

Participatory Gaming Simulation as a Science Communicator: Toward a Communication Bridge between Specialists and Citizens

Reiko Hishiyama

Abstract— In this paper, we propose participatory gaming simulation that is used for science communication at the science café or science workshop. In general, there is a short talk by an invited speaker on a new or controversial science-related topic at the science café. And followed by a discussion, the audience gets the chance to ask any questions they may have. However, the audiences, who are ordinary citizens, don't have enough technical knowledge about the topics, so it is not easy to understand the complicated scientific issues. To help solve the problem, we have been working to develop participatory gaming simulation as educational communication tools. In this paper, we report the findings of an analysis of a science communication trial using participatory gaming simulation that deals with global warming.

Index Terms— participatory gaming simulation, science communication, citizenship education, interpreter, field communications.

I. INTRODUCTION

Science and technology today has penetrated deeply into all parts of daily life, and the potential impacts of advances in technology are becoming much more significant. On the other hand, some issues are raised by advances in technology. For example, people's reaction to the BSE (bovine spongiform encephalopathy) problem seems to be damaging the growing public trust in science. In order to eliminate these problems, which are based on scientific trust, we have been constantly focusing attention on communication concerning the relationship between *science and technology* and *society*.

Recently, science communication events such as "science cafés" or "science workshops" are becoming increasingly common as a way of communication between scientists and ordinary citizens; however, after starting communication there, we soon face a big gap between the perspective of the specialist and that of the citizen. It is not easy to narrow this gap. Because communication between scientists and citizens is brief and temporary, it is difficult for citizens to understand scientific issues in society.

In this paper, we propose melding science cafés or workshops, which is a method of science communication,

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Reiko Hishiyama is with the Waseda University, Graduate School of Creative Science and Engineering, Faculty of Science and Engineering, Okubo 3-4-1, Shinjuku-ku, Tokyo 169-8555, Japan, (e-mail: reiko@waseda.jp).

with participatory gaming simulation, which is a method in computer science. The aim of this study is to create a new communication space for science communication for understanding problems, sharing information about risk and benefit influences, and predicting the future.

The rest of the paper is organized as follows. Next, in section 2, we give a brief introduction to science communication. Section 3 discusses some hints on how we may achieve better performance in sharing scientific understanding and proposes our communication model, which melds the science communication with participatory gaming simulation. In section 4, we detail the experiments carried out with the results obtained. Finally, in section 5, we present our conclusions and future lines of work.

II. WHAT IS SCIENCE COMMUNICATION?

A. *The method of science communication*

Science communication has been conducted through technical briefings or public education as a way of holding public lectures and symposia in various regions. However, in the wake of debate about the BSE disaster, we are losing trust in science, which means that failure of communication is connected directly with science's failing credibility. In order to have the problem lead to a solution, swing-over from educational enlightenment science communication to interactive science communication is required for reviewing and determining the future course of science.

As a practice of interactive science communication, the number of science cafés or science workshops is increasing. Science cafés take place locally and voluntarily outside a research institution, for example, a café, bookstore, bar, shopping mall, forest, etc. Ordinary citizens and scientists share and discuss scientific issues that are closely relevant to the daily life of the people. Its aim is to gain an understanding of the issues and to share new perspectives about the topics with each other. Science cafes are expected to play an important role in narrowing the gap between scientists and citizens if science communication gives back some of the results to society. In other words, the results of science communication reflect the values of citizens and are used to design or define the new technologies that are coming.

B. *Issues of the science café*

Usually, communication in current science cafés consists essentially of two parts: presentation by a specialist and

subsequent discussion by citizens. However, there are the following problems:

- The specialist is unused to speaking about scientific issues and their backgrounds in plain words, so it is difficult for citizens to understand clearly.
- Ordinary citizens have various backgrounds and knowledge, different ages, careers, and academic fields including humanities and sciences. Although there is a possibility to elicit various opinions or ideas, it is not easy to create a common platform for discussion.
- If citizens do not understand the issue sufficiently, they are likely to remain in the role of questioner, while the specialist as speaker is likely to remain the respondent. In this case, it is hard to discuss interactively. It is difficult to compile the collective opinions of all. The point of discussion might sometimes be off track, and it is difficult for both scientists and citizens to digest information about the problem.

