Effect Analysis of Creators' Environmental Factors in Making a Tourist Map for a Familiar Place

Yoko Nishihara
College of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
nisihara@fc.ritsumei.ac.jp

Ryosuke Yamanishi
Faculty of Informatics
Kansai University
Osaka, Japan
ryama@kansai-u.ac.jp

Xinran Lin
College of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
is0440re@ed.ritsumei.ac.jp

Ryohei Ohyama
College of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
is0400hs@ed.ritsumei.ac.jp

***Abstract*—People use maps for directions and sightseeing, but they rarely consider the process of map-making. Since maps are made by several creators cooperatively, map-making can be considered a collaborative decision-making process. If this process is analyzed, we may discover that environmental factors influence map-making. This study discovers the effects of environmental factors for map-making through experiments and analysis. We invited participants to join in the experiments, in which they made a tourist map for a familiar place, and we controlled the environmental factors in the map-making process. The environmental factors include the following: (1) the number of creators, (2) the presence of creators' conversations, and (3) the creators' space. We analyzed the created maps, tourist attractions, and participants' conversations to determine the effects of the environmental factors and found the following three effects: (a) If the creators are many, then more tourist attractions will be mapped, which corresponds to factor (1). (b) If the creators have conversations, the rate of minor tourist attractions increase, which corresponds to factor (2). (c) If the map-making environment is virtual, then the map has more tourist attractions than a physical one, which corresponds to factor (3). We discovered the above effects of the environmental factors in tourist map-making. According to the results of this study, it is expected that people can obtain their desired maps using these factors and effects.**

Keywords - collaborative decision-making; tourist map making; number of creators; conversation; physical and virtual spaces.

I. Introduction

People look at the map for sightseeing that introduces tourist attractions. Tourist maps can be found in guidebooks or the Internet. These maps are available at the tourist information center of the tourist location. Through this map, they can understand the outline of the tourist destination and locate exciting places. Further, they can plan a route to see and enjoy the fascinating tourist attractions.

Although the tourist maps are for the same location, the creators are different, thus the maps are different. Each map has original photos and descriptions of the tourist attractions. People rarely consider the decision-making conducted in making maps and choosing tourist attractions. Map-making is considered a collaborative decision-making process since it is conducted by several creators cooperatively. If the process of map-making is analyzed, we may discover environmental factors influencing it, which is not for automatic generation of map but for interaction design for map-making.

This study discovers the effects of environmental factors for map-making through experiments and analysis. We invited participants to partake in the experiments of making a tourist map. If the participants are unfamiliar with an area, they may fail in an attempt to create a tourist map. Additionally, if tourist maps already existed, the participants may be confused when creating maps and choosing tourist attractions. Thus, we asked the participants to create a map of a familiar place in the experiment. They re-evaluated the familiar place and chose spots that were preferable for tourist attractions. We controlled factors in the experiments to obtain several types of tourist maps and analyzed the maps to discover how the factors affect tourist map-making.

The task in the experiment is not just find the spot we have already known but more creative where the participants have to re-evaluate and create the meaning toward the spot, thus, we consider that it should be "creator(s)" rather than just "contributor(s)." We also consider that it should be "environmental factor(s)" rather than just "context." Because the creator's space of map-making is not context.

A. Contribution

The world is full of contents. The research in computer science has tried to analyze and utilize such big data of contents, e.g., text classification and music recommendation. So many papers have proposed brand new techniques for processing the data and claimed the effectiveness for some intended tasks. However, we believe that the point of the research focusing on contents should be not only the effectiveness in the designed tasks but also how the data is coming. Especially for some experience-based contents, how the data is created should be more notable.

