

Title: Learner-centered Communication on Nuclear Risk: Public Participation and Transparency through a Gaming/simulation Approach

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Abstract: This paper discusses our project under a three-year research contract with the Japanese Government to gain public acceptance of nuclear facilities in local communities by improving risk communication through a gaming/simulation approach. Evidence suggests that nuclear public education programs are not communicating the critical safety information necessary to eliminate anxiety of people living around nuclear facilities. To most utilities and government, risk communication means persuasion. Based on the findings of our visits to several authorities, municipalities and nuclear facilities in Japan, Sweden, Norway and USA, we built a causal-loop model regarding nuclear risk communication. According to our model, the root cause of the problem is lack of trust, and the leverages are public participation and transparency which can create learner-centered two-way communication environment. "THE TREASURE HUNTING", one of our five gaming/simulations for this project, is intended to create such an environment so that local residents may deepen understanding of nuclear risk and build up a mutual trust relationship with disaster prevention experts. After many internal test runs, we have run this exercise six times so far with the nuclear disaster prevention experts and the local residents near nuclear facilities in various parts of Japan. The results have been quite satisfactory.

Keywords: causal-loop model, gaming/simulation, learner-centered, nuclear risk communication, public participation, transparency.

1. Introduction

Despite a substantial effort to provide people living around nuclear facilities with a variety of risk information, evidence suggests that nuclear public education programs are not communicating the critical safety information that would be needed eliminate their anxiety.

For example, although emergency plans for protecting public health and safety in a nuclear plant accident are predicted on the assumption that people will follow instructions, most EPZ (emergency planning zone) residents say that they will make decisions in an emergency contrary to those recommended. Instead of waiting for official instructions in a nuclear plant emergency, a majority of EPZ residents are more likely to try to contact family members not at home, telephone for more information, or simply leave the area. They will take a first action contrary to the recommended response of turning on a radio or television for instructions. Those contrary actions could be extremely harmful to the public health and safety.

Gwin (1990) critiques risk communication programs and questions whether these programs have convinced residents close to nuclear power plants to follow instructions in an emergency. His study demonstrates that:

- Programs do not communicate critical safety information
- People living near plants will make decisions in an emergency contrary to those recommended
- Technical risk perception differs from lay risk perception.

The purposes of this paper are (1) to examine how risk information is communicated to the public near nuclear plants, (2) to build a causal-loop model on the issue, (3) to find the leverages to solve the problems, and (4) to discuss our gaming/simulations to support risk communication with local residents.

2. Analysis and modeling of the issue

2.1. Risk communication

To most utilities and government, risk communication means persuasion. However, trying to address risk controversies primarily with more science is, in fact, likely to exacerbate conflict. The risk communication should be defined as the “interactive process of exchange of information and opinions among individuals, groups, and institutions concerning a risk or potential risk to human health or the environment” (NRC, 1989).

Risk communication is a process by which scientific organizations both disseminate technical information and gather information about the opinions and concerns of nonscientific groups. The implication for those who communicate risk is that any form of successful risk communication must incorporate that “exchange of information and opinions” and the participation of the stakeholder groups from the beginning.

A contributing factor to the apparent failure of nuclear risk communication is the industry’s historic reluctance to raise issues it considers “negatives” about nuclear power for fear that these issues will somehow “delegitimize” the industry as a contributing force toward achieving societal goals of safety and security. To many of the manufacturers or managers of technologies that create risks, “risk communication” means persuading the public that the risk from a technology is small and should be ignored.

Risk is inherently subjective. Risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional and cultural factors.

Risk perception is influenced by the interplay of psychological, social and political factors. Members of the public and experts can disagree about risk because they define risk differently; have different worldviews, different affective experiences and reactions or different social status. Another reason why the public often rejects scientists’ risk assessments is lack of trust. Trust in risk management, like risk perception, has been found to correlate with gender, race, worldviews and affect (Slovic, 2000).