In order to solve these problems, we need a new communication method to enable interactive talk on a common platform and easy understanding of the topics or issues.

III. PROPOSAL OF A COMMUNICATION MODEL

A. *The aims of the proposal*

In this section, we propose introducing participatory gaming simulation in order to solve these problems. We need a new communication method to enable interactive talk on a common platform and easy understanding of the topics or issues. We integrate participatory gaming simulation into the science café or workshop as a communication interface, an interpreter, so to speak. Viewpoints of evaluation of communication effects using participatory gaming simulation are as follows:

- *Boosting explanation capability*
We handle the simulation by modeling the problem. This enables representation of the problem structure from a scientific perspective and its expression mechanism. This will help reveal the heart of the problematic intersection of scientific problems and social problems easily. This promotes understanding of the problem of technoscience that is placed within the technological and social context of science.
- *Sharing the situation of the problem, sharing common understanding*
The backgrounds of the ordinary citizens who attend science cafés or workshops are diverse, so it is difficult to find what can commonly be discussed. Participatory gaming simulation provides a common base for understanding and solving problems as scenarios. Simulation is an ideal way of bringing citizens into the situation of a problem.

- *Creation of interactive communication*

The citizens who come to science cafés or workshops meet new people in almost every case, so it is not easy to create opportunities for communication among them. Participatory simulation is expected to play an important role in sharing the structure of a problem, even though it is a pseudo-situation in computational virtual space, and it provides a chance to share the communication base to discuss the problem commonly faced. It enables creation of opportunities for communication among participants.

The aims of this paper are to integrate the method of science communication with participatory gaming simulation, and to realize a pluralistic communication space for both specialists and non-specialists to share problems, which cannot be provided just by traditional means such as science cafés or workshops.

- *B. Related work: using participatory gaming simulation as an interpreter*

In this section, we discuss evaluation of participatory gaming simulation as science communication. Participatory gaming simulation has been used for decision making[1,7], political planning[4], psychological analysis[2] and experiment for social or economic systems[3], educational training[5,6], etc. It is openly used in the area of informatics and social science. Some of those simulations use computers, and some do not. The former are simulations in which humans participate (sometimes using an avatar)[1-3], and the latter uses board games. We have been using participatory gaming simulation for citizenship education[5,6]. There are various types of simulation method.

Our idea in this paper is to accomplish science communication by using participatory gaming simulation. This has different roles and ways from the previous simulation method. Our participatory gaming simulation method is used for creating a common understanding base. Business simulations[1,4] are used for understanding the structure of business or for decision making, or evacuation simulations[7] are used for grasping behavior in a evacuation situation and analyzing it. On the other hand, using participatory gaming simulation in science communication aims to study scientific knowledge and *to examine the best relationship between "human society" and "science and engineering" in the future.*

In the case of management games or simulations for studying decision making in management activities, participants struggle for mastery of financial statements. This participatory gaming simulation requires the communication and collaboration of the participants who have various types of thinking, sometimes creating conflict among the participants. Therefore, its goals are pluralistic.

We consider participatory gaming simulation as an "interpreter" in this paper. An interpreter is a person who simply explains difficult scientific nature issues as a mediator between nature issues and human beings at eco-tours in forests or environmental learning schools. We consider participatory gaming simulation as an interpreter; therefore, participatory gaming simulation plays the role of shortening the distance between the specialist and the public,

encouraging participants' initiative, and sharing the problem structure.

C. Practical communication models

In this section, we explain the communication model in line with the practical process.

Figure 1 compares the "traditional science communication model" with the "participatory science communication model that integrates participatory simulation."

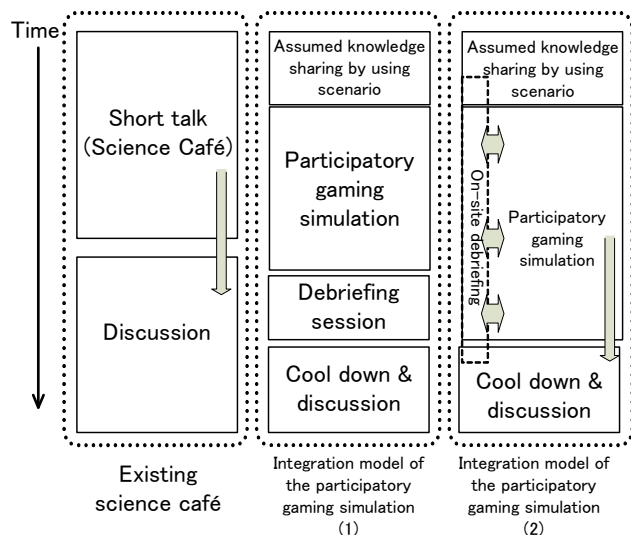


Fig 1. Traditional science communication model and participatory science communication model that integrates participatory gaming simulation

