Satoyama Forest Management Learning Game for SDGs Education: Comparing the Effect of Providing Additional Information in the First Half and Latter Half of the Game

Koga Yago[1], Yukiya Shingai[1], Wakana Kobayashi[2], Ryota Aoki[2], Yoshiaki Takeda[2], Fusako Kusunoki[3], Hiroshi Mizoguchi[1], Masanori Sugimoto[4], Hideo Funaoi[5], Etsuji Yamaguchi[2] and Shigenori Inagaki[2]

[1]*Department of Mechanical Engineering, Tokyo University of Science, 2641 Yamazaki, Noda-shi, Chiba-ken, Japan*
[2]*Graduate School of Human Development and Environment, Kobe University, Hyogo, Japan*
[3]*Department of Information Design, Tama Art University, Tokyo, Japan*
[4]*Graduate School of Information Science and Technology, Hokkaido University, Hokkaido, Japan*
[5]*Faculty of Education, Soka University, Tokyo, Japan*

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Abstract: Conservation of biodiversity and the forest environment has become increasingly important in Japan because it has been set as the 15th sustainable development goals (SDGs). In Japan, Satochi-satoyama is currently drawing researchers' attention from the perspective of learning about forests and biodiversity. However, there are concerns that the biodiversity of Satoyama will soon deteriorate both in quality and in quantity due to the decline in the population that manages it. Therefore, Satoyama management needs to be promoted through education to continue sustainable development. The authors are currently developing a simulation game called "Satoyama Management Game" to use it as an effective tool for learners to absorb in-game information about Satoyama and learn about the process involved. In this paper, we discuss the experiments conducted to investigate the effect of providing in-game information on learners and present its results.

1 INTRODUCTION

In recent years, educational activities focusing on biodiversity conservation and forest environment conservation have become increasingly important because conserving terrestrial ecosystems has been set as the 15th sustainable development goal (United Nations, 2015).

In Japan, Satochi-satoyama is attracting attention to learn about forests and biodiversity. Satochi-satoyama refers to areas comprising farmlands, irrigation ponds, secondary forests, plantation forests, and grasslands that border human settlements. Even before the SDGs were established, Satoyama has been part of the rich culture of people coexisting with nature through the use of recycled resources and intervention in vegetation. The Satoyama landscape serves as a valuable model of a nature-harmonious society because it fosters the biodiversity of a secondary natural environment created through interaction between human activities and nature (Takeuchi, 2020).

However, with the declining population, an aging population, and changes in the industrial structure, many Satoyama are exposed to major environmental changes due to the reduced circulation of natural resources with the exploitation of Satoyama forests and wild grasslands. There are concerns that the biodiversity of Satoyama will deteriorate in terms of both quality and quantity (Ministry of the Environment, Government of Japan, 2010). It is necessary therefore to learn about Satoyama management and continue Satoyama conservation and sustainable development (Dublin and Tanaka, 2014).

Games have always been found to support learning (Prensky, 2003) (Calderón and Ruiz, 2014). Thus, various learning support games have been developed to learn how to manage Satoyama and the ecosystem. The Satoyama management game we developed is a simulation game. Learners can

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experience simulating Satoyama management on a longer time scale than usual, such as 10 or 100 years.

Kawaguchi et al. (2017, 2018) developed a Satoyama management game in which learners become Satoyama managers to learn Satoyama management methods and vegetation successions. We improved on the user interface of the Satoyama management game and added in-game information (Shingai et al., 2020). We conducted an experiment on elementary school students and confirmed that the improved user interface enhances the immersive feeling of the game. However, the effect of adding in-game information on learners' understanding was not investigated.

We conducted an experiment to clarify whether the in-game information added by Shingai et al. (2020) enhanced learners' understanding of Satoyama. The results of the experiment confirmed that the added in-game information was indeed effective in promoting learners' understanding. The results also indicated that presenting in-game information after the learner has become accustomed to the game would make the game more effective.

The remainder of this paper is organized as follows. Section 2 describes the Satoyama management game previously developed by us. Section 3 describes the experiments performed and their results, and Section 4 presents an evaluation of the experimental results and the rationale. Finally, Section 5 summarizes the main conclusions.

2 SATOYAMA FOREST MANAGEMENT GAME

2.1 Overview of the Game

The simulation game developed can help learners understand Satoyama management and vegetation successions. In the game, learners can experience Satoyama management on a time scale of 10 years or 100 years, which is not possible for ordinary people to experience. Learners understand the difficulty of maintaining a Satoyama environment and sustainable development. Figure 1 shows the play screen of the Satoyama management game developed by us (Shingai et al., 2020)

Learners manage Satoyama once per turn using one of the six management methods mentioned at the bottom of the screen. When converted to real time, one turn manages about 15 years, and one game manages Satoyama for 20 turns, which adds up to 300 years.

