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Shelter GO: Multiplayer Location-based Game for Learning Evacuation

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Abstract: We evacuate to a shelter in the event of a disaster. Furthermore, we abandon the evacuation or wander toward an unknown shelter if we do not remember our shelter location. For successful evacuation, residents should not only remember shelter locations in their local community but also shelter capacities and features. By visiting and observing shelters in advance, residents can remember not only shelter locations and capacities but also shelter features. However, it is difficult to maintain the motivation to visit shelters. Additionally, residents should remember shelters within and outside their local community and acquire several shelter-related knowledge from other residents. Thus, we developed a prototype of a multiplayer location-based game (a geofencing mobile application) that adopts a game element similar to Pokémon GO. The game prototype prompts players to visit different local communities by making them expect encounters from other players and enhancing knowledge acquisition from encountered players.

Keywords: Multiplayer location-based game, knowledge exchange, shelter, evacuation

1. Introduction

Severe natural and artificial disasters have caused damage and deaths worldwide (CRED, 2022). When a disaster strikes or is predicted, we evacuate to a shelter depending on the circumstances. Shelters are indispensable for protecting lives during disasters. However, the evacuation is usually difficult and the difficulty remarkably increases with unpredictable disasters. For example, there is time to decide which shelter to evacuate to and then calmly begin evacuation when there is an incoming typhoon. Contrarily, if an earthquake occurs, we must quickly decide which shelter to evacuate to. Such quick decisions are difficult if shelter locations are forgotten. Failure to remember these locations results in abandoning the evacuation or wandering toward an unknown shelter. In a worst-case scenario, lives may be lost during evacuation. Therefore, remembering the shelter location results in quick decisions and successful evacuation.

Shelters can also be marked on a local community map. Although when there is panic or limited perception (e.g., low visibility due to a blackout), residents may be unable to locate the map, as shelters can be marked, when an unpredictable disaster occurs, residents can begin evacuation by referring to the marked shelter locations on the map. Thus, it is important to remember shelter locations from the map in advance. However, simply looking at the map does not always help in remembering shelter locations because the map is not specialized for evacuation. A hazard map, which not only emphasizes shelters but also visualizes simulated damage (e.g., inundation depth by flood or tsunami), is not only used to remember shelter locations but also to make evacuation plans (e.g., selecting suitable shelter candidates). For example, looking at a flood hazard map can generate the idea that a suitable shelter in a flood is not the nearest shelter surrounded by inundated areas but a little-distant shelter unaffected by inundation. Recently, hazard maps have been digitized based on geographical information systems (GIS) to provide multimedia content and interactivity for better disaster risk reduction planning (Dransch et al., 2010) (McCallum et al., 2016). For example, a web-based hazard map system using social media GIS allows residents to upload and share local disaster information (e.g., potential disaster-induced dangers) on Google Maps (Yamamoto & Fujita, 2015). Another web-based hazard map system is used to educate high school students to identify flood risk areas (Song et al., 2022).

Compared with paper-printed hazard maps, digital hazard maps can be easily distributed among those who frequently use smartphones, i.e., modern people.

Under normal circumstances, residents who consider disasters as someone else's problem will never be motivated to look at a hazard map, regardless of whether it is paper-printed or digital. Thus, a new motivational method other than looking at a hazard map is required for such residents to remember shelter locations. Furthermore, to decide which shelter to evacuate to, residents must remember not only shelter locations but also shelter capacities and features. For example, if numerous residents rush into a small-capacity shelter, the elderly who cannot evacuate quickly might abandon the crowded shelter and evacuate to a less crowded one. Families with infants who do not remember shelter features might go to the nearest shelter, which does not have nursery facilities. A hazard map occasionally shows shelter capacities (and features in some cases) but does not always show information sufficient for various residents to decide on a suitable shelter. For example, as residents should not only study a hazard map but also visit and observe shelters to effectively remember shelter locations, capacities, and features, a hazard map not showing altitudes around shelters might make the elderly take a steep route to the nearest shelter in a high place. However, the new motivational method must prompt residents to visit shelters without feeling burdened, as even for residents who consider disasters a problem, it is difficult to be motivated to visit shelters because of a temporal and/or physical burden.

Introducing game elements is a promising approach for maintaining motivation. Particularly, educational games or game-based learning have attracted considerable attention and have proven high efficacy in various domains, such as disaster education. A narrative-driven location-based augmented reality (AR) mobile game was developed for players to study English by interacting with non-playable characters or to obtain items displayed on a digital map (Lee, 2022), where location-based games are frequently introduced when focusing on learning activities that require real world exploration. For example, a location-based game for local cultural learning displays context-aware learning content (e.g., quizzes) by detecting whether students are near historic monuments (Lin et al., 2018).