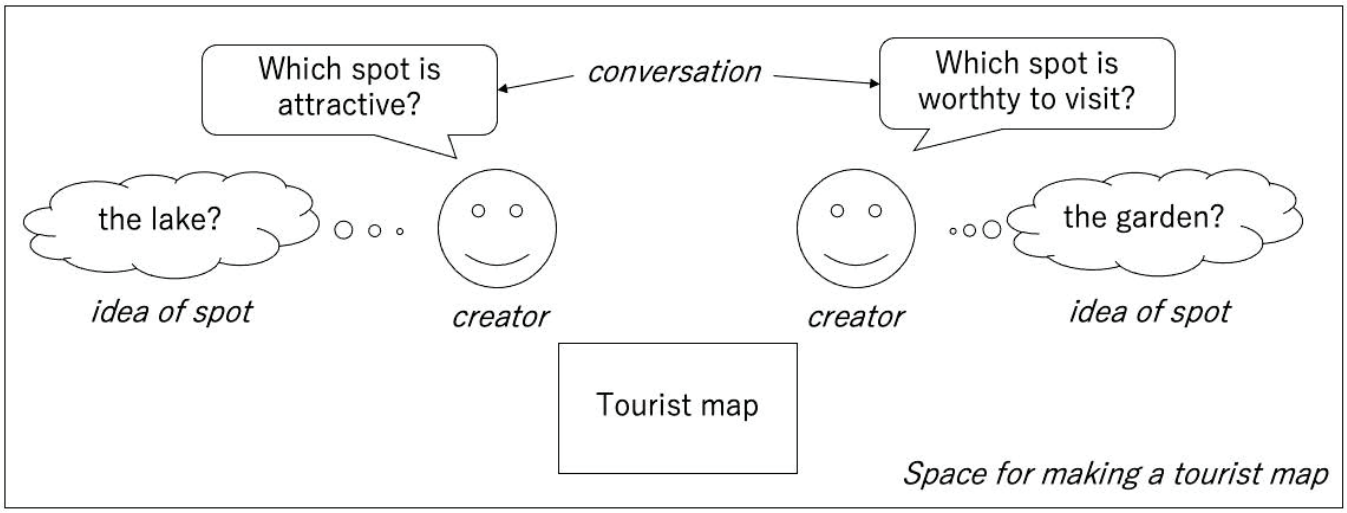

Figure 1. Interaction of tourist map-making. Creators have ideas of spots. They choose spots that would be tourist attractions and map them. They have conversations among them to find the other spots. They can work either in a physical and virtual space.

In our previous study presented at ACHI2021 [1], we conducted a preliminary analysis of two factors and their effects on tourist map-making. This study presents detailed analysis results for the previous experiment and clarifies the effects of the number of creators and the presence of creators' conversations. Further, we include another factor about the creators' space and clarify the effect on tourist map-making.

The contribution of this paper can be summarized as follows;

1) It has been found that the number of creators and the usage of virtual space increase the number of tourist attractions on a tourist map.
2) It has also been found that conversations between creators increase the rate of minor tourist attractions that may be exciting for tourists. The minor tourist attractions included personal memories and impressions in their descriptions. They re-evaluated their familiar place and found spots preferable for tourist attractions. The re-evaluation can generate a new value for a place even if it is familiar.

The rest of this paper is organized as follows. Section II describes related works. Section III demonstrates a map-making interaction and discusses the expected factors. Section IV describes the first experiment to verify the effect of the number of creators and their conversations in map-making and the results. Section V describes the second experiment to verify the effect of the creators' space in map-making and the results. Section VI concludes this paper.

II. Related Work

We introduced previous studies on map- and decision-making supports.

A. Map-making with sensors and social media

People use map services on the Internet to search for buildings and facilities. If the name of a building in the United Kingdom and France are Big Ben and The Arch of Triumph, respectively, the service will show the location of the building on map [1]. The outline of a city changes continuously as new roads and buildings are built. Sensors such as GPS (Global Positioning System) [2], [3] are used to update the existing map to a new one. GPS data is used not only for updating maps but also for making new ones; for example, a cycling map [4], an evacuation map in a disaster-hit area [5], and a floor map inside [6]. The traffic volume of a city changes daily. There may be a traffic jam in the morning and evening, but not during the day. GPS in automobiles is used for making a traffic map of a city [7]–[9]. Sensors are installed across a city. Acoustic sensors are used for making a city noise map [10]. Geographic Information System (GIS) data are also sensor data that is used for making a hazard map of a landslide [11].

Recently, short messages on social media such as tweets are used for locating tourist attractions in a city [12], [13]. People can locate streets suitable for jogging by collecting tweets that include the word "jogging." Further, by collecting short messages such as sunset, people can discover viewpoints for a beautiful sunset [14]. Tweet data can be used for detecting a neighbor's boundary [15]. The activities of pets can be collected and mapped from social media [16]. Because search results on a Web's search engine include future event information, the event information is extracted and shown on a map [17].

Our study does not create a map using sensors or social media. The creators remember suitable spots for tourist at-

[1]For example, Google Map is one of the services (https://www.google.com/maps).

tractions on the map. We analyze the characteristics of the maps to find how the desired map can be obtained.

B. Decision-making support

Decision-making has been supported in various ways, and multi-agent simulation systems have been studied for complex tasks with numerous constraints and alternatives [18]. Further, optimization methods have been studied for interaction among agents, robots, and people [19]. Virtual reality environments are designed for specific decision-making processes, such as policymaking [20]. Health care support is provided through online social networking services [21]. Each study discovered points that should be considered in decision-making. These points differ in each decision-making task. The decision-making process would be analyzed to determine these points [22].