2.2. Causal loop model

In order to investigate present situation and find problems related to risk communication with local residents, we visited twelve municipalities, seven Offices of the Inspectors for Safety Management of Nuclear Installations, three nuclear power plants in Japan, and several competent authorities, municipalities, nuclear power facilities and researchers in Norway, Sweden and USA.

Based on the findings, we built a causal-loop model that shows the root cause of risk communication failure and the leverages to improve the situation. Leverage is where actions and changes can lead to significant, enduring improvements. Figure 1 is the current version of the model after many revisions based on the discussions with experts and stakeholders.

The model clarifies the following:

- Scientific safety and perceived safety are often quite different. Scientific literacy and public education are important, but they are not central to risk controversies. It is not safe until it is perceived as safe.
- Elimination of anxiety is only possible by improving ‘perceived safety’ by local people.
- Perceived safety by local people depends on trust.

2.3. Building up trust

Social relationships of all types, including risk management, rely heavily on trust. The limited effectiveness of risk communication efforts can be attributed to the lack of trust. If you trust the risk manager, communication is relatively easy. If trust is lacking, no form or process of communication will be satisfactory (Fessenden-Raden et al, 1987). Studies by risk perception experts demonstrate that people must trust the disseminator of information before they will accept that information

(Stenzel, 1987).

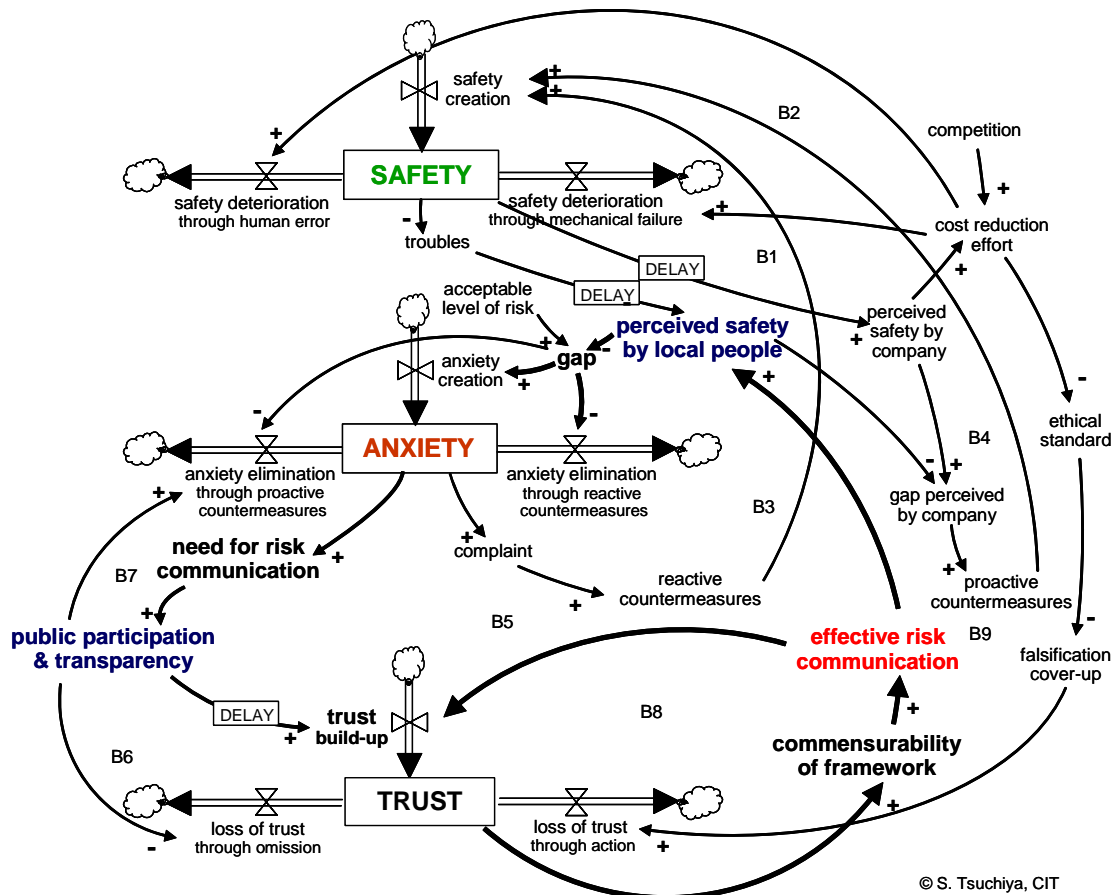


Figure 1: Risk Communication

Figure 1 shows that the apparent failure of nuclear risk communication is due to insufficient public participation and inadequate transparency.

