The Effect of Bilateral Risk Communication on the Web with Multilayered Ethical Contents on High-Level Radioactive Waste Disposal

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Abstract

The general public in Japan remains unfamiliar with the issues of high level radioactive waste (HLW) geological disposal although the disposal policy has been clearly stated. If Japan is to be successful in implementing HLW disposal then its society must gain an understanding of the task and it is essential that a positive attitude toward this effort develops. The purpose of this research was to develop a HLW risk communication model on the Web that would result in introspection and instill problem awareness, involvement, and a sense of responsibility in those who visited the website. In order to achieve this purpose, a new model which presented HLW topics with a form of dialog based on Norm Activation Theory with environmental ethics as meta-cognition has been developed. To confirm the effect of this model, a psychological experiment was conducted. It could be seen that subjects who browsed this model became interested in an unfamiliar topic (HLW), and posted their own opinions actively on the Bulletin Board System (BBS), compared to those with conventional knowledge-based content. Therefore, it was confirmed that the dialog content was effective in promoting introspection and a positive attitude, leading to pro-social behaviour.

1 Introduction

In the countries which are developing nuclear power, it is essential that high-level radioactive wastes (HLW) be disposed within national borders, as dictated by the Basel Convention (1989) and London Dumping Convention (1972). Realizing that this disposal effort is one of the most important and political tasks, Japan favors the geological disposal of waste several hundred meters deep in stable rock formations. The Nuclear Waste Management of Japan (NUMO) was established in 2000 as part of the Specified Radioactive Waste Final Disposal Act to take an initiative in promoting the geological disposal of HLW in Japan. The length of storage for HLW is the 30 to 50 years that it takes for the decay heat and radioactivity to be sufficiently reduced so that the waste can be handled with relative ease and safety. Since then the NUMO has solicited public opinion for Preliminary Investigation Areas (PIAs) for a disposal facility as the first step. It is recognized that societal consensus on acceptable disposal practices will be very difficult to attain in a short period of time.

However, the general public still remains unfamiliar with this issue although the HLW disposal policy in Japan has been clearly stated. Therefore, much more effort is required to inform the public about HLW disposal so that society has a better understanding and acceptance of the task of implementing HLW disposal.

The goal of our study is to develop an effective risk communication model that will lead to introspection of an individual’s own thought, fostering a positive attitude toward pro-social behavior surrounding HLW disposal on a Web system. In this paper, the design concept applied to the Web contents is introduced in 2, the results and observation of the experiment to confirm its effect is in 3, and then the conclusion in 4.

2 Design of the Communication Model

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The communication model is aimed to allow the public to think about HLW disposal issues on their own, exchange their concerns with risks, recognize the responsibility for the consequences, and reach a stage of compliance with pro-social behaviour. To this end, a stepwise development which includes knowledge base contents, introspective contents, and finally interactive discussion would be helpful and constructive. The dialog-mode contents model developed through this research was part of the second step of the model. It was confirmed to be more effective than the first-step model in instilling awareness of the problems in the subjects for the psychological experiment and triggering their involvement and sense of responsibility.

In the following section, the relationship between HLW disposal and environmental ethics as meta-cognition played an important role by encouraging subjects to share their day-to-day concerns about these issues is described in 2.1. The dialog of the contents, which made use of the concept of Norm Activation Theory by Schwartz (1977) as the navigation path to pro-social behaviour, is described in 2.2.

2.1 Environmental Ethics as Meta-Cognition

Everybody is interested in environmental problems such as global warming. Damage due to serious disasters such as floods and typhoons at various places on the earth have been seen on TV. Moreover, the public at large generally accepts a growing awareness of the ecological seriousness of global warming consequences, and the issues of energy conservation and appropriate recycling of waste resources. In this sense, environmental ethics has become a common standard of value among the general public. HLW issues, in fact, have a close relationship with these themes.