The volume of decision-making increases as the number of workers increases; this is called collaborative decision-making. Many studies have supported collaborative decision-making. Each worker in a collaborative decision-making process has the best solution for themselves. However, when a worker provides the best solution for a small problem, the set of solutions fails to solve the entire problem [23], [24]. Consensus-building models and methods have been studied [25], [26]. Workers in decision-making have a conflict of opinions. Thus, the degree of conflict is evaluated to eliminate consensus-building [27]. An enormous decision-making task is broken down into small decision-making tasks for consensus-building [28]. Our study focuses on map-making as a collaborative decision-making process and analyzes the process of locating the support point.

III. Expected environmental factors in tourist map-making

We consider tourist map-making a collaborative decision-making process. We demonstrated a tourist map-making interaction and discussed the expected factors.

In map-making, people congregate in a space to discuss and give their opinions [29]. Previously, the creators' space was physical, but people can now use virtual space and Web services for map-making. Figure 1 illustrates the interaction of a tourist map-making process. Each creator gives an idea of a spot to map them. If there are several creators, they will share their ideas of spots that others have not provided. If the creators can have conversations, they would get others' opinions to locate the other ideas of spots. If they are in the same physical space, they can walk the area on the tourist map to choose the spots for tourist attractions. Map-making is conducted collaboratively in a physical space. Even if the creators are in a virtual space, they can walk the area and map the tourist attractions using Web services.

Figure 2 shows the relations between expected environmental factors and map-making if tourist map-making is performed. There are three expected environmental factors:

- (1) The number of creators
- (2) The presence of creators' conversations
- (3) The creators' space

Although each creator's choice of tourist attraction is different and uncontrollable, the three factors are controllable through experiments. Thus, we chose three environmental factors that would affect map-making. It is unclear whether these factors affect map-making simultaneously or individually. Further, we analyzed how the factors affect map-making in this study.

We conducted two types of experiments to determine the effects of the three factors. The first experiment was conducted to find the effects of factors (1) and (2) (in Section IV). The second experiment was conducted to find the effect of factor (3) (in Section V).

IV. Experiment 1: Do the number of creators and their conversations affect tourist map-making?

In this section, we set the main hypothesis as follows: **if two creators make a tourist map while walking the area and conversing, the tourist map will be different from a map created by a single person**. The hypothesis has two factors: factor (1) and (2), which are the number of creators and the presence of conversations, respectively. We divide the main hypothesis into four smaller hypotheses: H1(a), H1(b), H2(a), and H2(b).

- H1(a): **The number of tourist attractions is higher** if a tourist map is created **by two people** instead of a single person.
- H1(b): **The number of tourist attractions is higher** if a tourist map is created **by two people with conversations** instead of without conversations.
- H2(a): **The rate of minor tourist attractions is higher** if a tourist map is created **by two people** instead of a single person.
- H2(b): **The rate of minor tourist attractions is higher** if a tourist map is created **by two people with conversations** instead of without conversations.

A. Experimental settings

The experimental procedures are as follows:

1) An experimenter directs participants to a place for tourist map-making.
2) The participants navigate the place and choose spots for tourist attractions by taking photos. They have a limited time.
3) After procedure 2), the participants upload the photos to Google map [2] with a title and a description to map the tourist attractions.

Each individual/pair of the participants created a tourist map of the Biwako-Kusatsu Campus of the Ritsumeikan University. The campus was not a tourist destination, but it is familiar to the participants. The experimenter was the third author. The participants were 35 students who had been on the campus for over a year.

[2]https://www.google.com/maps

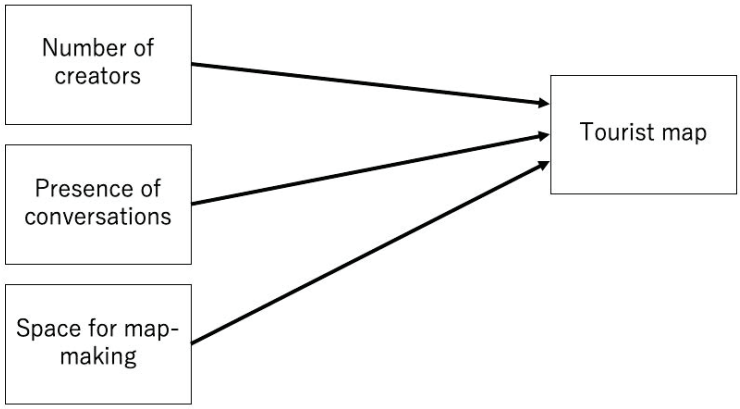

Figure 2. Relations between expected environmental factors and map-making. We assume that the environmental factors are the number of creators, the presence of conversations among creators, and the space of map-making.