2.3.1. Transparency

There is a sharp dichotomy between the experts and the public. Experts are seen as purveying risk assessments, characterized as objective, analytic, wise and rational. In contrast, the public is seen to rely on perceptions of risk that are subjective, often hypothetical, emotional, foolish and irrational. In addition, experts tend to believe that they should give to the public information that, in their opinion, is relevant to them, whereas the public want to know almost everything happened at nuclear facilities.

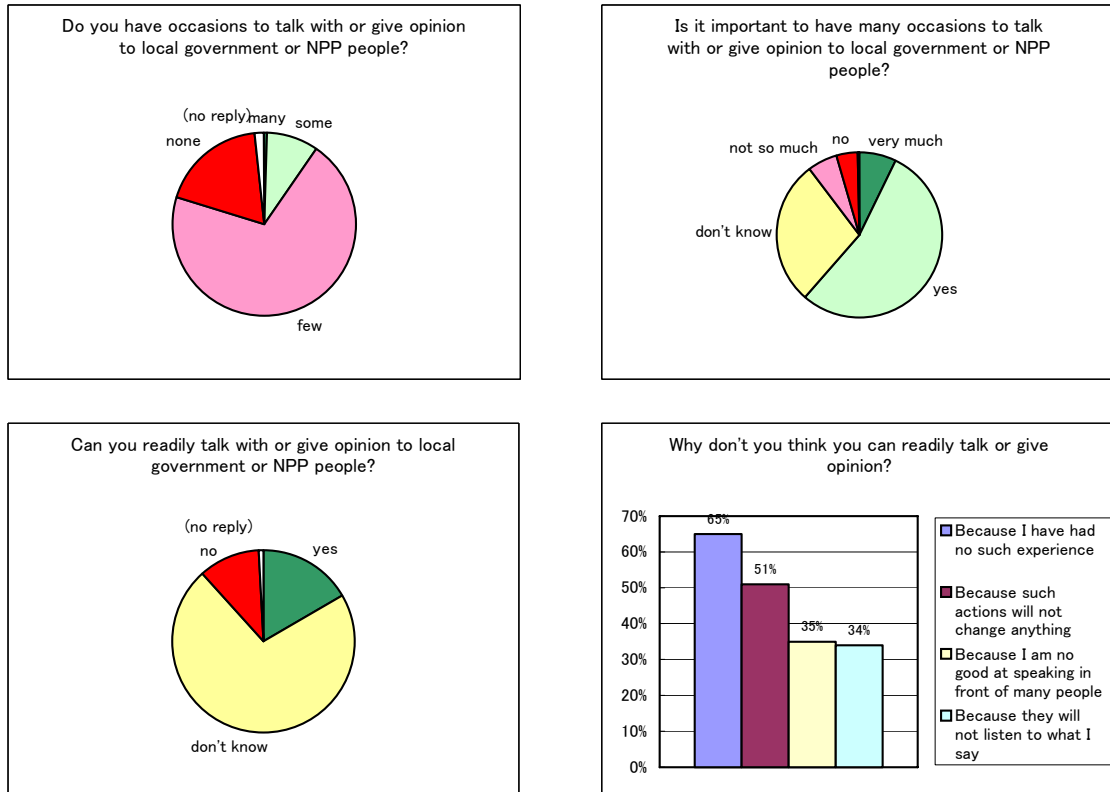
For decades, people were told by “experts” in government and industry that accidents at nuclear power plants were extremely unlikely. However, accidents did happen, and investigations revealed that the experts had been overconfident or simply wrong in their analysis of what could and could not happen at a nuclear power facility.

