# Examining Factors of Place Sameness: A Classroom Replication Task in Virtual Environment

Saizo Aoyagi[1][0000-0003-2359-1109], Satoshi Fukumori[2], Kenji Hirose[3], and Takayoshi Kitamura[2]

[1] Komazawa University, Setagaya-ku, Tokyo, 154-8525, Japan
[2] Kagawa University, Takamatsu-shi, Kagawa, 761-0396, Japan
[3] Hokkaido University, Sapporo-shi, Hokkaido, 060-0812, Japan

**Abstract.** The COVID-19 pandemic has boosted distance learning. The lack of a physical classroom environment in distance learning has been overlooked. A virtual classroom environment can be a solution to this problem. However, how accurately a virtual classroom should replicate the appearance of the original classroom is questionable. In this study, the authors focused on the layout and type of objects placed in a virtual classroom as factors that influence the appearance of the classroom. How they relate to the degree to which the classroom is perceived to be the same as the original classroom is investigated exploratively. Furthermore, how the role of objects in the classroom affects their relation to each other is examined. An experiment including a task that required participants to replicate the classroom by themselves was conducted. The results suggest that the replication of the number of objects associated with activities commonly performed at a place and the inaccuracy of the position of objects are factors that affect place sameness.

**Keywords:** Place, Virtual Environment, Virtual Replica, Place Sameness.

## 1 Introduction

Many countries have mandated emergency remote teaching due to the COVID-19 pandemic, which has increased distance learning opportunities in many schools. Existing video calling and video-on-demand systems are often used for distance learning. It has been reported that distance learning can be as effective as face-to-face classes in terms of teaching [1]. However, many students prefer face-to-face classes, and there have been requests for tuition refund or withdraw from classes [2]. What is the problem with distance learning?

One of the problems of distance learning is the negative impact of the lack of a classroom space[3]. There are many aspects to this problem. The social aspect that is characterized by a lack of interaction with others and a loss of connection has received much academic attention. The social aspect has been addressed in many studies [1, 3].

On the other hand, among the problems associated with a lack of a classroom space, the aspect of the lack of a physical environment has been overlooked. According to

environmental psychological findings, human behavior and experience are influenced by physical environments around them. In real-world schooling, classroom atmosphere and design are known to influence the attitudes, learning effectiveness [4], and level of participation of student [5]. One way to compensate for the lack of a physical environment for distance learning could be to create a classroom in a virtual environment that exactly replicates the original classroom.

However, the extent to which the original classroom should be replicated is questionable. In principle, the more accurate the appearance of a building such as a classroom, the more aesthetically appealing it is. However, within a certain range, the more accurate the appearance, the more the aesthetic appeal is conversely reduced. In other words, there is an uncanny valley of buildings [6].

This study focuses on the layout and types of objects placed in a virtual classroom as factors that affect the appearance of the classroom. How they relate to the degree to which the classroom is perceived to be the same as the original classroom is investigated exploratively. Furthermore, how the role of objects in the classroom affects their relation to each other is examined. In this study, an experiment is conducted in which participants position objects to replicate classrooms in a virtual environment.

The main contribution of this study is to address the previously overlooked lack of a physical environment, the classroom, in the context of distance learning. Additionally, it presents a promising hypothesis, based on experiments, regarding the degree of accuracy required in replicating a virtual classroom.

## 2 Method

This experiment was reviewed by the Komazawa University Ethics Committee on Research Involving Human Subjects (examination number: 23-5). A total of 15 Japanese university students (4 females and 11 males) participated in the experiment. The participants were compensated with 1,000 yen after completing the experiment.

The experiment was conducted in a laboratory on the campus of a university where the participants were students. The experimental system can be used via a web browser on a computer. The computer display was 27 inches with a resolution of 3840 x 2160 pixels. The experimental system used the Unity and questionnaires with JsPsych [7]. The system contained one virtual environment for practice and two virtual replications of two actual university classrooms. The participants could freely move their viewpoints and position objects using a mouse. Information about the classrooms is presented in Table 1.

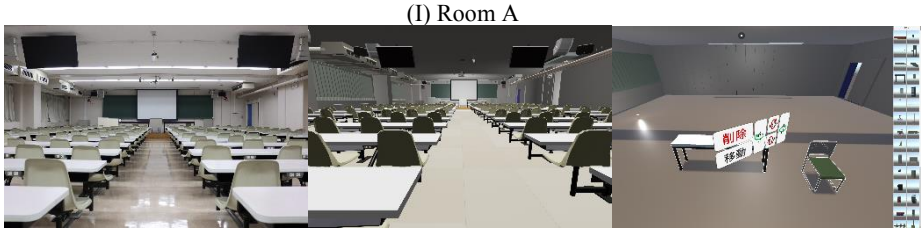
Figures1 (a), (b), and (c) show the picture, 3D model, and experimental scene of Room A, respectively. Room A is a small classroom that is basically the same as that in Aoyagi and Fukumori [8]. This room is used for small lectures and seminars. Fig.1 (d), (e), and (f) show the picture, 3D model, and experimental scene of Room B. Room B is a large classroom and is used for large group lectures.