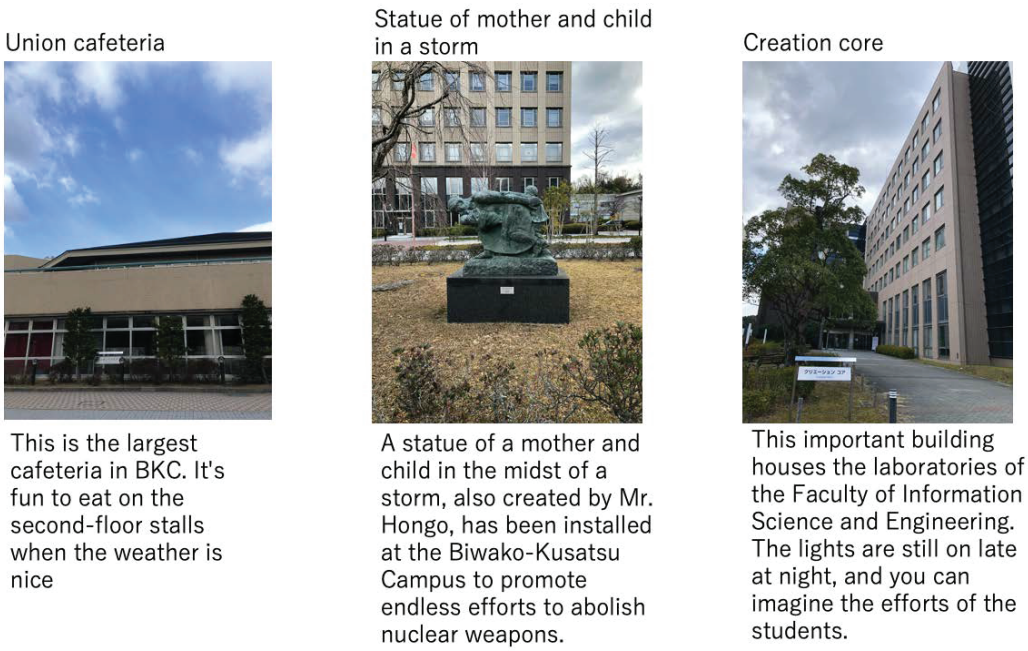

Figure 3. Example of tourist attractions by Group A in Experiment 1. Group A made a map by a single person.

We divided the participants into Groups A, B, and C. The information in each group is given as follows:

- Group A: Creating a map by **a single person**: seven participants
- Group B: Creating a map by **two people without conversations**: seven pairs and 14 participants
- Group C: Creating a map by **two people with conversations**: seven pairs and 14 participants

Group C recorded their conversations using a voice recorder. The time to navigate the campus in procedure 2) was 45 minutes. The experiments were conducted between April and September 2020.

B. Obtained data

We obtained the following data.

- Data 1: The number of tourist attractions of each map
- Data 2: The duration for map-making in procedure 3)
- Data 3: Transcripts of creators' conversations (if any)

C. Method of hypothesis verification

We used Data 1 and Data 3 to verify hypotheses H1(a) and (b) and hypotheses H2(a) and (b), respectively. The campus has buildings for classes and research. The participants might choose the buildings as tourist attractions. Further, we would like to evaluate the quality of each map based on the types of tourist attractions. We regard a tourist attraction as a major spot if it is a building/facility that is mapped on a campus map, which is published by the university [3]. However, if the description of a tourist spot includes personal memories and