2.3.2. Public participation

Although nuclear experts have been trying very hard to communicate risk information to them, most local residents living near nuclear facilities are of the opinion that they have few occasions to talk with or give opinion to local government or nuclear power plant people.

Figure 2 shows the results of a questionnaire survey conducted in Japan by Central Research Institute of Electric Power Industry, in 2002. The samples were taken from the residents living in Tokai Village and its adjacent areas. The results prove a deficiency of two way communication

between nuclear experts and local residents. To the question “Do you have occasions to talk with or give opinion to local government officials or nuclear power plant people?” 19 percent replied none and 69 percent replied few. What is more important, 82 percent replied “No” or “Don’t know” to the question “Can you readily talk with or give opinion to local government officials or nuclear power plant people?” although most of them believed that it was important to have many occasions to do so.



Questionnaire survey conducted by Central Research Institute of Electric Power Industry, 2002
 Samples: Tokai Village 1,000, its adjacent areas 600, Responses: Tokai Village 703, its adjacent areas 4

Figure 2: Questionnaire survey to local residents

2.3.3. Leverage

From the above discussion, we argue that the leverage to build trust indispensable for perceived safety by local residents is risk communication with public participation and transparency.

3. A search for new methodology

According to our analysis, trust is indispensable to effective risk communication and that public participation and transparency are the key elements in building up trust. How, then we can realize public participation and transparency and build up trust?

In order to realize two-way risk communication by public participation and transparency, we need to transform interpretative frameworks through double-loop learning (Argyris, 1993). Based on the results of their recent research, the first author and his colleague claim that gaming/simulation can provide interactive learning environment and make double-loop learning possible (Tsuchiya, T. & Tsuchiya, S., 1999).

The most powerful learning comes from direct experience, but "learning by doing" only works so long as the feedback from actions is rapid and unambiguous (Senge, 1990). Learning by experience is difficult because, in the real world, there exist what Senge called the "dilemma of

learning from experience." The factors include:

- Learning horizon: Individuals and organizations have a “learning horizon,” a breadth of vision in time and space within which they assess the consequences of their actions. When our actions have consequences beyond our learning horizon, it becomes impossible to learn from direct experience.
- Scarcity of experience: History offers only meager samples of experience. Historical events are observed, and inferences about historical processes are formed, but the scarcity of historical events works against effective learning.
- Irreversibility: Actions cannot be reversed or taken back in real business. The risk and cost of trial and error is often too much for us to take. Therefore, even when the feedback is rapid and clear, most of us tend to avoid tests and therefore we miss opportunities to learn.
- Ambiguity: In addition, ambiguity in the real world makes it difficult to learn from experience.

The problem is in the intuitive-uncalibrated quadrant in Armstrong’s theory where scientific techniques are hardly effective. Gaming/simulation can provide an overview or gestalt mechanisms which illustrate the major dynamics of the linkages among the system components (Duke, 1974). Gaming-simulation is a simulation that works wholly or partly on the basis of players’ decisions. Gaming/simulation can overcome the dilemma by compressing time and space, providing risk-free environment for trial and error, and making shared experience possible. It can change actions of participants in their work and in their life through experiential learning in the simulated world (Tsuchiya, S. & Tsuchiya, T., 2000; Tsuchiya, S., 2003; Tsuchiya, S., 2005).

Figure 3 briefly describes process of a gaming/simulation. Gaming/simulation design starts with the clear expression of purpose and the careful definition of the intended audience. Then, a schematic (conceptual map) such as Figure 1 is developed before construction of the gaming/simulation. It is a graphic representation of a problem environment and has been found to be valuable tools in communicating complexity in gaming/simulation. A gaming/simulation can be designed at various level of abstraction. The higher the level of abstraction, the safer the participants feel to open up their minds and make trials and errors. Debriefing is systematic facilitator-controlled discussion at the conclusion of the exercise to evaluate the initial objectives (Duke & Geurts, 2004). The primary function of the debriefing is to refocus the participants on the issues and problems in the real world.

