



# Using Gamification to Activate University Library Use

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**Abstract.** This paper proposes a territory building game to activate library use. Each bookshelf becomes the territory of the player who spends the longest time in front of it, and players compete to win more territories. The time spent in front of each bookshelf was calculated by matching an image taken every 0.5s by a camera attached to the chest with an image of each bookshelf taken beforehand. According to the questionnaire, players who were more enthusiastic about the game visited the library more frequently and stayed longer, and explored bookshelves they would not normally visit. We present an example of the experimental use of the proposed game in a university library. Fifteen university students were recruited as players of the game, and an eight-week experiment was conducted. The results of the experiment showed that players were divided into four types according to the degree of immersion in the game, with more active players tending to visit the library more often and stay longer, and an interest in new areas of books was also observed.

**Keywords:** Gamification · University library · Territory building game · First-person view image

## 1 Introduction

This paper proposes a territory building game as a means of activating library users. Gamification is used to increase the number of times players use the library and the time spent there. It is also expected to broaden players' interest in books by encouraging them to stop by bookshelves they would not normally stop by.

University libraries are responsible for supporting the collection, accumulation, and provision of academic information related to education and research. They are also expected to support students in recognizing the importance of their own active learning. Therefore, libraries are required not only to provide information but also to function as a place for students to learn and share information. To fulfill these functions, libraries have made various efforts, including the development of learning spaces and distinctive collections by theme.

Meanwhile, the widespread use of the Internet has enabled library users to search for information on the Web and easily access a variety of information resources. Online libraries and academic information retrieval services allow users

to search for more information by keywords and browse information without having to search the library. Students can now easily find the information they need online without having to physically visit the library or search through bookshelves.

However, there is also information that can be obtained by actually visiting a library. It is a chance encounter with a book in a field the user would not normally see. In the real library, the user would actually go to the bookshelf where the book she/he wants to borrow is located. On the way to the bookshelf, there will be many different types of books. Libraries offer the possibility of encountering books that arouse the user's potential interests.

In order to gain such experiences, we have to reach the real-world library. In the present situation where information can be gathered on the Internet, some motivation is needed to take the trouble to go to the library. Therefore, we thought that using gamification as a motivation would encourage the use of libraries. Gamification is a technique for enhancing user's motivation and loyalty by incorporating gaming elements in fields other than games [8,9]. By using this game for library use, we first use the library to participate in the game, but gradually borrow books and use the library as a place of learning.

In order to obtain such an experience, we must visit a real library. With the current situation where information can be gathered on the Internet, some motivation is needed to go all the way to the library. Therefore, we thought that we could promote the use of libraries by arousing motivation through gamification. Gamification is a method of increasing users' motivation and incentives by incorporating game elements into non-game areas [8,9]. By using a game for library use, we aim to encourage users to use the library to participate in the game, and then gradually borrow books and use the library as a place for active learning.

In this paper, we propose a territory building game for the purpose of activating the use of libraries. As a technology to realize the game, we introduce a method to automatically estimate the time spent at each bookshelf from first-person view images in the library. The game encourages users to visit bookshelves they do not usually visit. We examine whether these changes in player behavior have an impact on the expansion of the field of interest in books.

## 2 Related Work

### 2.1 Gamification

Gamification is a method of improving user motivation and incentives by incorporating game elements into non-game areas. It has already been adopted in various fields and studied from various viewpoints [13], e.g., e-learning, marketing, system development and so on [10,14,23].

Studies verifying the effectiveness of gamification have also been studied from various viewpoints, and there are various studies such as the efficient design of gamification [7], influence of game design [22], focusing on usability [12], etc. [20]. Especially in the field of learning, effects such as using the system voluntarily by

using gamification for student motivation have been obtained [3, 15, 26]. In these studies, the purpose is mainly to continue or improve motivation, and many studies have continued or improved motivation of subjects [4, 16, 19]. GamiCAD conducted by Li et al. gave higher achievement and speed than usual by using gamification for AutoCAD's tutorial [17].

In those studies, they use gamification to achieve a specific objective, such as improvement scores. Our study seeks to revitalize library use by using gamification in library use. By using gamification, we aim to increase the number of library visits and the time spent in the library, and focus on how users changed their behavior through the game. We are also examining the impact of user behavior changes on active learning through library use.