Based on this background, we developed a prototype of a single-player location-based game (a mobile application (app)) that motivates players (residents) to visit shelters by introducing a game element similar to that of Pokémon GO (Mitsuhara et al., 2022). The players visit a shelter to earn a point equal to the capacity of the shelter and visit an informative disaster management spot to collect a digital creature by paying a required point from their earned points. The digital creature collection can motivate players to visit and observe various shelters without feeling burdened; thus, players can remember several shelter locations, capacities, and features. Our preliminary experiment revealed that the game prototype helped players to remember more shelter locations and accurate shelter capacities compared with just looking at a hazard map. However, the game prototype focuses on a single-player mode and does not introduce a multiplayer game element, which is a characteristic of Pokémon GO. The single and multiplayer modes have several learning-related merits and demerits, and game/instructional designers should consider a better mode to maximize learning effects in educational games to be developed (Harteveld & Bekebrede, 2011). Because a multiplayer mode is effective in maintaining motivation and learning evacuation by encountering other players, we extended the game prototype to a multiplayer location-based game. The extended game prototype, Shelter GO, focuses on knowledge exchange (KE) among players.

2. Learning Process

Residents must remember shelters for a successful evacuation (i.e., location, capacity, and feature). Furthermore, they must acquire available shelter-related knowledge to decide which shelter to evacuate to (e.g., "This small shelter was crowded during a previous earthquake. Let's evacuate to a large shelter.") Thus, learning about evacuation corresponds to remembering shelters and acquiring shelter-related knowledge.

Residents can effectively learn evacuation by visiting and observing shelters. However, this type of learning forces residents to walk around the real world. Walking may entail a temporal and/or physical burden and consequently cause players to be unmotivated to continue learning. To remove the burden, we introduced a game element similar to that of Pokémon GO, in which players explore the real world to get a reward (i.e., collect imaginary creatures), in the game prototype.

2.1 *Pokémon GO's Potential*

Pokémon GO has gained worldwide popularity, and several studies have been conducted to investigate its influence on physical activity (Lee et al., 2021), mental health (Watanabe et al., 2017), and cognitive performance (Ruiz-Ariza, et al., 2018), among others. According to reports, factors driving the use and gratification of Pokémon GO are enjoyment, challenge, competition, socialization, etc. (Hamari, et al., 2019). Because the game system involves a real world exploration, Pokémon GO is available for health education (Finco, et al., 2018), language learning (Wu, 2021), etc. Using Pokémon GO for educational purposes has several advantages and disadvantages (Tran, 2018). For example, traffic accidents caused by the use must be avoided. However, adopting a location-based game is the most prospective approach for promoting an ideal learning process.

2.2 *Single-Player Mode*

The single-player mode of the game prototype followed the four-phase learning process described below. Although shelter-related knowledge is sharable via a web-based hazard map system, the game prototype does not rely on an external system and achieves knowledge acquisition within the learning process.

- Preview: In the introductory phase, a player (resident) previews a hazard map and gets a sense of shelter locations (e.g., distance and direction) and capacities. Then, the player decides the shelters to visit. This phase can be skipped if the player knows the shelter locations and capacities.
- Walk: This phase involves moving between shelters and acquiring shelter-related knowledge. During this phase, the player will recognize the conditions of routes to and/or surroundings of the shelter and acquire shelter-related knowledge (e.g., "Let's evacuate via a wider street if possible because a huge earthquake can make narrow paths to this shelter impassable.") Acquiring this type of shelter-related knowledge is difficult by only looking at the hazard map.
- Visit and observe (VO): This phase involves remembering shelters and acquiring shelter-related knowledge. The player visits and observes a shelter and clearly remembers the shelter. For example, if there is a remarkable difference between the official capacity shown on the hazard map and the player's presumed capacity via observation, the player will be surprised, thus making the player remember the official capacity. Furthermore, observing the shelter features (e.g., building material and apparent age) can help determine whether the shelter is suitable in the case of various scenarios, such as the occurrence of a mega earthquake. The player walks to another shelter after the observation.
- Visit and collect (VC): Informative spots are placed on disaster monuments and alert signs. The player visits an informative spot to collect a digital creature and obtain tips for successful evacuation. The digital creature collection, similar to Pokémon GO, will eliminate the walking-caused burden and keep players motivated; thus, the collected tips will result in acquiring a wide range of knowledge.

2.3 *Multiplayer Mode*

It is reasonable from an efficiency perspective that players (residents) want to only remember shelters in their local community (i.e., living area). The single-player mode covers the learning process, which presumes that individual players walk around their local community. Ideally, players must remember shelters within and outside their local community and acquire a variety of shelter-related knowledge from other players, as it is impossible to predict where and when a disaster will strike. Additionally, individual players' shelter-related knowledge may not vary depending on their interests, experience, and other characteristics.