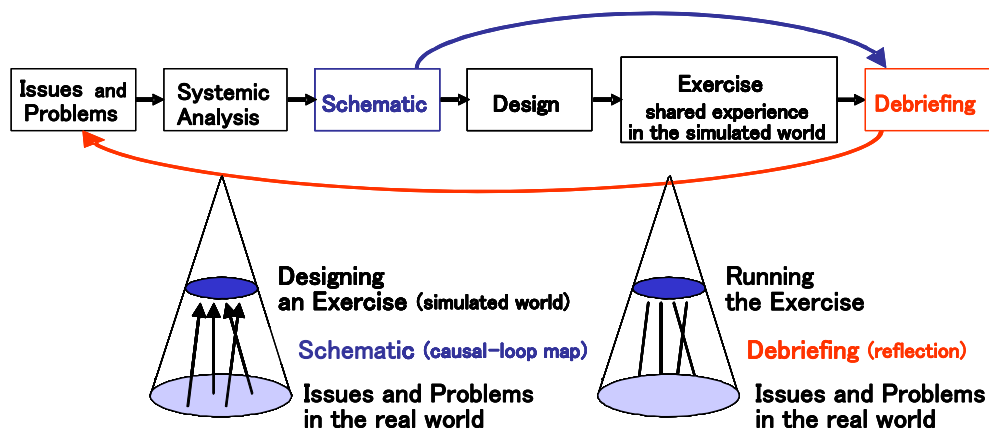


Fig. 3 Gaming/simulation

4. ‘THE TREASURE HUNTING’

In order to realize public participation and transparency to building up trust essential for effective risk communication, we have developed five policy exercises so far:

- ‘THE TREASURE HUNTING’: To provide the local residents with a space (environment) of two-way communication with nuclear disaster prevention experts

- ‘THE CHAIR OF THE PRESIDENCY’: To let NPP employees realize importance of good relationship with local community and change their behavior
- ‘HITTING MOLES’: To let nuclear experts appreciate difficulties in communication among people with different expertise and background
- ‘THE TRANSFER STUDENT’: To let nuclear experts understand difference of interpretative frameworks and change their action
- ‘THE SHEPHERDS IN ALM’: To let nuclear experts recognize the gap of risk perception between experts and the public

In this paper, we will deal with ‘THE TREASURE HUNTING’.

4.1. Background

Nuclear public education programs are not communicating the critical safety information that would be needed eliminate their anxiety. The typical examples of risk communication failures are:

- Contrary to the recommended actions, most emergency planning zone (EPZ) residents say that they will try to contact family members not at home, or simply leave the area.
- Most people still believe a nuclear power plant could blow up like a nuclear bomb.

Despite a substantial effort to provide them with a variety of risk information, most local residents living near nuclear facilities are of the opinion that they have few occasions to talk with or give opinion to local government of nuclear power plant people.

According to our analysis, trust is crucial for effective risk communication. Public participation and transparency realize learner-centered two way risk communication that is indispensable to building up trust.

4.2. Objective

The purpose of ‘THE TREASURE HUNTING’ is to minimize anxiety about nuclear plant accidents. Its Objective is to provide the local residents with a space (environment) of two-way communication with nuclear disaster prevention experts in order (1) to deepen understanding of nuclear risk and (2) to build up a relationship of mutual trust with the experts.

4.3. Structure

Figure 4 shows the outline of ‘THE TREASURE HUNTING’. One team consists of one leader and five to seven members. Several teams can play this exercise simultaneously under one facilitator. In addition, the monitor screens of the members are projected on the wall of the room so that even the observers can participate in the process. Therefore, the number of participants can be quite flexible.

The time required for the exercise itself is about 30 minutes and about one hour is allocated for debriefing and two-way communication.