[3]http://en.ritsumei.ac.jp/campusmap/

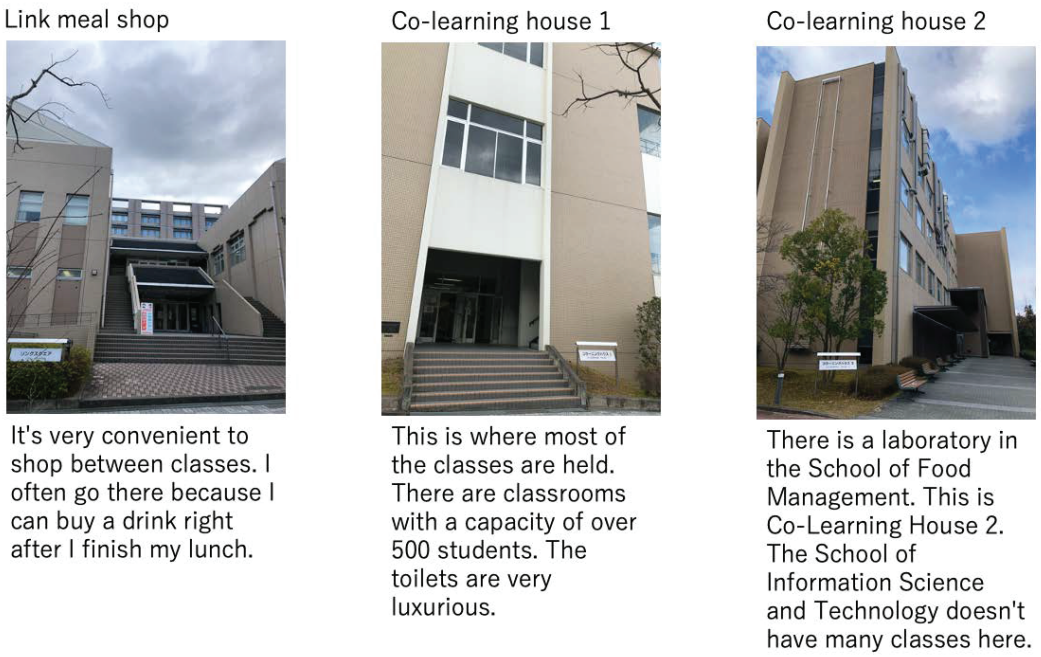

Figure 4. Example of tourist attractions by Group B in Experiment 1. Group B made a map by two people without conversations.

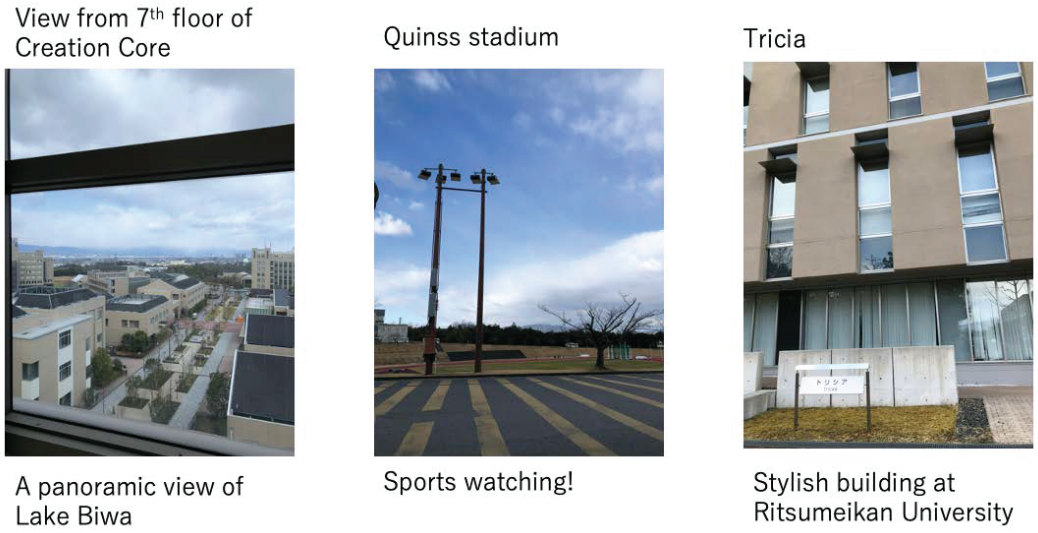

Figure 5. Example of tourist attractions by Group C in Experiment 1. Group C made a map by two people with conversations.

impressions, the above mentioned building/facility is a minor spot. If a tourist attraction does not exist on the campus map, it is a minor spot.

D. Experimental results

Figure 3, Figure 4, and Figure 5 show examples of the tourist attractions chosen by the participants. The figures show photos, titles, and descriptions. Buildings (Co-learning House 1 and 2), cafeterias (Union Cafeteria and Link Meal Shop), and facilities (Creation Core and Tricia) are shown.

The second column of Table I shows the number of tourist attractions corresponding to Data 1. The numbers are averages of seven pairs in each group. The averages of Groups A, B, and C are 17.6, 18.1, and 10.3, respectively.

The third column of Table I shows the duration of map-making corresponding to Data 2. The durations are averages of the seven pairs in each group. The averages for Groups A, B, and C are 32.1, 28.6, and 22.1 minutes, respectively.