In Figure 1, the ordinate axis means the passage of time. The left-hand process means the previous science communication process. The middle is the model that integrates participatory gaming simulation, which places participatory gaming simulation before debriefing and explanation. Participatory gaming simulation gives the participants a basic understanding of scientific issues and their structure. This also gives the opportunity for discussion between the specialist and participants. The right-hand process is the completely integrated science café and participatory gaming simulation. This model means that participatory gaming simulation and comments by the specialist are concurrently processed. Interactive concurrent communication between the specialist and participants is expected to be promoted by conducting this new type of science communication.

Figure 2 shows the communication model in the science communication style. The black circle means the specialist and the white circle means the participants. The differences between the workshop style (middle in Figure.2) and collaboration style using the computer tool (right in Figure.2) is in intergroup communication. Simulation using computers provides not only interpersonal but also intergroup communication.

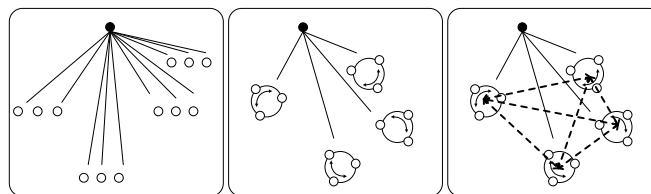


Fig 2. Communication model in the science communication space (Left: lecture room style, Middle: workshop style, Right: collaboration style using the computational tool)

IV. TRIAL OF THE NEW SCIENCE CAFÉ THAT INTEGRATES PARTICIPATORY GAMING SIMULATION

A. Summary of the trial

On the basis of the previous communication model, we conducted a science café that integrated participatory gaming simulation. In this section, we report the results and discuss the implications of the proposed method.

The participants in the trial were undergraduate students, and the topic was "the carbon cycling and global warming." We conducted science communication that integrates participatory gaming simulation. The experimental flow of science communication is as follows:

First, we handed out materials "Eco-experiment scenario: Let's protect our Earth from global warning!" before conducting the science café.

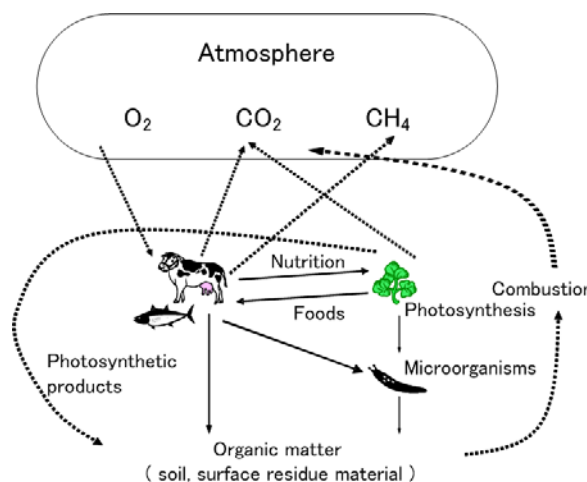


Fig 3. Structural drawing sample in handout

The role of the carbon cycling and photosynthetic microorganisms is described in the handout as an easy scenario. In order to understand the global warming problem scientifically, it is necessary to understand scientifically the mechanism of the carbon cycling or the energy utilization system. One of the illustrations in the scenario is shown as Figure 3. It is also important to understand the role of biomass energy resources in a recycling society with a low impact on the environment, as well as fossil fuels and the action of photosynthetic microorganisms. Participatory gaming simulation is used for formulating a common understanding regarding fundamental scientific assumptions. Therefore, we used an easy story and illustrations, and we planned to share minimal knowledge for considering the

global warning problem. The participants were able to ask and answer questions of the specialists who attended the science café after reading the scenario. After reading the scenario, we conducted participatory gaming simulation based on the handout. The participants played the role of government regulator, controlled the utilization volume of following three energies: fossil fuel, natural gas (biogas), and biomass energy. The participants planned to grow forest resources and rejuvenate the livestock industry, reconciling economic growth and environmental policies by collaborating with other participants. The participants went through the pseudo-situation of the global warning problem in the participatory simulation.