The extended game prototype adopts a multiplayer mode that promotes players to visit shelters outside their local community and exchange knowledge with other players. Digital creatures unique to each local community are assigned regardless of the single or multiplayer mode. Players must visit shelters in different local communities to collect the unique digital creatures. Furthermore, the multiplayer mode enables players to meet face-to-face in the real world to exchange their collected digital creatures. The digital creature exchange, which is similar to that in Pokémon GO, prompts players to visit different local communities by making them expect to encounter other players there; the encountered players are expected to have collected unique digital creatures for exchange. Furthermore, to enhance acquired knowledge with the encountered players, the multiplayer mode presents players with the following duties:

- Register knowledge: When collecting a digital creature from an informative spot, a player must register his/her knowledge to the creature. This type of knowledge registration is known as knowledge externalization, which helps stabilize the acquired knowledge. Both shelter-related and general knowledge for successful evacuation are acceptable as the registered knowledge.
- Transfer knowledge: The player can no longer see the registered knowledge on the extended game prototype as, when exchanging a digital creature with another player, the player must transfer the registered knowledge together with the creature. Therefore, the player must remember the registered knowledge while assuming that his/her collected digital creatures will leave.

Figure 1 illustrates the ideal learning process that combines single and multiplayer modes.

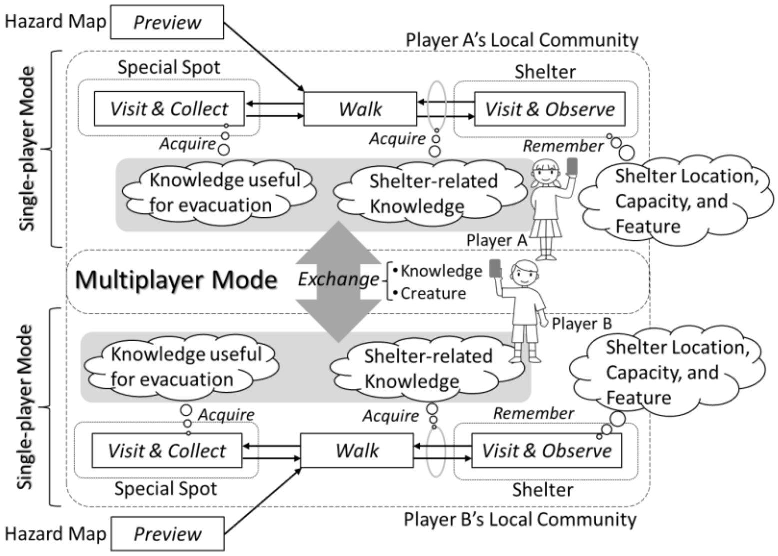

Figure 1. The ideal learning process for remembering shelters and acquiring knowledge.

3. Shelter GO

Shelter GO is a geofencing mobile app extended from our single-player location-based game prototype, which equips the multiplayer mode.

The mobile app, which was developed using Unity3D, works on a GPS-enabled smartphone (or tablet) and allows players to switch to the single-player (i.e., without an Internet connection) or the multiplayer modes (i.e., with an Internet connection). For the single-player mode, the app has basic modules (e.g., phase detection, phase transaction, and point management) and internal data storage (e.g., shelter, informative spot, and point). Shelter data consist of name, latitude, longitude, and capacity (i.e., point). Informative spot data consist of latitude, longitude, digital creature, and tips for successful evacuation. For the multiplayer mode, the app additionally has modules (e.g., knowledge registration and transfer) and external data storage required for KE. The external data storage, where a data interface module (implemented by PHP) makes the transaction, has a CSV file for each KE that records temporary data, such as player ID, player name, creature ID, and registered knowledge.

3.1 Single-player Mode

The app deals with three phases in the single-player mode, i.e., walk, VO, and VC.

1) Walk (Figure 2-a): The app takes a player to the walk phase where a digital map, "Gallery" button, and some information (e.g., earned points) are presented. The map shows the player's current location, shelters, and informative spots. When a shelter is reached (invisible rectangle area enclosing the shelter), the player can move to the VO phase corresponding to the shelter. When an informative spot is reached, the player can move to the VC phase, further, by tapping the button, the player is taken to the gallery where he/she can see the list of the collected digital creatures. At

random intervals, the app compulsorily takes the player to a digital creature encounter event, which is not associated with the location. Although not originally required, this compulsory transfer is prepared to avoid a situation where the player cannot efficiently visit informative spots.