## 2.2 Promoting Behavior Change with Simple Game Rules

Our study aims to activate library use by gamification. There are several similar studies targeting libraries and museums [24, 28]. The study by Vandecasteele et al. [27] uses a maze-search type game LIBRARINTH to estimate users' interest in the library. Another study developed a game-like user interface in a library to connect information with the real-world [5].

This paper aims to increase the number of library visits and the time spent in the library by using simple game rules. We expect a change in players' behavior specific to the territory-building game and a consequent accidental broadening of their field of interest. The broadening of the field of interest takes place through encounters with new books.

Thudt et al.'s study [25] also aimed at serendipitous encounters with books in the library by devising visual representations. Our game does not directly produce the encounter with the book itself, but focuses on the effect of leading to an indirect encounter with a new book from the immersion in the game.

## 2.3 Activity Recognition Using First-Person View Images

In the study of gamification, there are ones that developed games for the purpose of extending research and databases that collected information for feedback to game players by adding game elements to physical activity [1, 21].

In these games, a variety of technologies are used in game design. Library-based research includes the development of mobile games using smartphones and QR codes and research using RFID and Bluetooth [11, 18]. Similarly, some studies have gamified museum tours by using exhibits as game contents [24, 24].

In contrast, our research tracks player behavior in the library and reflects it in game information without the use of devices that require player manipulation in the field. We use a wearable camera as a device to track user behavior and collect first-person images of player behavior.

To feed back game information to players, a badge system or a virtual space with user avatars are often used [2, 6]. In our research, we propose a territory building game in which players compete to take bookshelves in a library by mapping the game space to the library space.

### 3 Proposed System

This paper proposes a territory building game as a gamification system to activate university students' use of the library. Figure 1 shows the conceptual diagram of our territory building game in the library.

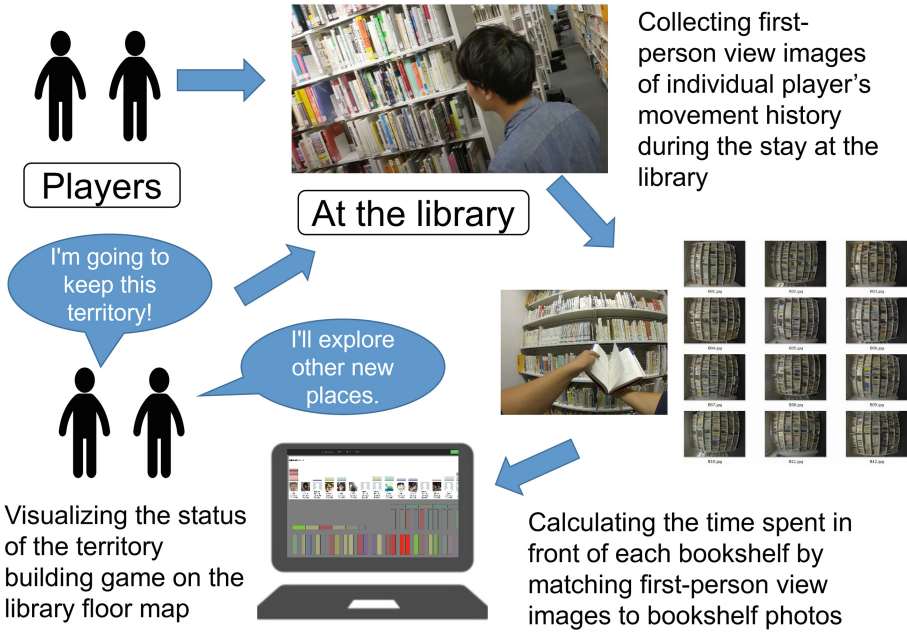


Fig. 1. Conceptual diagram of the proposed territory building game in the library

This paper uses the library as the field for a territory building game. We expect that this will result in an increase in the number of library visits and time spent by players. Furthermore, we hope to broaden the interests of players by using this territory building game. As a side effect of participation in the game, we expect an increase in the number of books borrowed from the library and an expansion of the field of books borrowed. The purpose of this study is to observe whether participation in the game leads to active learning.