The fourth column of Table I shows the rate of minor spots. The averaged rates for Groups A, B, and C are 68.3%, 73.7%, and 86.1%, respectively.

TABLE I
EXPERIMENTAL RESULTS IN EXPERIMENT 1. AVERAGED NUMBERS OF TOURIST ATTRACTIONS ON CREATED MAPS, AVERAGED DURATIONS USED FOR MAP-MAKING, AND AVERAGED RATES OF MINOR SPOTS ARE SHOWN.

Group	Averaged number of tourist attractions	Averaged duration (minutes)	Rate of minor spots (%)
A	17.6	32.1	68.3
B	18.1	28.6	73.7
C	10.3	22.1	86.1

TABLE II
CONVERSATION EXAMPLES BY PARTICIPANTS OF GROUP C IN EXPERIMENT 1.

Tourist attraction: A view from 7th floor of Creation Core
Participant B: You can see a nice view from the top floor of Creation Core. Participant A: It's so nice. Participant B: The windows are messy but you can see Biwa-lake here. How do you feel it? Participant A: I love this. This is the highest building in the campus? Participant B: Probably yes. This angle is also nice. You can see the whole view of Biwa-lake.
Tourist attraction: Tricia
Participant A: The building is for Department of Architecture. I hear that is a cool building. Shall we go there? Participant B: I have never been there. Participant A: Students' works and architecture models are displayed in the building. Participant B: Their works are so nice. I love them. Participant A: Me too. They are so beautiful.

E. Results of hypothesis verification

We examined H1(a) and there was no difference between the number of tourist attractions of Groups A and B (17.6 and 18.1). We discovered that hypothesis H1(a) was not held.

We examined H1(b) and there was a difference between the numbers of tourist attractions of Groups B and C (18.1 and 10.3). The number of Group B was higher and hypothesis H1(b) was not held.

We examined H2(a) and there was a difference between the rates of minor spots of Groups A and B (68.3% and 73.7%). The rate of Group B was higher and hypothesis H2(a) was held.

We examined H2(b) and there was a difference between the rates of minor spots of Groups B and C (73.7% and 86.1%). The rate of Group C was higher and hypothesis H2(b) was held.

F. Discussion

1) H1(a) was not held: The small hypothesis H1(a) occurred because the number of tourist attractions is bigger if a tourist map is created by two people instead of a single person. However, there was no difference between the two groups. Each pair of the participants in Group B consisted of two people. We assumed that Group B mapped more tourist attractions because there were more participants in a pair. The participants walked on the campus together and with a time limit. Thus, the participants of Group B did not discover more tourist attractions. Although there was no difference between the number of tourist attractions, the time for map-making of Group B was approximately three minutes more than Group A ($= 32.1 - 28.6$ minutes). This is because the Group B participants can split between uploading photos and writing descriptions about tourist attractions.

2) H1(b) was not held: The small hypothesis H1(b) occurred because the number of tourist attractions is higher if a tourist map is created by two people with conversations instead of without conversations. However, the number of Group B (two people without conversations) was greater than that of Group C (two people with conversations). We assumed that the difference occurred because of the participants' conversations. Group C participants were permitted to have conversations while walking and map-making. They suggested spots that the others might not be aware of. Table II shows examples of their conversations. Both conversations are for two different tourist attractions. The conversations show that a participant introduces a spot the other is unfamiliar with. Group C participants assumed that sharing common knowledge about the campus was meaningless. They re-evaluated the campus and discovered tourist attractions that the others are not aware of and mapped the areas on their map. Although the condition to converse positively affected finding minor tourist attractions, Group C participants required more time to locate the spots. Thus, the number of tourist attractions for Group C was smaller.

3) H2(a) was held: The small hypothesis H2(a) occurred because the rate of minor tourist attractions is higher if a tourist map is created by two people instead of a single person. Though the participants of Group B walked together, they chose spots individually. There are the limited number of major spots so that the two participants can cover most of them. They tried to find another spots rather than the major spots. Thus, the rate of Group B was greater than that of Group A.

4) H2(b) was held: The small hypothesis H2(b) occurred because the rate of minor tourist attractions is higher if a tourist map is created by two people with conversations instead of without conversations. The reason is the same as the reason of the small hypothesis H1(b). The participants of Group C were permitted to have conversations. The conversation affect positively to introduce minor spots to the others. Thus, the rate of Group C was greater than that of Group B.

V. Experiment 2: Do the difference between physical and virtual spaces affect tourist map-making?

In this section, we set the main hypothesis as follows: **the tourist map is different from each other if the spaces where the creators occupy for map-making are different**. The hypothesis is based on one factor (3) the space where the creators occupy (physical versus virtual). We divide the main hypothesis into two small hypotheses H3 and H4.