The structure of ‘THE TREASURE HUNTING’ is as follows:

- Only the leader has a map of the whole area. It shows the location of the treasure for each member and the location of the gates which are moving clockwise. However, it does not show the location of the members.
- Each member has a detailed map (information) covering only a small area around him/her
- Any member can stop the moving gate by placing his/her car at the gate
- In the first cycle, (1) every member has the same speed, and (2) can find and get the next treasure as soon as he/she gets one. The prize money is given to the highest scorer.

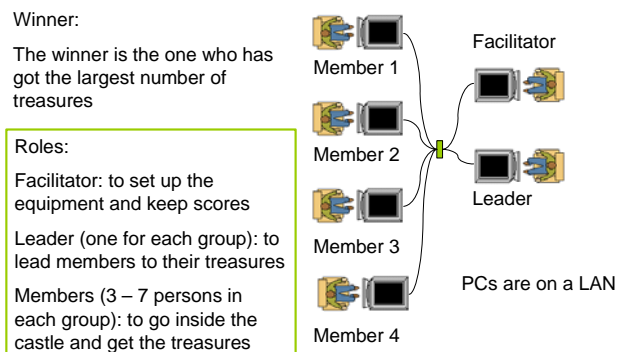


Figure 4 The outline of the exercise

- In the second cycle, however, (1) one of the members is much slower than the others, and (2) the next treasures do not appear until every member in the team gets his/her treasure.
- At the end of the exercise, (to the surprise of the participants) the facilitator gives a Championship prize to the member who stopped the gate and helped others get treasures.

In the debriefing, the facilitator shows two slides (Figure 5) and explains how the elements and mechanism in the exercise correspond to the issues in the real world. The most important points are:

- Hunting for a treasure selfishly corresponds to immediate evacuation without waiting for official instructions. Such an action could unnecessarily clog roadways and prevent others who were at risk from leaving the area.
- A low-speed member corresponds to a weak person unable to evacuate quickly in a nuclear accident. Just like in the exercise, it is very important for you and your neighbors to know in advance what kind of problem you and/or your neighbors have in order to evacuate orderly.
- Many people believe a nuclear power plant could blow up like a nuclear bomb. In reality, however, it is extremely unlikely that any radioactive particles are released to the atmosphere during a nuclear plant accident. Even when they should be released, the release will be many hours (for example 30 or 40 hours) after the accident in the plant.

Exercise and the real world (1)

Exercise and the real world (2)

Exercise and the real world (1)		Exercise and the real world (2)	
Exercise	Real World	Exercise	Real World
Leader	Evacuation/shelter leader	Since members have only limited information, it is hard for them to get treasures without united efforts	If everybody act separately based on his/her limited information, evacuation will become extremely difficult
Members	Residents near nuclear facility		
Leader has a map of the entire area, but members have only a small part of the map	Evacuation leader has whole information, but information of residents is limited	Due to time pressure, players tend to take independent action	Believing a nuclear facility can blow up, many residents are likely to take self-centered action
Information about location of treasures	Information about evacuation/shelter		
Routes to treasure are different	Evacuation routes are different	Speed of each player is different	Some residents have various kind of difficulties in evacuating rapidly
Location of the gates changes			
Some members do not follow the leader's instructions	Some residents take actions contrary to official instructions.	To get a high score, it is important to identify and help the low-speed member	In preparation for emergency, residents should share information about difficulties some of them may have
Nobody can get next treasure until all members get treasure	Selfish actions can prevent others at risk from evacuation		

Figure 5 Exercise and the real world

Then, the facilitator guides the participants to think together about nuclear accidents. He/she encourages the local residents to ask any questions and/or express their anxiety about nuclear accident and evacuation to the nuclear disaster prevention experts. In order to open up conversation, the facilitator gives the participants one of the following scenarios, and asks them what they would do in such a situation:

- The television is broadcasting a serious accident has happened at the nuclear power plant nearby. You are concerned about safety of your children at school.
What would you do?
- You are visiting your mother in hospital. An evacuation order was issued.
What would you do?
- You are going to take shelter in a concrete building as ordered. However, neighbors have got into a panic and are evacuating the area by car.
What would you do?
- You are living near a beautiful swimming beach. It is a nice summer day. You happen to see people on the beach are hurriedly evacuating the area by car. Turning on the television, you know a serious accident has happened at the nuclear power plant nearby.
What would you do?