The situation of the participatory gaming simulation was commented on by the specialist. The backdrop to the simulation creates the opportunity for conversational interaction. Once every four years (=four game rounds), all participants attended a virtual world meeting to discuss the global warning problem. At this meeting, they recognized and shared the situations of their global warning, discussed problem solving interactively, made decisions regarding the targets for each country toward reducing greenhouse gasses, and issued joint statements. This simulated meeting was not only for sharing the problem and future target but also for creating the opportunity for conversational interaction, standardizing the experiment, and promoting the integration of each participant.

After the simulation, the facilitator conducted a brief debriefing. She facilitated the discussion about future global warning in the simulated world.

In the trial, the facilitator asked the participants to make “small tetrahedral eco-dice (Figure 7).” They wrote “selected actions to stop global warning” on each face of the dice to decide on workable actions in everyday life. This gave the participants time to cool down after discussing a serious problem.

B. Result of the trial

Participatory gaming simulation is conducted round by round on computers directly connected to the Internet. The simulation program can be controlled by interfacing a web page with the Perl & CGI server program that runs on the web server. It sends the participants feedback on the situation data of global warning (Figure 4).

Figure 5 shows the transitional changes in the simulated global warning on the earth at the trial. The first round data are taken as the criterion. This shows the change as a corollary of all participants’ activities on the simulated earth. The details of the result are as follows: In the early simulation rounds, global warming was appearing because of the positive use of the energies. The simulated global warming conference was held two times; after the 4th round and after the 8th round. In the conference held after the 4th round, they reached a deal on a joint statement about the greenhouse gas emission target. After that, each participant made a reduction target and cooperated with each other. Therefore, the gas decreased after the 5th round; however, they faced a heavy slump in economic activities. In the meeting held after the 5th round, they reached a deal on a joint statement about the greenhouse gas emission target. However, it was a decision

in which each country considered achievement of an economic goal. As a result, the level of warning gas fell. In the course of the simulation, they discussed the reduction of methane gas, which has a high greenhouse impact. They also made a prediction about the future of the greenhouse gas effect under rejuvenation of the livestock industry. One participant analyzed the data of the simulation using MS-Excel. Active data analysis by the participants seemed to help in understanding the problem’s structure and relationship between economic activities and greenhouse gas effects.

After the participatory simulation, the specialists explained not only the role of fossil fuel energy and biofuel but also the role of photosynthetic microorganisms. In this explanation, the specialist introduced the fact that photosynthetic microorganisms with plants who immobilize the CO₂ cycle have the function of heat insulation, and specialists believe that analyzing this role of microorganisms would help prevent global warming.