- H3: **The number of tourist attractions is higher** if a tourist map is created **in the virtual space** rather than the physical space.
- H4: **The rate of minor tourist attractions is higher** if a tourist map is created **in the virtual space** rather than the physical space.

A. Experimental settings

The experimental procedures are almost the same as those in Experiment 1. The differences are explained below. The experimenter was the fourth author. The participants were also different from those in Experiment 1; they consisted of 28 students who had been on campus for over a year.

We divided the participants into Groups D and E. Groups D and E walked into the physical and virtual spaces of the location, respectively. The information in each group is given as follows:

- Group D: Walking and map-making **in a physical space**: seven pairs and 14 participants
- Group E: Walking and map-making **in a virtual space**: seven pairs and 14 participants

The physical space was the university campus, whereas the virtual space was Google's Street View [4]. The experiments were conducted between June and December 2021, which was the year after Experiment 1.

B. Obtained data

We obtained the following data: Data 1, Data 2, and Data 3, which were the same as those in Experiment 1. Data 4 was acquired newly.

- Data 4: Walking routes of the participants.

C. Method of hypothesis verification

We used Data 1 and Data 3 to verify hypotheses H3 and H4, respectively. We employed the same criteria to determine if a tourist attraction is a major or minor spot in Section IV.

D. Experimental results

Figure 6 and Figure 7 show examples of the tourist attractions chosen by the participants. The figures show the buildings (Central Arc), facilities (Across Wing), and track field (Quinns Stadium).

The second column of Table III shows the number of tourist attractions that correspond to Data 1. The numbers are averages of seven pairs in each group, and the averages for Groups D and E were 9.9 and 15.3, respectively. Groups D and C had the same conditions in Experiment 1. The numbers of the two groups were almost the same (10.3 and 9.9 for Groups C and D, respectively).

The third column of Table III shows the duration of map-making that corresponds to Data 2. The durations are averages of seven pairs in each group. The averages were 26 and 25 minutes for Groups D and E, respectively. The duration of Groups C and D was almost the same (22.1 and 26 minutes).

The fourth column of Table III shows the rate of minor spots. The averaged rates were 49% and 52% for Groups D and E, respectively. Although Groups D and C had the same conditions in Experiment 1, the rate of Group D was smaller than that of Group C (86.1% and 49%). In the next section, we will discuss why the rate for Group D was smaller.

E. Results of hypothesis verification

The number of tourist attractions for Group D was lower than Group E (9.9 and 15.3, respectively). We discovered that hypothesis H3 was held.

There was no difference between the rates of minor spots for Groups D and E (49% and 52%). We discovered that hypothesis H4 was not held.

F. Discussion

1) H3 was held: The small hypothesis H3 occurred because the number of tourist attractions is higher if a tourist map is created in a virtual space instead of a physical space. The participants of Group E used Google's Street View to walk and choose tourist attractions. They could walk faster than those in Group D who were walking on the actual campus. We examined the routes of Group E and discovered that they jumped from one spot to another. The routes of Group E were sets of dots, whereas those of Group D were linear lines. Because of the jump actions, the participants of Group E could check a wider portion of the campus, thus increasing the number of tourist attractions. Therefore, the small hypothesis H3 was held.

2) H4 was not held: It occurred because the rate of minor tourist attractions is higher if a tourist map is created in the virtual space rather than the physical space. However, there was no difference between the two rates. We assumed that the participants of both groups were students who knew the campus and would have similar experiences in either the physical or virtual spaces. The participants of both groups chose tourist attractions without effects from their spaces.

3) Difference between Group C in Experiment 1 and Group D in Experiment 2: The rate of the minor spots of Group D was smaller than that of Group C in Experiment 1. This might be because of the amount of personal memory of each participant. Experiment 1 in Section IV was conducted between April and September 2020. Experiment 2 in Section V was conducted between June and December 2021 after Experiment