The territories in the game are associated with the bookshelves in the library, and the time spent in front of the bookshelves is credited as points for gaining territory. To win in this game, players must increase their territory, and to do so they must visit the library and stay in front of many different types of bookshelves. In other words, the game score will be higher if players visit a variety of bookshelves instead of staying only on the same bookshelf. We hope that such rules of the game will encourage players to encounter new books and help them broaden their interests.



## 4 Territory Building Game in the Library

### 4.1 Design of Territory Building Game

This paper proposes a territory building game that encourages library use. In this game, players can expand their territory by increasing the amount of time they spend in the library. The time spent in front of each bookshelf is counted as a point, and that bookshelf becomes the territory of the player who currently has the most points (Figs. 2 and 3).

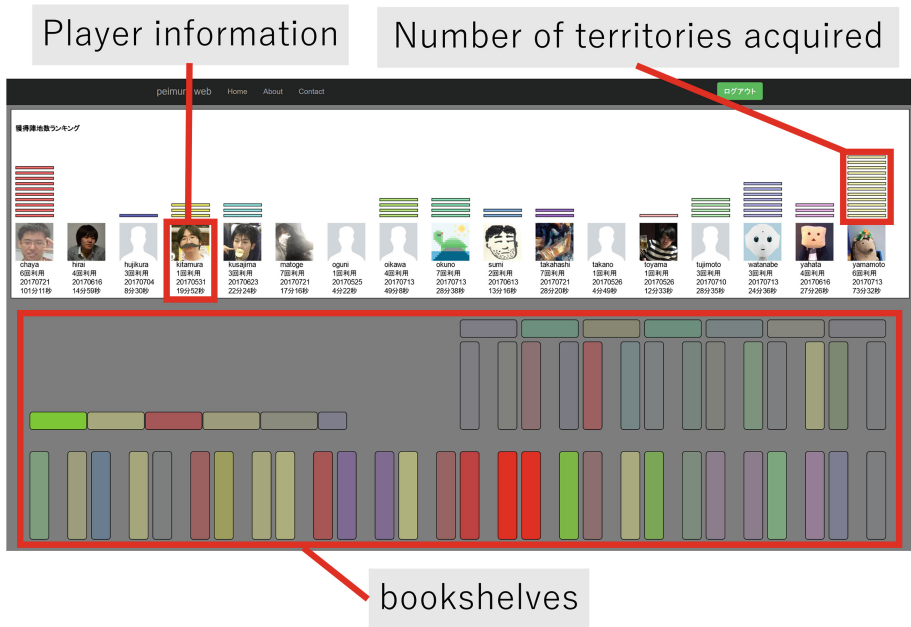


Fig. 2. Display of the number of territories acquired by each player

Players in our game visit libraries to earn points. To automate the calculation of points obtained by staying in the library, players are asked to wear a camera capable of interval photography in front of their chest, and their activities in the library are collected as multiple footprint images. After using the library, the collected first-person images are matched with marker images previously taken of bookshelves in the library to link the player's first-person images to each bookshelf. SURF (Speed-Up Robust Features) was used for matching between images.

The number of first-person images for which the correspondence was confirmed was considered as the time spent, and the game screen reflected points for how long the player spent on the bookshelf. A website was constructed so that the game screen could be easily viewed at any time. The game was played