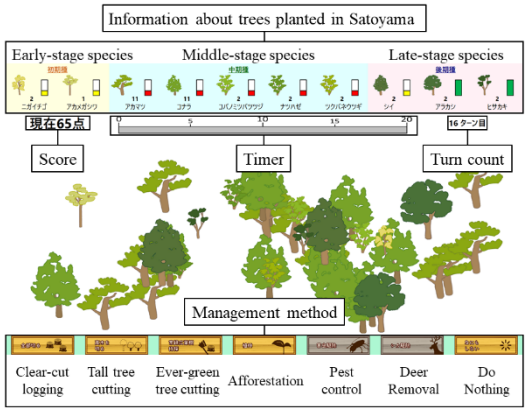

Figure 1: Play screen of Satoyama management game by Shingai et al. (2020).

In the game, there are early-, middle-, and late-stage types of tree species on the vegetation succession of Satoyama. Each tree has different characteristics, such as tree height, or pattern of growth.

Learners aim to maintain an ideal Satoyama environment by referring to the score displayed on the upper left of the game screen. Scores of the game ranged from 0 point to 100 points. The more ideal the number and proportion of trees, the higher the score. For 20 turns, the learner seeks the ideal tree ratio and effective management methods. By repeating this game, users can learn Satoyama management and vegetation successions.

2.2 Additional In-game Information

In our previous research, we added a meter for the number of trees and an information picture with the characteristics of trees, as shown in Figure 2 and Figure 3 (Kawaguchi et al., 2018) (Shingai et al., 2020). This is important information for Satoyama, but there has been no study to verify whether learners are making good use of this information during play.

2.2.1 Information Picture

The information picture is displayed at the top of the screen when the cursor hovers over each tree (Figure 2). In this picture, important information has been written for the game, such as wood types and features. Checking the information provided in the pictures will help learners find appropriate Satoyama management methods.

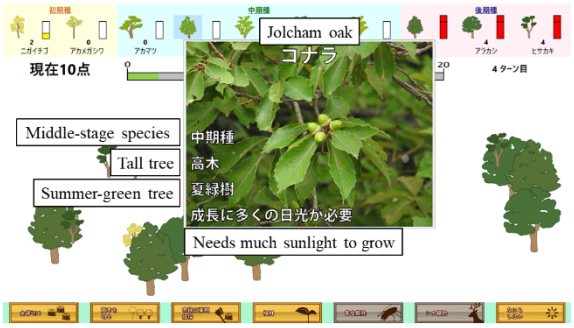

Figure 2: Information picture display.

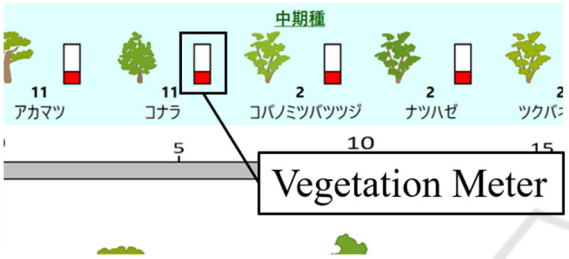

Figure 3: Vegetation meter display.

2.2.2 Vegetation Meter

The vegetation meter shows whether there are many or few trees (Figure 3). The early- and late-stage species appear in red when the ideal number of trees is exceeded, and the middle-stage species appear in red when the number of trees is much smaller than the ideal number. Learners are not aware of this condition. Learners need to find the right percentage of trees through the play.

3 EXPERIMENT

3.1 Experimental Design

The Satoyama management game experiment was conducted over four days, from October 27 to October 30, 2020. The participants in this experiment were 22 students from the Tokyo University of Science.

3.2 Experimental Method

To clarify whether in-game information helps learners understand Satoyama, we prepared two types of Satoyama management games: one with the information added and the other without the information mentioned above.

We assessed the level of understanding of the participants from their scores when playing with and without the added information. Further, to investigate whether the timing of providing in-game information affects the score of participants, we divided the participants into two groups, A and B, and compared the scores.

In the six rounds of the game played, Group A was given the information in the first three rounds, and Group B in the latter three rounds.