4.4. Outcomes

After many in-house test runs, and a test run at the Annual Conference of International Simulation & Gaming association in Munich in 2004, we have run 'THE TREASURE HUNTING'

six times so far with the nuclear disaster prevention experts and the local residents near nuclear facilities in various parts of Japan.

At the end of 'THE TREASURE HUNTING', the participants are asked to answer a questionnaire. The questions are as follows:

- (1) In this exercise, were you able to communicate satisfactorily?
- (2) In this exercise, have you done any selfish behavior?
- (3) Did today's exercise give you an opportunity to think together about nuclear accident?
- (4) Through today's exercise, did you find answers to your questions about evacuation?
- (5) Through today's exercise, did you understand that a nuclear plant cannot explode like an atomic bomb?

4.4.1. Test run at Munich

We ran 'THE TREASURE HUNTING' with about fifteen participants of the ISAGA Annual Conference in Munich in 2004. Partly because of language problems, the exercise took more than one hour, more than twice as much time as planned. However, the evaluation by the participants was encouraging.

Figure 6 shows the results of the questionnaire after the gaming/simulation. Nine persons filled out the questionnaire. The questionnaire showed that most participants were quite satisfied with the exercise.



Figure 6 Questionnaire at ISAGA 2004

Some of the comments from the participants:

- ◆ “I believe cognition can reduce anxiety with sufficient knowledge about nuclear energy + reactor and simple game like today. It will move!”
- ◆ “This exercise was quite eye-opening for me. Language is very important especially in the case of emergency.”
- ◆ “Though 15 km/h (his speed) is extremely slow and get a lot of troubles, I enjoyed the other member’s support.”
- ◆ “This is interesting, simple, but has very deep meaning.”
- ◆ “Nice game. Overall speed could be faster.” (Based on this comment, we improved our exercise)
- ◆ “Too long. Bit confusing.” (Based on this comment, we improved our exercise)

4.4.2. ‘THE TREASURE HUNTING’ in Japan

We have run ‘THE TREASURE HUNTING’ six times so far with the nuclear disaster prevention experts and the local residents near nuclear facilities in various parts of Japan. The total number of the participants was about seventy.

