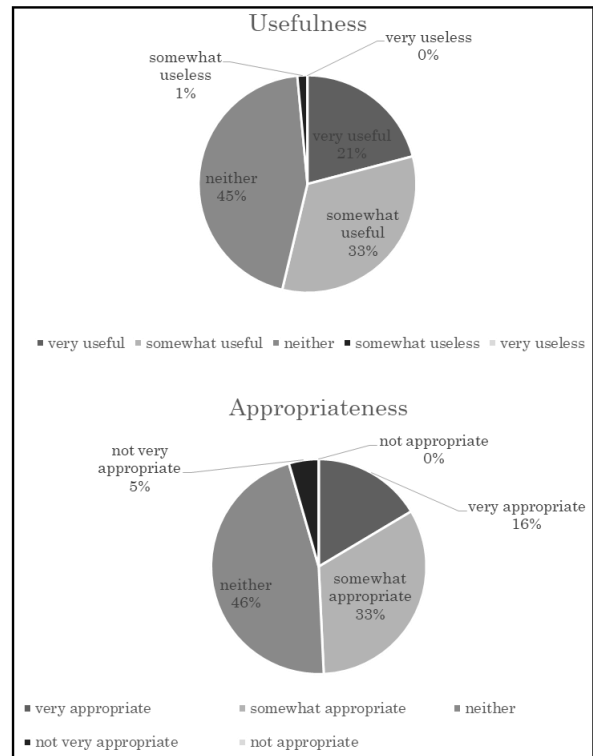


Fig. 2. Questionnaire results

### 6. SUMMARY

We developed an educational framework for judgment in environmental education, employing the concrete sample of judging the necessity of using nuclear power in Japan. Within this five-step framework, the core notion is that a comprehensive judgment is composed of smaller-scale judgments, each of which is organized so that it can be made easily by designation of alternatives and itemized perspectives. In addition, the concrete sample is designed and shown to students in order to help them determine whether they should be for or against ongoing use of nuclear power. In cases difficult for students to judge, a quantitative system is supplied, and this system can be applied to any other subject.

Using a questionnaire, we evaluated and confirmed the educational framework’s usefulness and appropriateness. Other samples should be created to confirm those results. Moreover, other educational frameworks should be proposed for developing students’ ability to judge. Development of concrete educational frameworks for general critical thinking is crucial as well.

### ACKNOWLEDGMENTS

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