Discussion of the social dilemma of HLW issues also was very similar to that of global warming issues since it is very difficult to experience their immediate effects on a local basis. Individual suggestions to deal with these problems seem quite limited, yet cooperation from society as a whole is necessary for a solution. This has suggested environmental ethics, as a social norm would play an important role in public communication of these issues.

Thus, by bringing environmental ethics into the “risk communication model,” participants on the Website with a common background would be able to discuss the HLW issues.

2.2 Dialog Content Aimed at Pro-Social Behaviour

When designing a website, it was necessary to provide a navigation to control users behaviour. Since the users were supposed to be the general public, the contents required easiness to understand and attractiveness to lead to introspection.

Therefore, the contents were presented in a dialog fashion in order for the subject to form his/her own attitude through the pseudo-process of thinking. In addition the previous psychological research reported that pro and con information that presented two opposing views was effective to gain subjects’ trust. This assumed they were at a certain knowledge level compared to a one-sided information presentation with web-links for references connected to both anti and pro nuclear organizations. The context of the dialog was also composed of differing viewpoints.

Moreover, according to Schwartz’s norm activation theory, five psychological steps were introduced into the context of the dialog. These steps were as the follows:

1) Recognizing how important the issue was (perception of problems)
2) Overcoming the urge to think that the subject's participation is of no significance (subjective norm)
3) Recognizing the issue as one's own responsibility (awareness of consequences)
4) Deciding to bear the burden of actual behaviour (recognition of external costs)
5) Pro-Social behaviour (recognition of action)

The final goal for this navigation is to persuade the subjects to publicly join the decision-making process for HLW geological disposal. The web model created through this study validates the effect by simulating the subject joining the BBS to post his/her opinions. The example of the dialog-mode contents which was designed based on the policies mentioned above and the explanation-mode contents (conventional knowledge-based contents) are shown in Figures 1 and 2.
In order to evaluate the effectiveness of the dialog-mode contents which were designed and constructed to promote introspection and thereby to activate pro-social behaviour, a control experiment was conducted, comparing the results of the explanation-mode contents which have the same quantity of information as the dialog-mode contents.

In this experiment, subjects were divided into two groups; namely an explanation-mode group to read the explanation-mode contents and post their opinions on the BBS, and a dialog-mode group to read the dialog-mode contents which were created through this research, and then post their opinions on the BBS. Log data for each website was collected. Also, questionnaires were given before and after the experiment, to measure the changes of

3 Evaluating the Dialog-mode Model

Figure 1: Basic design and characteristics of the dialog-mode contents

Figure 2: Basic design and characteristics of the explanation-mode contents
the participants’ attitudes for social cooperation. The method of the experiment is discussed in 3.1 and the results of the experiment are found in 3.2.

3.1 Method of the Experiment

Fifty university students and working people (25 males and 25 females in total) with no specialized knowledge of nuclear power generation or HLW geological disposal were recruited for a psychological experiment. The experiment lasted approximately 90 minutes, including time to watch the website contents and take part in the BBS discussion. The subjects for this experiment were asked to fill in questionnaire sheets before and after the experiment. Detailed experimental phases are described as the following.

Phase 1
Using a face sheet survey ahead of time, the subjects were divided into two groups, namely the dialog-mode group and the explanation-mode group, ensuring even distribution of participants in each group in terms of experience with e-mail and BBS posting. Each group consisted of four to six people. One dialog-mode group and one explanation-mode group were asked to access the same BBS web-address.

Phase 2
Questionnaire surveys on the subjects were conducted two times. Prior to the experiment, the first questionnaire was given to determine the participants’ awareness of nuclear power generation, knowledge and awareness of HLW, and their opinions regarding HLW geological disposal. The second questionnaire was given just after the experiment to determine their awareness of pro-social behaviour and their impression of the website’s content included the contents of the first questionnaires. Respondents were asked about their feeling towards the questions which they rated on a seven-point scale ranging from 1 = totally disagree to 7 = totally agree.