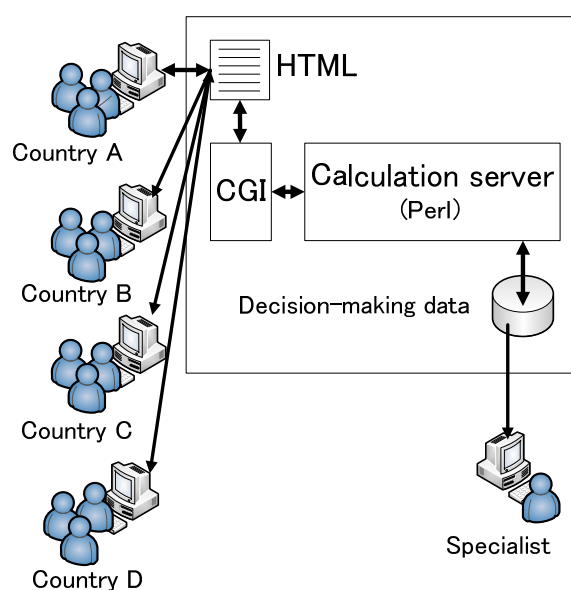


Fig 4. Participatory gaming simulation system architecture

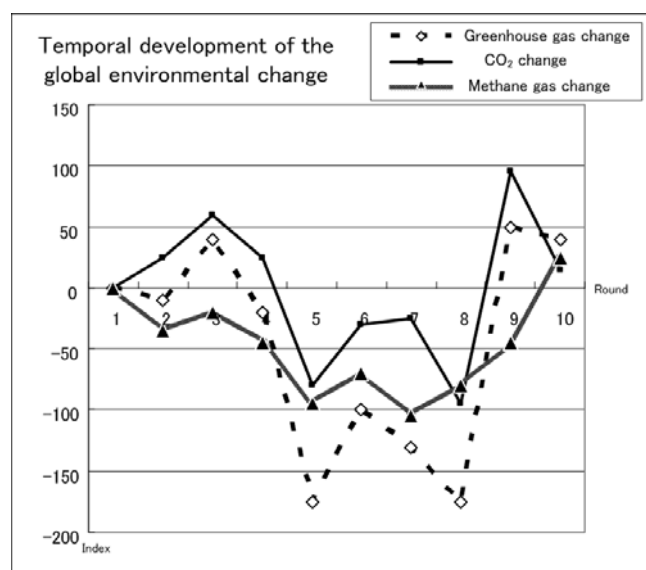


Fig 5. Participatory gaming simulation result

At the end of the workshop, the participants made a small tetrahedral eco-dice (Figure 7). These were a tool for the participants to think about the first step toward solving the global warming problem in the real world. It connected thinking in the virtual space to specific action in the real world. The participants shared the time to make eco-dice. The purpose is to promote face-to-face conversation among participants away from the serious environmental situation of the global warming problem. They casually talked about daily environmental awareness and environmental improvements.



Fig 6. Photo of the computer simulation room



Fig 7. Photo of the small tetrahedral eco-dice are made by the participants

We asked the participants for feedback regarding the science café using participatory gaming simulation. Their comments were as follows:

- In the real world, the people usually only focus on the CO₂ level. One of the lessons we learned from the participatory gaming simulation and science communication today was that we have to focus more on the methane gas level.

- Though scientists may be familiar with the greenhouse effect of methane gas due to their scientific background, we are less than familiar with it. We could understand the control structures of the environmental situation easily.
- Careless policy making in one country has considerable influence over other foreign policy decisions. In particular, the overlapping of policy making has a significant impact on global warming problems.
- The international conference held once every four years gave a chance to prevent political abuses in this problem. It also gave a chance to come to grips with environmental problems.
- We could understand the difficulties of policy making and the complexity of taking environmental measures.
- It is not only necessary to reduce the CO₂ level. The global warming problem may be more of a challenge than I thought it would be.

From the results of simulation and previous comments, the following are shown as findings:

- (1) As typified by the understanding of methane gas effects, participatory gaming simulation plays an effective role in gaining a correct understanding of the scientific structure.
- (2) Participatory gaming simulation creates the opportunity for interaction among participants.
- (3) Participatory gaming simulation establishes a comprehensive understanding of the framework of problems. The scope of the problem is addressed not only scientific understanding but also social or political understanding.
- (4) Describing a dynamically reconfigured situation is easy with participatory gaming simulation on a computer. This provides an opportunity for participants to create a conflict or collaborate in policymaking.

The participants' comments range from scientific understanding to social problems. We assume that participatory gaming simulation based on conversation among participants including specialists is excellent in terms of providing diversified viewpoints that at a science café one cannot give. In particular, problems as complex as global warming need multidimensional understanding based on social and political viewpoints. By using participatory simulation, participants try to seek what's going on in the simulation. A fusion of the science café and participatory gaming simulation leads participants to diverse yet profound discussion.

V. CONCLUSIONS

We propose a fusion of the science communication method and participatory simulation as a new methodology to share scientific and social problems with specialists and non-specialists. We conducted simulation experiments and analyzed the effects and characteristics of communication.

This methodology uses the design of social problem solving. Providing a new human communication space and expanding the functions of the traditional science café is a new methodology. The new methodology has the advantage of not only providing diversified viewpoints but also leading participants to experiential situations that include conflict and collaboration.

As a future work, we hope to examine the effects of communication in participatory gaming simulation that gathers many participants, citizens. And we rely on statistics to analyze the effects of the new methodology. At the same time, we hope to explore a more effective way of using the communication model to bridge the gap between science and society.

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