3.3 Experimental Result

Table 1 presents the summary of the final scores for each round for each participant. Group A participants were assigned numbers starting with A, and Group B participants were assigned numbers starting with B. For convenience, 16 out of 22 participants were omitted, and only 8 were listed under each group.

Table 1: Final score for each round after 6 rounds.

Participant Number	Final Score for Each Round					
	First Half			Latter Half		
	1	2	3	4	5	6
A1	69	67	63	54	55	65
A2	57	62	60	31	37	35
A3	66	29	66	67	34	74
A4	45	14	56	54	64	77
A9	6	15	56	62	55	59
A10	30	34	29	30	41	58
A11	26	54	70	56	56	61
A12	32	60	47	45	68	59
B1	18	18	64	64	64	53
B2	41	70	66	78	69	65
B3	33	53	44	61	61	64
B4	69	75	72	70	72	56
B7	60	66	66	76	77	70
B8	47	67	70	62	74	63
B9	32	36	65	69	77	77
B10	56	65	44	55	65	55

4 ASSESSMENT

The average score is calculated from the experimental results shown in Table 1. We compared the results of the first half and the latter half to assess the validity of the additional information and compared the results of each group to assess the impact of the timing of giving information.

4.1 Assessing Effectiveness of Providing In-game Information

Figure 4 shows the average scores of the participants in the first half and the latter half. Figure 4 reveals that there is almost no difference in the average points in the first half of Group A and Group B. This implies that learners are unaware about using the information well in the first half. At the start of the game, learners may not yet be accustomed to the game. On the other hand, Group B's scores improved significantly in the latter half as information was added after getting used to the game. Thus, it may be inferred that it is more effective to provide information after learners have become accustomed to the game.

4.2 Effect of the Timing of Providing Information

We compared the average scores of each participant in the first half and the second half and divided them into those whose scores increased those whose scores decreased. Participants whose scores had a difference of less than 1 point were classified as almost unchanged. Figure 5 shows the percentage of participants whose scores showed an increase and those whose scores showed a decrease in each group

According to Figure 5, 42% of Group A participants showed a reduced score in the latter half while in Group B, no decrease was seen in anyone's score. By playing the Satoyama management game repeatedly, participants tended to increase their scores (Shingai et al., 2020). These results lead us to understand that the scores of Group A decreased because of lack of information. Thus, it was confirmed that in-game information is important for increasing the scores. In other words, the added in-game information is effective in helping learners understand.

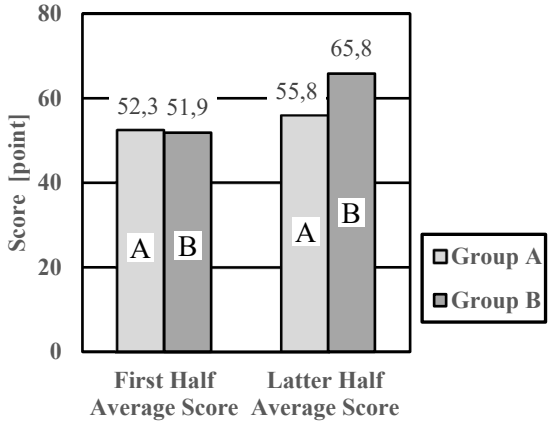

Figure 4: Comparison of average scores for the first half and the latter half.

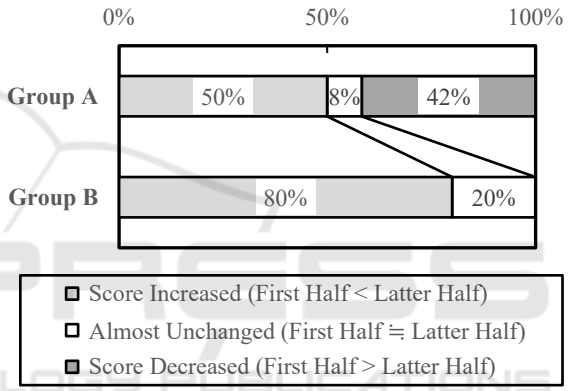

Figure 5: Percentage of participants whose score increased and whose score decreased in each group.

5 CONCLUSION AND FUTURE WORK

This paper describes how in-game information added to the Satoyama management game of Shingai et al. (2020) can help learners understand the process of Satoyama management better. The experiment performed on university students in playing the Satoyama management game confirmed that the learners' scores increased when presented with the additional information. Further, if the information were presented after learners got used to the game, it was found to be more effective than if it were presented at the start of the game.

In future, we aim to develop a system that can infer missing information from learners' scores and patterns of play and present the requisite information on priority.

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