Phase 3
Using the Internet web, one half of the subjects for this experiment were asked to watch the dialog-mode contents while the other half watched the explanation-mode contents. Then they were asked to join the discussion on the BBS. The participants from the two groups consisted of 10 on each BBS side; (5 from a dialog-mode group and 5 from an explanation-mode group). Log data such as number of opinions and responses, time for reference, the amount of words written on the board and other data were collected.

3.2 Results of the Experiment

3.2.1 Opinions Posted on the BBS

The total number of posted opinions on the BBS by 50 subjects amounted to 129, 66 of which were written by the dialog-mode groups, and 63 by the explanation-mode groups. No significant difference between the dialog-mode group and the explanation-mode group could be found (F=0.03, p>0.05). The number of the leading opinions, which were registered on a series of opinions regarding one topic of discussion, did not significantly differ between them (F=1.94, p>0.05).

On the other hand, 59 responses of the 63 explanation-mode group opinions were received from members on the BBS, as compared to only 40 responses for the 66 dialog-mode group opinions. The results showed a significant difference between the two groups (F=4.99, p<0.05).

Also, the number of responses for the leading opinion by the dialog-mode group was 54, while the explanation-mode group had 45 postings. In particular the number of challenging responses from the dialog-mode group was 13, while there were only 7 without objection from the explanation-mode group. It was found that the dialog mode group tended to respond more negatively. The results of BBS listed in this section are shown in Table 1.

These results suggest that the dialog-mode contents helped subjects organize arguments so that those who experienced pseudo-process discussion in the dialog-mode groups could easily predict opposite opinions. Conversely, those who experienced the explanation-mode contents would tend to accept information presented in the contents and could easily organize their opinions without introspection. Thus, subjects in the dialog mode group tended to be more restrictive regarding initiation of discussion, but were more active in posting second or third
opinions. In contrast, subjects in the explanation-mode group tended to initiate discussion, but tended not to pursue the theme in depth.

### 3.2.2 Recognition of Geological Disposal

In order to confirm the increase of recognition of geological disposal among the subjects, analysis of variance was performed based on the answers of the questionnaires conducted before and after the experiment. "Interest in geological disposal" for the dialog-mode group increased significantly after the experiment while it did not increase for the explanation-mode group. [Significance was determined with Scheffe's comparative test ($x^2 = 8.70, p<0.05$).]

Conversely, “sense of safety regarding geological disposal” significantly rose after the experiment for the explanation-mode group, but it did not rise for the dialog-mode group. [Significance was determined with Scheffe's multiple comparison test ($F=5.53, p<0.05$).]

Figure 3 shows that the dialog-mode contents could be more effective in gaining interest in geological disposal than the explanation-mode approach. Figure 4 shows that the “explanation-mode” contents could be more effective in subjects accepting the safety of geological disposal compared to the dialog-mode.

Furthermore, it was also tested whether the dialog-mode content could be effective in reducing NIMBY (Not In My Back Yard) mentality. “NIMBY-I *" and “NIMBY-II **" were evaluated by composing variables. The statistical difference between the dialog-mode groups and the explanation-mode groups was determined by two-sided Student’s $t$ test. The feeling of NIMBY in the dialog-mode group increased more than that in the explanation-mode group. [“NIMBY-I” scores for the dialog-mode group decreased significantly more than that for the explanation-mode group after the experiment ($t=2.37, p<0.05$). A similar trend was also observed for the NIMBY-II ($t=1.87, p < 0.10$).]

* NIMBY-I is "admitting necessity but rejecting creation of new disposal facilities"

** NIMBY-II is "admitting necessity but rejecting creation of disposal facilities at the neighbouring town"

These results suggested that the explanation-mode contents without the inclusion of both modes of risk information seemed to be more effective in giving a sense of safety at the initial stage of persuasion than the dialog-mode contents. Conversely, the dialog-mode contents had more effect in increasing interest and concern in the HLW issues than did the explanation-mode contents.

The level of the NIMBY effect increased with the dialog mode content though "recognition of the necessity of geological disposal" was increased. This could confirm psychological survey results which showed that in the stage of knowledge acquisition for the general public, it was better to persuade with only one view rather than presenting both sides (Aronson, 1992).