[4] https://www.google.com/streetview/

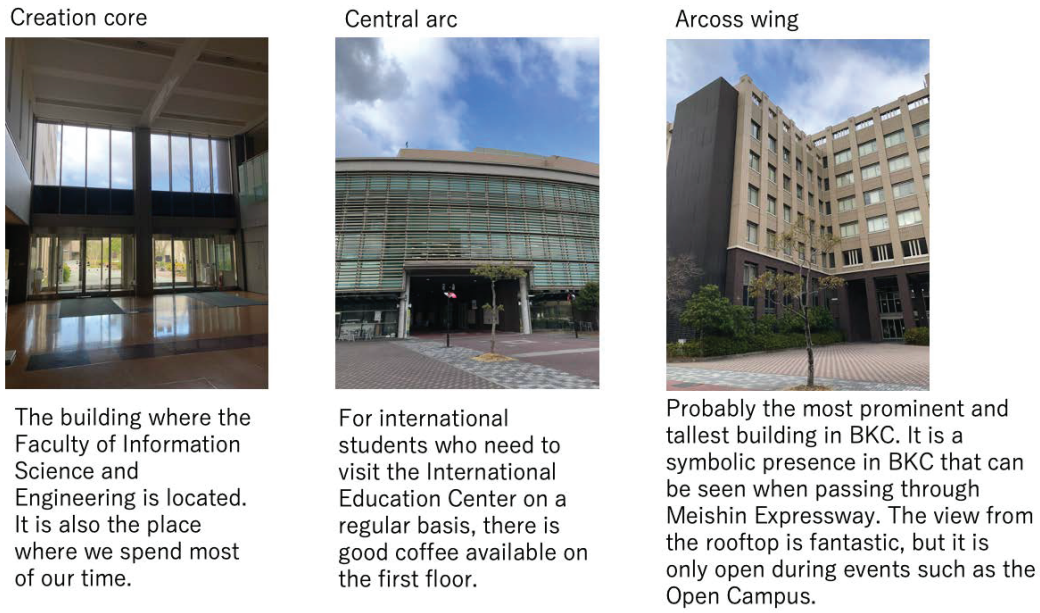

Figure 6. Example of tourist attractions by Group D in Experiment 2. Group D made a map in a physical space.

Figure 7. Example of tourist attractions by Group E in Experiment 2. Group E made a map in a virtual space.

1. The campus was occasionally closed because of COVID-19 from the beginning of 2020. The participants of Experiment 2 might have less personal memories of the campus because of the long shutdown. Thus, the rate of the minor spots of Group D is lower.

4) Selection order of tourist attractions: We examined the selection order of tourist attractions for both groups and assigned a turn number for each utterance. Then, we marked the utterances where the tourist attractions appeared first. The turn number of the utterance was the number where the tourist attraction was chosen. We calculated the averaged numbers of the major and minor spots' first appearance. Each transcript had different lengths; thus, the numbers of utterances differed. We normalized the turn-numbers so that the minimum and maximum were one and 10, respectively. Table IV shows the averaged turn-numbers of the major and minor spots' initial appearance. There was no difference between the averages of major spots of Groups D and E (4.5 and 4.3). There was also no difference in the minor spots (6.6 and 7.0).

TABLE III
EXPERIMENTAL RESULTS IN EXPERIMENT 2. AVERAGED NUMBERS OF TOURIST ATTRACTIONS ON CREATED MAPS, AVERAGED DURATION USED FOR MAP-MAKING, AND AVERAGED RATES OF MINOR SPOTS ARE SHOWN.

Group	Averaged number of tourist attractions	Averaged duration (minutes)	Rate of minor spots (%)
D	9.9	26	49
E	15.3	25	52

TABLE IV
AVERAGED TURN NUMBERS INCLUDING A TOURIST ATTRACTION NAME.

Group	Major spots	Minor spots
D	4.5	6.6
E	4.3	7.0

The common point was that major spots were mentioned first, and minor spots were mentioned later. When choosing tourist attractions, the participants first remembered familiar spots that became major spots. Once they had exhausted the idea, they started considering other preferable spots for tourist attractions. During that time, they would look for spots that others might not know, which they could recall; those spots would become minor spots. The results indicate that the selection order of tourist attractions was not affected by the creators' spaces.

VI. CONCLUSIONS

This study focused on map-making as a collaborative decision-making process. We analyzed the map-making process and conducted experiments to determine the effects of environmental factors. The expected environmental factors were (1) the number of creators, (2) the presence of creators' conversations, and (3) the space occupied by the creators. We asked participants to make a tourist map for a familiar place under controlled factors. We analyzed the created maps and other experimental results. The following three effects were discovered:

(a) The more the creators of a tourist map, the more tourist attractions obtained.
(b) Since conversations are allowed, the creators can change their minds while choosing tourist attractions unknown to others. Thus, the created map has more exciting tourist attractions.
(c) The number of tourist attractions becomes higher if the space in choosing them is a virtual space.

The participants made a tourist map for a familiar place in this study. As the future work, we would like to conduct another experiment to create a tourist map for an unfamiliar place. The three factors will be examined in the next experiments to discover how they affect map-making.

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