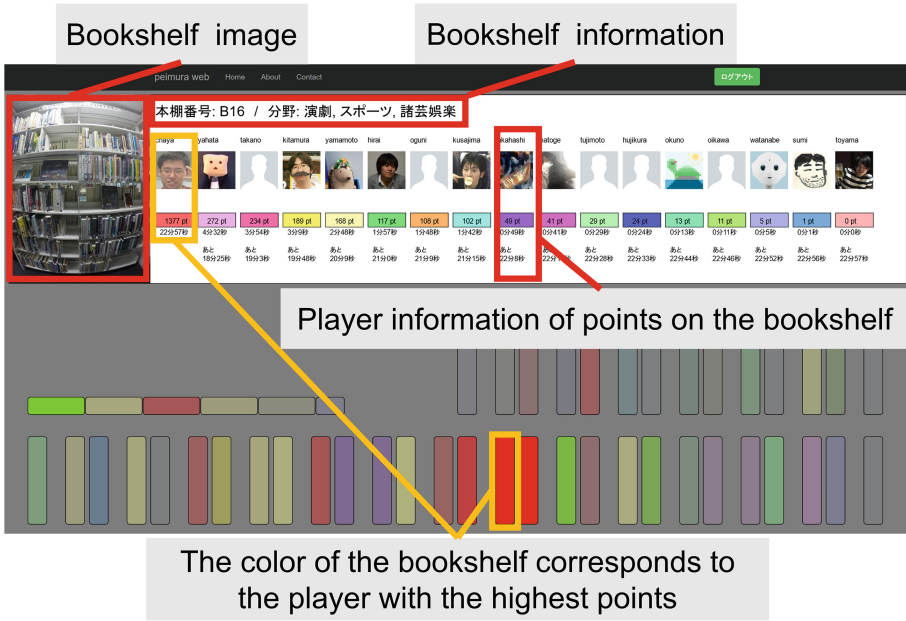


Fig. 3. Number of points earned by each user on a bookshelf

at Future University Hakodate, to which the authors belong, and a floor plan of the university’s library was displayed on the game screen.

Each bookshelf was painted with a color associated with each player to indicate which player currently occupies the bookshelf. The number of points was counted according to the time spent and the color intensity was changed accordingly. In other words, a bookshelf painted in a darker color indicates that it is firmly protected by a particular player, while a bookshelf painted in a lighter color indicates that it is temporarily in someone’s territory but can be taken over quickly.

The game screen displays the points required for each bookshelf to be taken by the player viewing it. This was intended to encourage players to browse this screen prior to visiting the library and to aim for the bookshelves that can be taken efficiently. The ranking of all players according to the number of territories acquired was also displayed to stimulate competition among players.

#### 4.2 Behavior Record of User by First-Person View Image

We used GoPro Hero 4 which is a camera capable of interval shooting to record the behavior of players in the library. Our game players wear the camera on their chest during visiting the library (Fig. 4).

The camera was set to take one interval shot every 0.5s and recorded the player’s behavior as a first-person viewpoint image. The recorded first-person



**Fig. 4.** Walking through the library with a camera attached to the chest

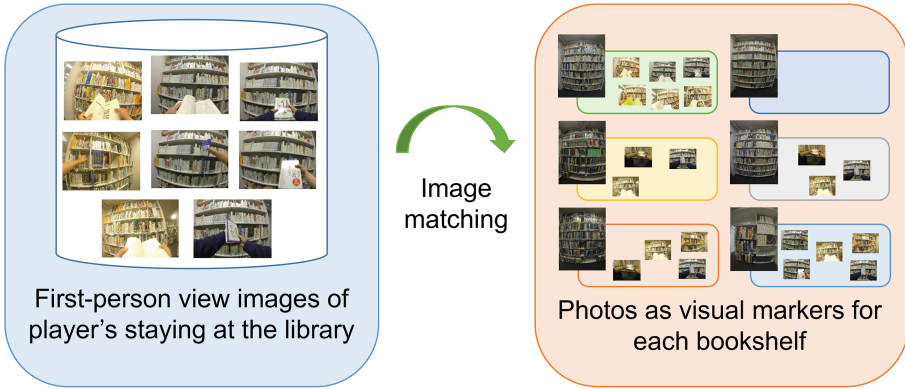
viewpoint image of the player was compared with marker images obtained by shooting each bookshelf in advance, and the feature values were compared.

The system compares the feature points of the two images using SURF, and if the feature values exceed a certain threshold, the system considers that the player stayed in front of the bookshelf corresponding to the marker image with the most features (Fig. 5). Our system matches all first-person images taken during the player's visit to the library to create a record of the player's bookshelf stay (Fig. 6).



**Fig. 5.** Matching bookshelf and first-person view images using SURF

The reason for using first-person view images is that data on stay records for each bookshelf can be collected with a single wearable camera, without the use of complicated equipment. First-person images were also used for more detailed analysis of user behavior in the library.