However, considering the increase of subjects’ introspection with the dialog-mode contents, the dialog-mode contents could be much more useful to promote pro-social behaviour.

<table>
<thead>
<tr>
<th></th>
<th>dialog-mode</th>
<th>explanation-mode</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of the leading opinions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>female</td>
<td>10</td>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>sub total</td>
<td>12</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>Number of voices to the leading opinion</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>opposed</td>
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<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Q&amp;A</td>
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<td>4</td>
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</tr>
<tr>
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<td>33</td>
<td>71</td>
</tr>
<tr>
<td>sub total</td>
<td>54</td>
<td>45</td>
<td>99</td>
</tr>
</tbody>
</table>

**Table 1:** Postings on the BBS

<table>
<thead>
<tr>
<th></th>
<th>dialog-mode</th>
<th>explanation-mode</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of opinions</td>
<td>66</td>
<td>63</td>
<td>129</td>
</tr>
</tbody>
</table>
3.2.3 Increase in Norm Activation

The increase in the subjects’ norm activation awareness for promoting pro-social behaviour was examined by using the questionnaire survey results.

Norm activation awareness in the dialog mode groups was observed at the high level score from “recognition of importance (first step),” “perception of subjective norm (second step),” to “awareness of consequences (third step)” and decreased at the “recognition of external cost (fourth step).” [The difference of the stepwise score was determined based on Kruskal Wallis test and Scheffe’s comparison test. ($x^2=10.11$, $p <0.05$)]

Conversely, norm activation awareness in the explanation-mode groups did not have a significant trend for each step ($x^2=4.40$, $p >0.05$). The differences between the dialog-mode and the explanation-mode for each step are indicated in Figure 5.

There was a significant difference between the dialog-mode groups and the explanation-mode groups. These results suggested that the dialog-mode contents could function more effectively in terms of norm activation to a certain extent than the explanation-mode contents. Pseudo-experience was surely activated by reading objective dialogs between two people in the dialog-mode contents, thus, awareness for self-involvement was more easily promoted.

However, attention should be given to the fourth step decreases. The reason for the decrease could be ascribed to a lack of effective measurement presentation. In order to overcome “recognition of external cost or burden”, a much more concrete image of utilization in regard to HLW disposal would be required in the contents.

![Figure 3: Comparison between before and after the experiment for “Interest in geological disposal”](image)

![Figure 4: Comparison between before and after the experiment for “Sense of Safety”](image)

![Figure 5: Step-wise norm activation](image)
4 Conclusion

In order to gain a better understanding and acceptance by society of the task of implementing HLW disposal, our study was aimed to develop an effective risk communication model on a Web system that would lead to introspection, instilling an awareness of the problem, nurturing a sense of responsibility, and thereby fostering a positive attitude toward pro-social behavior surrounding HLW disposal. Therefore the ethical dialog contents based on Schwartz’s norm activation theory was developed since it was anticipated that participants on the Website with common backgrounds would be able to share information about HLW issues.

To verify the effect of the dialog-mode contents, we conducted this experiment. By browsing the website which was composed of dialog contents with external links and BBS, the participants of the experiment increased their interest in the topic with which they were not familiar, and actively posted their opinions in this matter on the BBS. It was found that the dialog-mode contents were significantly more effective than the explanation-mode contents (knowledge-based content) in promoting the kind of introspection that brought people into a greater awareness of the problems and sense of responsibility for those problems. Thus the dialog-mode contents will play an important role in increasing the public’s motivation to take part in pro-social behaviour, though it is necessary to develop effective contents which activate the motivation of willingness to accept external costs.

In the future, we are planning to prepare a website with a clear-cut image for utilizing the HLW resources that incorporates its structure. The second phase of the model development will be achieved when people show their approval of deep underground geological HLW disposal on the BBS. This Risk Communication Model on the Web will allow the public to communicate with both concerned citizens and experts in the nuclear industry more effectively and constructively.

Acknowledgments

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