**Table 1.** Specifications of rooms.

| | Room A | Room B |
|---|---|---|
| Number of chairs | 60 | 272 |
| Height[m], width[m], depth[m] | 3.66, 6.72, 9.1 | 3.34, 13.87, 17.72 |
| Number of objects (object types) | 105(39) | 151 (42) |
| Display devices [%] | 3% (7%) | 2% (5%) |
| Student settings [%] | 43% (2%) | 45% (3%) |
| Others [%] | 55% (97%) | 52%(90%) |

(a) Picture. (b) 3D model. (c) Experimental scene.

(I) Room A



(e) Picture. (d) 3D model. (f) Experimental scene.

(II) Room B

**Fig. 1.** Pictures, 3D models, and experimental scenes of rooms A and B.

The object types were divided into three categories. Display devices included whiteboards, blackboards, and displays; student settings included desks and chairs; and others included all remaining objects such as switch boxes, outlets, and fluorescent lamps. The display devices were related to the lectures and the seminars; the student settings were related to seminars, chatting, and self-study; and others were not related to any activities.

In the classroom replication task in virtual environments, all objects except walls, floors, and ceilings were removed in advance. The participants could freely position, move, and rotate objects by clicking object icons on the right side of the screen.

All instructions and questionnaires were provided in Japanese. Informed consent was obtained from participants before the experiment. The participants sat in a chair in front of a desk, facing the computer display. First, the participants viewed a screen that described the procedure of the experiment and provided instructions on how to operate the experiment system.

On the next screen, the participants were presented with a featureless virtual environment for practice and asked to practice operating the experimental system. The participants could proceed to the next screen at any time by pressing the end button on the screen. The next screen automatically loads 10 min after the previous one.

After completing each task, the participants answered the questionnaire that included questions about the original rooms. In addition, items on the place sameness index were answered in random order. Place sameness implies the degree to which a virtual place is perceived to be the same as the original place [8]. The place sameness index includes the following seven items: It looks like the original place; it is similar to the original place; I can tell it is a re-creation of the original place; it looks familiar; I feel uncomfortable (a reversing entry); I successfully recreated it; and I am satisfied with the result. The participants answered these questions using a 5-point scale: strongly disagree, disagree, neutral, agree, and strongly agree.

## 3 Results and Discussion

Answers to the question "how attached are you to that room?" showed that Room A had a higher attachment than Room B. The most common answer to "how often did you use that room?" was once a week for all rooms. The most common answer to "when was the last time you used that room?" for Room A was "1 month to 1 year ago", and that for Room B was "today or yesterday". The original classrooms were known to most experimental participants and used them recently. Thus, it can be inferred that most participants remembered and were able to replicate the rooms.

The most common answers to "what is the most memorable activity in the room?" was "lecture" for all rooms, with 9 for Room A and 14 for Room B. Answers for Room A were more diverse than those for Room B. Three participants answered "seminar" for the original Room A. However, for Room B, no participant answered "seminar"". It can be inferred that Room A was large and used mainly for lectures, whereas Room B was small and used for seminars in addition to lectures.

The place sameness index included seven items, and the value for Cronbach's coefficient alpha was $\alpha = 0.86$. The averages of the seven items were used as the values of the place sameness index in the following analysis. To explore the factors of place sameness index, some variables were calculated based on logging data.

Some participants placed too many objects in the virtual rooms, whereas others placed too few, compared to the original rooms. In this study, the value calculated as $\left|1 - \frac{N_p}{N_c}\right|$, where $N_p$ and $N_c$ represent the number of replicated objects and the number of objects in original rooms, respectively, was used as a measure of how well the participants remembered the objects. This value represents how accurately the number of real-world objects is remembered, and hereinafter, it is referred to as the memory index. A memory index of 0 implies that the number of objects in the virtual room matches the number of objects in the original room.

The positions of objects placed in the virtual rooms were not always accurate. The average distances were calculated to represent the accuracy of replications in terms of the positions of objects. It was defined as the per-participant averages of Euclidean distances between the positions of all objects at the end of the experiment and positions of the objects in each original room. If there were multiple correct answers for the same type of object, the distance to the closest correct answer was considered. The distance of unplaced objects was calculated to be 0.

The third variable was the average positioning order of objects. Objects not placed were excluded. Recalling important objects was believed to be easy and placed early. These three variables were calculated for different object categories (display devices, student settings, and others).