**Fig. 6.** Classification of first-person view images to bookshelves

## 5 Experimental Use of Our Game in a University Library

### 5.1 Outline of Experiment

We applied our game to a university library and examined what effects the game would have. During the experimental period, participants were asked to wear a camera on their chest to record their behavior when visiting the library, and to view the game page on the web when they wished. The library usage history and the browsing history of the game page were collected.

### 5.2 Method of Experiment

#### Participants

Fifteen university students were recruited.

#### Instructions

The experiment was conducted for about two months. When using the library, participants were asked to walk freely around the library as usual without worrying about the time. No restrictions were placed on the frequency of use, and the participants were asked to use the library whenever they wished.

#### Accumulated data

Participants were asked to wear a camera (GoPro) capable of interval shooting on their chest to acquire first-person images in the library every 0.5s. After using the library, participants were asked to report the camera number on the communication tool Slack, and the experimenter promptly collected the data and reflected the data in the game. Participants were asked to cooperate with a subjective questionnaire regarding changes in behavior before and at the end of the experiment. They were also asked to provide a record of their book borrowing during the period.

#### Hypothesis

We expected that participation in the game would increase the number of visits to the library and the time spent in the library. We also expected that participation in the game would broaden the range of books borrowed.

### 5.3 Result of Experiment

Five players clearly increased the frequency of library use compared to the frequency of use answered in the questionnaire conducted before the experiment. The other 10 players showed no particular change in the frequency of library use. Figure 7 shows the time spent per library visit for all players. Figure 8 shows the change in the average time spent in the library over time during the experiment. Interestingly, the duration of stay tended to decrease with the number of times. Among the players who used the library more frequently, many of them

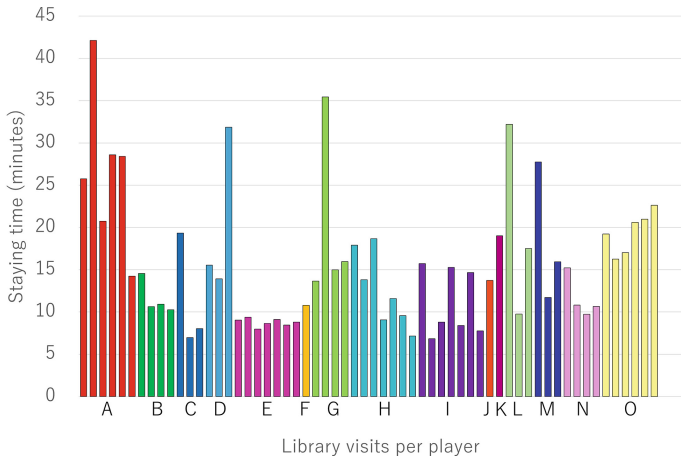


Fig. 7. Time spent per library visit for all players

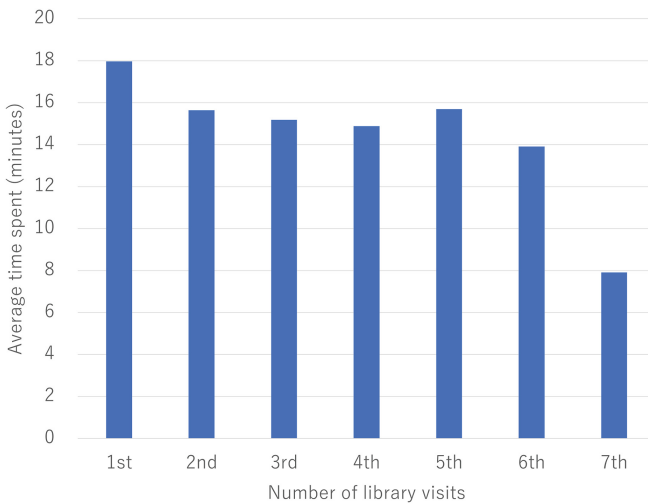
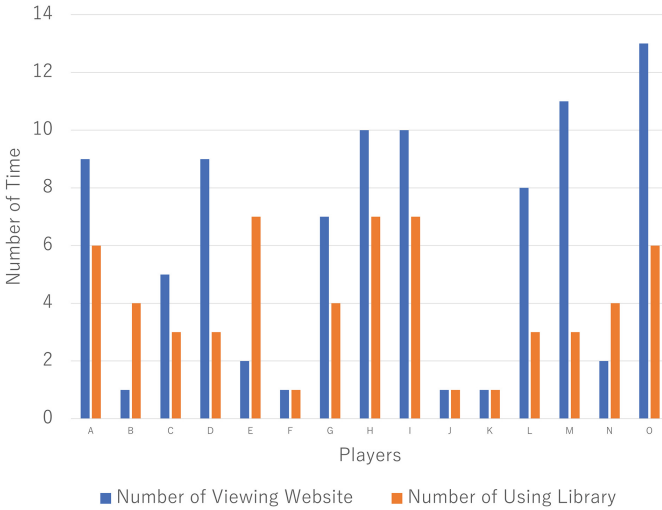