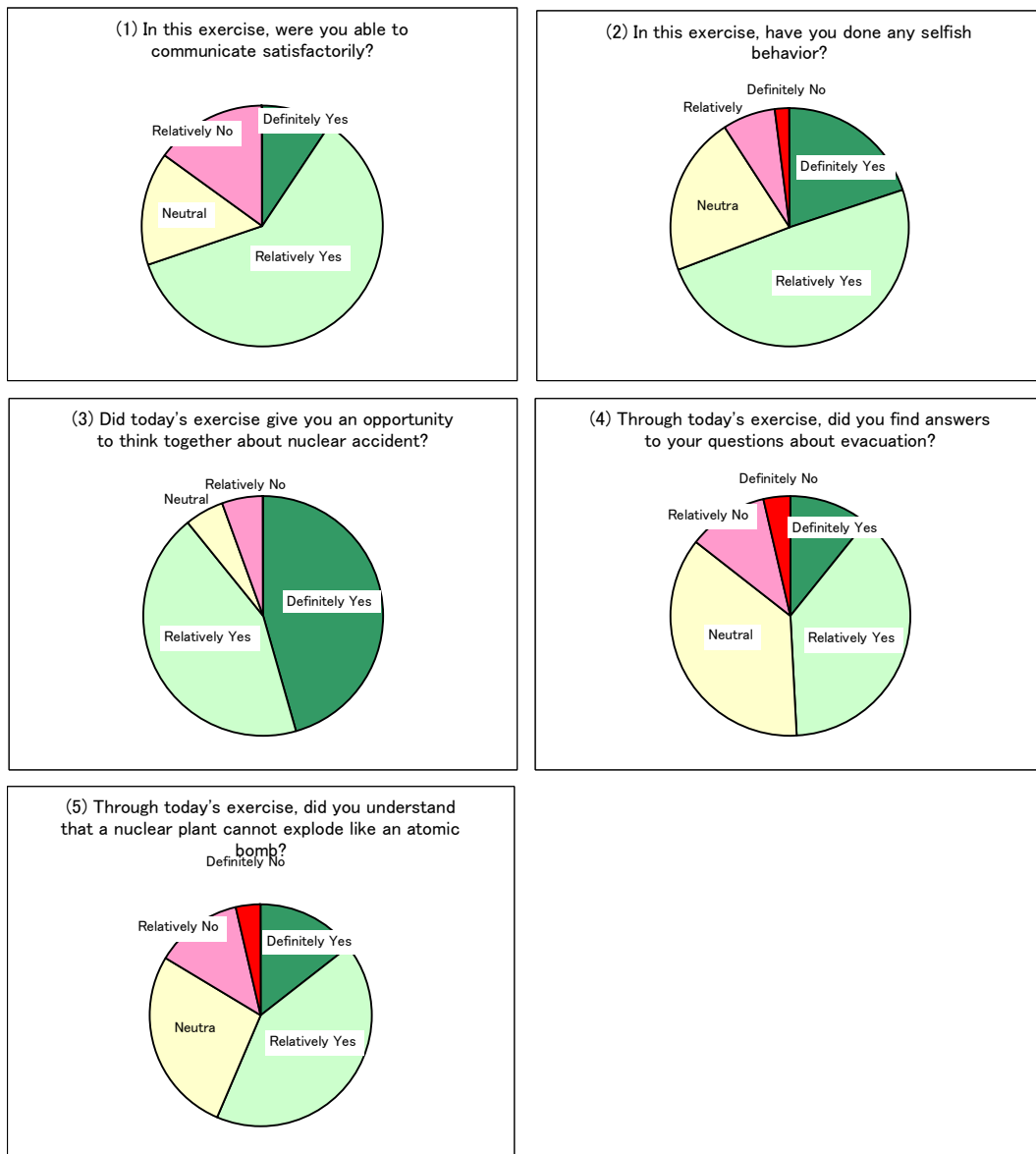


Figure 7 Questionnaires in Japan

Figure 7 shows the results of the questionnaires after the gaming/simulation. Fifty five participants filled out the questionnaire. A large majority, 89 percent, replied affirmatively to the most important question “Did today's exercise give you an opportunity to think together about nuclear accident?”

The comments we received from the participants were also very encouraging. Some evidence of success is evident in the following statements:

- ◆ “I think this exercise simulates very well the actual situations in the nuclear disaster prevention drills”
- ◆ “Participants will become interested in disaster prevention”
- ◆ “I have learned many things applicable to real situations through the exercise”
- ◆ “I was totally absorbed in the exercise and tried to get as many treasures as possible. But, when the Champion was announced and the reason was given, I regretted what I had done. I think I will remember this experience in a real disaster prevention situation”
- ◆ “I was waiting at the place where the next treasure would appear while the player Green was trying to stop the gate (to help the slow player Black. I am ashamed of myself.”
- ◆ “When I found my speed was much slower than the others, I became very reserved and did not dare to ask others for help. Now I understand the feeling of the elderly persons who were reluctant to go to the place of refuge in the Niigata Earthquake Disaster. It has been a good education for me.”

5. Conclusions

The effectuation of the Kyoto Protocol of 1997 has given a strategic importance to nuclear power as one of the clean energies lowering carbon dioxide emission. Our project has proved that a gaming/simulation can be an effective methodology to improve risk communication with people living near nuclear facilities and ease anxiety about safety by providing learner-centered communication environment. In the last year of this project, we will try to disseminate our gaming/simulations all over Japan and help nuclear power plants establish symbiotic relationship with local communities.

Acknowledgements

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