The variables for each room and category showed different trends. To make this difference easier to understand, a correlation analysis was conducted. Table 2 shows the correlation coefficients of the variables and the place sameness index. To calculate correlation, the values of one participant who reversed the front and back of Room A were excluded as outliers. Criteria defined by Mizumoto and Takeuchi [9] was used to interpret effect sizes. In the criteria, the values 0.1, 0.3, and 0.5 represent small, medium, and large effect sizes, respectively.

For the memory index, the accurate replication of the number of desks and chairs in Room A was correlated to the place sameness index, but not in case of Room B. Based on these results, the following inferences can be drawn. For activities reported only in Room A, such as seminar and chatting, students focused on other students and the desks and the chairs they were sitting in, and therefore, the desks and the chairs were impressive. Room B was used mostly for lectures, and therefore, the students did not focused on other students and the desks and chairs, and instead focused on the teacher and the whiteboard. Therefore, the desks and chairs were not impressive. In other words, the correct number of objects related to the activity of the room has a positive effect on place sameness.

The same inference can be drawn for display devices. Because Room B was used for lectures, students focused on the whiteboard, and therefore, the replication of that number had a moderate negative correlation with the place sameness index. Room A was not used only for lectures, and therefore, the correlation of the same value was small.

Some puzzling results were found regarding the average distance. A strong positive correlation of display devices only in Room A and a moderate correlation of student settings and others in Room B were observed. The trend was the opposite of memory index. It is possible that the positioning of objects that are less relevant to the activity of a place in a precise position may lower place sameness. It is unlikely that this trend

**Table 2.** Correlation coefficients of variables and place sameness index.

| Variables | Category | Correlation coefficient r *1 | | |
|---|---|---|---|---|
| | | Whole data | Room A | Room B |
| Memory index | Display devices | -0.16 | -0.14 | **-0.38** |
| | Student settings | -0.23 | **-0.39** | -0.04 |
| | Others | 0.16 | 0.10 | -0.05 |
| Average distance | Display devices | 0.19 | **0.53** | 0.14 |
| | Student settings | -0.07 | 0.01 | **0.33** |
| | Others | 0.15 | -0.20 | **0.30** |
| Average positioning order | Display devices | 0.21 | 0.16 | 0.27 |
| | Student settings | 0.22 | **0.52** | -0.02 |
| | Others | 0.02 | -0.09 | 0.08 |

*1: Values with medium and large effect sizes are in bold

will hold true on a broader scale. For example, does positioning an object too far away to see enhance place sameness? This could be a part of nonlinear curves, such as the uncanny valley [10].

There was a large positive correlation between the average positioning order of the student settings and the place sameness index only in Room A. In other words, the later the desks were placed, the higher the place sameness. This is difficult to interpret; however, it may be a consequence of the fact that student desks were given more attention in Room A than in Room B, in the same light as the memory index.

## 4 Conclusion

In this study, the experiment on the classroom replication task was conducted to explore how the layout, types, and categories of objects placed in virtual classrooms relate to place sameness. The results suggest that the replication of the number of objects associated with activities commonly performed at a place and the inaccuracy of the position of objects are factors that affect place sameness. In the future, the authors would like to conduct experiments to verify the suggested factors.

**Acknowledgement**
This work was supported by JSPS KAKENHI Grant Number JP20K20121 and Suntory Foundation.

## References

1. Murakami, M., Urata, Y.: “Sense of connection” at university and online lecture. Qualitative Psychology Forum **13**, 28-36 (2021)
2. Newsome, M.: More than 60 colleges hit with lawsuits as students demand tuition refunds. Newsweek. (2020), https://www.newsweek.com/more-60-colleges-hit-lawsuits-students-demand-tuition-refunds-1512378 last accessed 2023/07/19
3. Fujii, R., Hirose, H., Aoyagi, S., Yamamoto, M.: On-demand Lectures that Enable Students to Feel the Sense of a Classroom with Students who Learn Together. Transactions of Human Interface Society **23**(3), 315-328 (2021)
4. Wollin D. D., Montagne M.: College classroom environment: effects of sterility versus amiability on student and teacher performance, Environment and Behavior **13**(6), 707-716 (1981)
5. Ching, Y., Sommer R., Cook E. J.: The soft classroom 17 years later, Journal of Environmental Psychology **12**(4), 336-343 (1992)
6. Diel, A., & Lewis, M.: Structural deviations drive an uncanny valley of physical places. Journal of Environmental Psychology **82**, 101844 (2022)
7. J. R. de Leeuw: jsPsych: A JavaScript library for creating behavioral experiments in a web browser. Behavior Research Methods **47**(1), 1-12 (2015)
8. Aoyagi, S., Fukumori, S.: Proposal of place sameness and a realization trial with virtual reality. In: Human Communication Symposium 2022, HCG2-22 I-1-8 (2022)
9. A. Mizumoto, O. Takeuchi: Basics and considerations for reporting effect sizes in research papers. Studies in English Language Teaching **31**, 57-66 (2008)