Fig. 8. Change in the average time spent in the library over time



**Fig. 9.** Numbers of library use and game web browsing per player

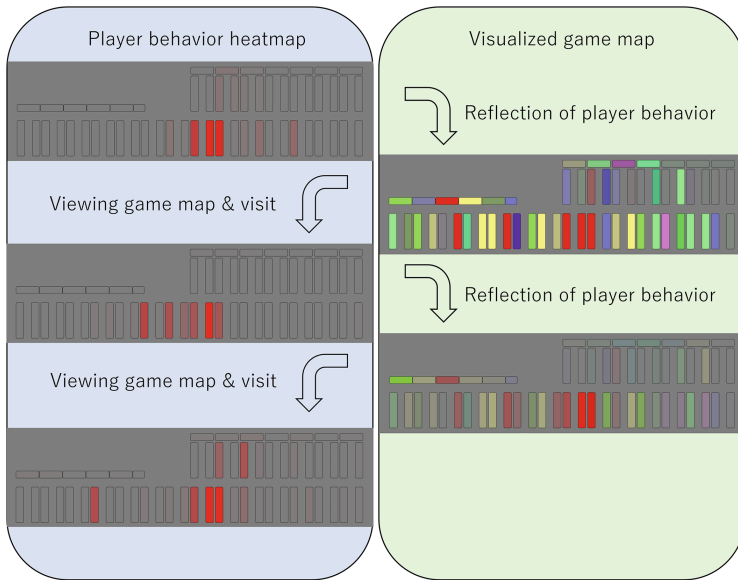
were absorbed in our territory building game. They stayed at the shelves that corresponded to the territories they strategically aimed to acquire, which may have resulted in a shorter time spent in the library.

Figure 9 shows numbers of library use and game web browsing per player. The overall correlation between the number of library visits and the number of game web views is low and appears to depend on the individuality of each player. Basically, players with a high number of web browsing are considered to be more enthusiastic about games, and they use the library more frequently. On the other hand, there were some players who used the library frequently regardless of their enthusiasm for games. Some players were found to have a high number of game web browsing but low frequency of library use. However, the results of the questionnaire confirmed that they actually used the library but skipped wearing the camera.

We observed the following four types of game players.

1. Player who continues to defend territory already acquired
2. Player who explores new territory that is not popular
3. Player who tries to take territory that could be taken from others
4. Player who visits the library regardless of the game

Figure 10 shows the behavior by the player who continues to defend territory already acquired. He acted to protect the bookshelves he had acquired during his first library visit from other players. Therefore, there was not much behavior to develop new bookshelves. In addition, he had many accesses to the web to defend his territory. He did not borrow many books. He was often observed browsing for a while looking for new books while staying in front of the bookshelf that was his territory.



**Fig. 10.** Behavior that continues to defend territory already acquired

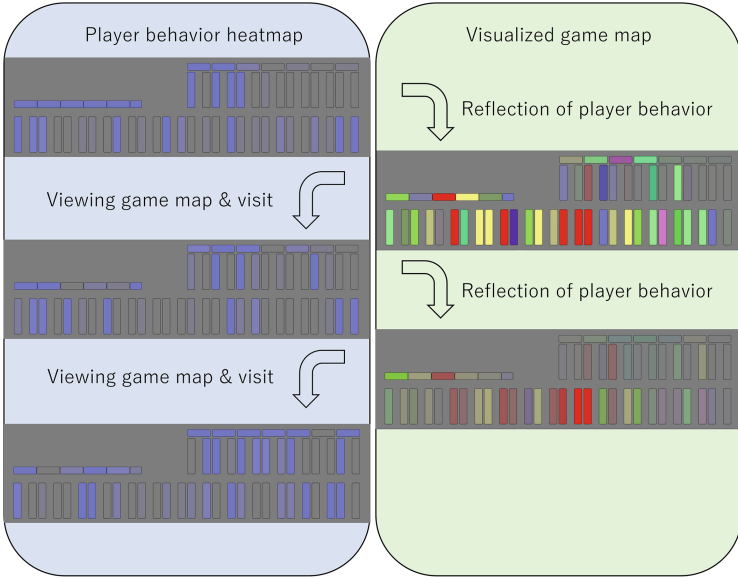
The behavior of players who actively explored the unpopular bookshelves was shown in Fig. 11. This player's strategy is reasonable because an unpopular bookshelf can be easily made into his/her own territory even during a short stay. The player often browsed the game screen and checked the unpopular bookshelves on the game before going to the library. In addition, this player used the library on a daily basis and borrowed many books, and by walking around in new areas, he expanded the field of books he borrowed.

Figure 12 shows the behavior of a player who strategically tries to seize other players' territories that he can take. The player frequently browsed the web site and always tried to keep track of other players' actions. He tended to choose to take bookshelves that were not much maintained by other players, while avoiding the positions defended by type 1 player (who defend the positions they have acquired). As a result, the time spent in the library was gradually increasing.

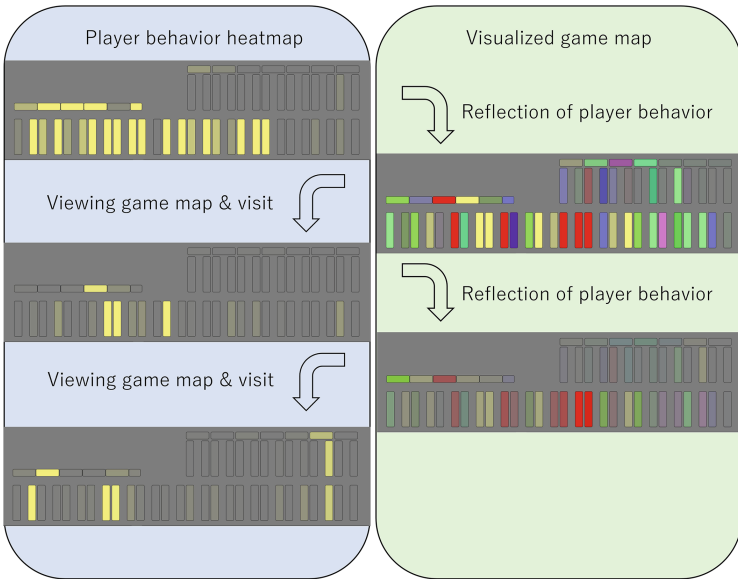
Figure 13 shows the behavior of a type of player who goes to the library to borrow the desired book, regardless of the game. This player browsed the Web site, but less frequently. In the post-experiment questionnaire, the player answered that the game had little effect on his behavior in the library. In reality, however, the player was interested in visiting bookshelves that were acquired by other players, and his book borrowing record showed that he had developed new areas of interest.

Figure 14 represents the field of books borrowed from the library by experiment participants. The fields enclosed by the inner circle are those obtained from the borrowing record prior to the start of the experiment. Since the par-

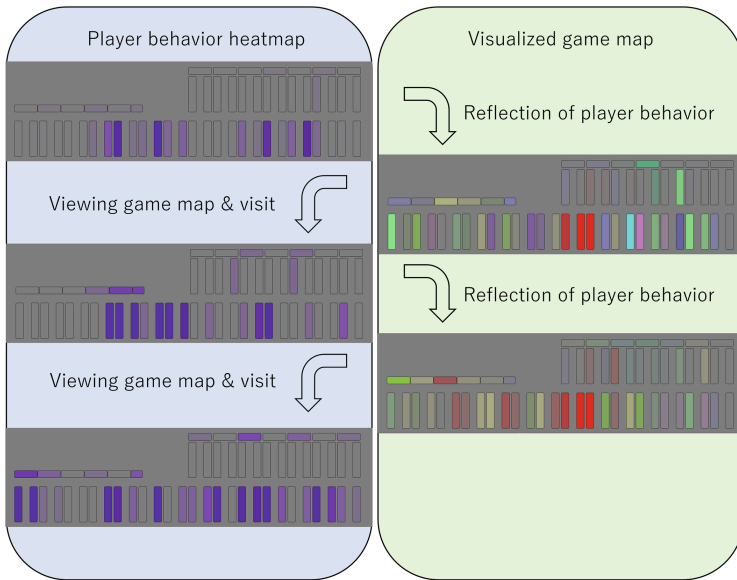




**Fig. 11.** Behavior that explores new territory that is not popular



**Fig. 12.** Behavior that tries to take territory that could be taken from others



**Fig. 13.** Behavior that visits the library regardless of the game

ticipants in the experiment were university students in the fields of computer engineering, many of the books were related to their fields of specialization. The fields of books borrowed during the two months of the experiment were extended outside the circle. These included books in fields such as art, literature, urban engineering, and aerospace engineering, which are different from their fields of specialization.

#### 5.4 Discussion

In this experiment, some players increased their time spent in the game by participating in the game. On the other hand, there were a certain number of players whose time spent in the game decreased as a result of participating in the game. A detailed examination based on the first-person view images and points gained suggests that the time spent in the library rather decreased due to actions taken to efficiently acquire territories. We found that changes in the number of library visits and time spent in the library due to the territory building game varied greatly from individual to individual. Although the rules of the game were simple, the immersion in the game was confirmed to be diverse.

The field of books borrowed was confirmed to have been extended during the experimental period. This result is interesting given that they do not need to borrow books in order to gain a position. The fact that the participants followed

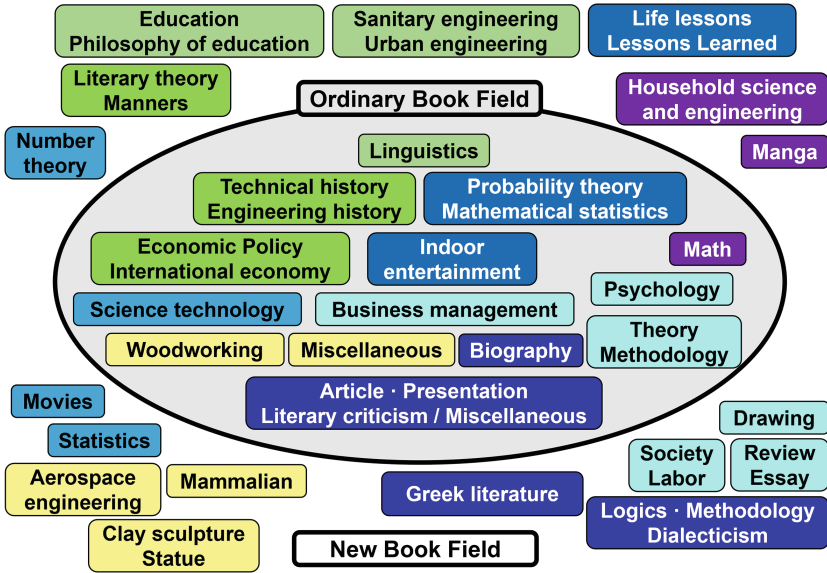


Fig. 14. Expansion of the field of books borrowed by experiment participants

the rules of the game, which were not directly related to their learning objectives, and thus attended the library, increased the chances that they would stay for some time in front of bookshelves that they would not normally stop by. This probably increased the probability that they would be lucky enough to come across a book that caught their interest. It can be said that the game stimulated the habit of going to the library even if the rules were meaningless at first, and this led to active learning. This is the value of gamification, which indirectly achieves the original goal by immersing oneself in rules that have nothing to do with the original goal.

## 6 Conclusions

A territory building game was proposed to activate the use of the library. The experimental use of the game in a university library increased students' opportunities to use the library and, as a result, the fields of books they borrowed expanded.

The way the game affected each player was different, and in some cases the library's behavior became monotonous for some participants. It will be necessary to find out the characteristics of each player from the game history and use different ways of evoking active learning according to individual characteristics.

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