2) VO (Figure 2-b): The app displays the name and capacity of the visited shelter, and the players receive a point equal to the capacity. They can backtrack to the walk phase by tapping the OK button. The app does not display a message encouraging the players to observe the shelter. However, they will be triggered to observe the shelter by comparing the displayed capacity and the shelter presented before them. They will visit another shelter to earn points, as the players cannot earn the point again at the same shelter until a certain time passes.
3) VC (Figure 2-c): At the arrived informative spot, the app first displays instructions (e.g., “Please look at the alert sign about a disaster around you.”). Next, the app activates the rear camera of the smartphone and displays a digital creature in an AR mode, which superimposes the digital creature CG onto the real-time vision using a markerless AR framework. When the players tap on the creature on the screen, the app displays tips associated with the spot (e.g., “0.9 m above sea level here. If you stay here during a big earthquake, you will be engulfed by the tsunami.”). The app provides general tips during the compulsory transfer (e.g., “School buildings are often registered as shelters.”) After reading the tips, the players can acquire the creature by paying the required points.

Figure 2. User interfaces in the single-player mode.

3.2 Multiplayer Mode

The app extended for the multiplayer mode forces a player to register his/her knowledge to digital creature and further adopts a client-server architecture required for KE (i.e., digital creature exchange). The server works as the relay point for KE. Currently, the app only allows KE between two players simultaneously. The KE phase begins when two players meet face-to-face in the walk phase and they agree to exchange knowledge.

1) Register knowledge (Figure 3): When players acquire a digital creature in the VC phase, the app displays a text component for them to register their knowledge to the creature (Figure 3-a). They must input short text knowledge after selecting one of three categories: shelter-related, evacuation general, and disaster general. Furthermore, they can register some pieces of knowledge to the creature. After completing knowledge registration, the app displays the creature together with the message “[The creature’s name] just remembered new knowledge” (Figure 3-b). By tapping the “Refer to Knowledge” button in the walk phase (Figure 3-c), the player can refer to their registered knowledge as the list of the digital creatures collected (Figure 3-d).
2) KE (Figure 4): A player who recognizes a nearby player in the walk phase can speak to the player and suggest KE. If the suggestion is accepted, both players tap the “Creature Exchange” button

(Figure 4-a) to display the menu (Figure 4-b). One player taps the “Host Mode” button and the app displays a QR code (Figure 4-c). Another player taps the “Guest Mode” button and then scans the QR code using the rear camera of a smartphone, which is activated using the app. After a successful scan, the app displays another QR code for the host player to scan. When both scans are successful, the app displays a list of digital creatures (Figure 4-d). The list includes unexchangeable digital creatures (i.e., not-yet-collected digital creatures) on each player’s app. Each player selects one from the exchangeable creatures as a creature to transfer and then selects one or more knowledge registered to the selected creature (Figure 4-e). Then, the selected knowledge is transferred together with the selected creature. The data of the transferred creature and knowledge are deleted from the app, where, when both players finish the selection, the app begins transacting the creature exchange (i.e., KE) and successfully displays the creature CG and the knowledge received via the server (Figures 4-f and g). Next, the players can continue creature exchange. In the walk phase, by tapping the “Knowledge Folder” button (Figure 4-a), the player can refer to the list of knowledge received from other players together with the corresponding received creatures (Figure 4-h). A gauge called “Knowledge Gauge” is displayed above the list. The value on the gauge indicates the amount of exchanged knowledge and expresses the player’s activeness of KE. Every time three pieces of knowledge are exchanged, a special digital creature not associated with an informative spot appears. The player acquires a special creature by paying his/her earned points. These special creatures will promote KE. Thus, the player will visit more shelters to earn points and acquire more knowledge from other players.

Figure 3. User interfaces for knowledge registration in the multiplayer mode.

Figure 4. User interfaces for knowledge exchange in the multiplayer mode.

4. Preliminary Experiment

We conducted a preliminary comparative experiment to examine the difference between the single and multiplayer modes. Here, we focused on the tsunami evacuation because participants resided in a coastal area where a tsunami can cause devastating damage. Thus, the participants must originally learn about evacuation to tsunami shelters.

4.1 Settings

The participants were ten undergraduate students in a computer science course who were found to have low interest and knowledge about tsunami risk reduction through a pre-questionnaire. They were divided randomly into the following groups:

- Group A (N = 5): The participants simultaneously played an extended game prototype that excluded the KE function. They played the game from a different location and registered knowledge to a digital creature when acquiring the creature.
- Group B (N = 5): On a different day from Group A, they simultaneously played an extended game of the prototype (i.e., the multiplayer mode), which allowed them to exchange knowledge. They played from a different location and freely decided whether to exchange knowledge.

After they were instructed on how to use the game prototype, we asked them to learn about the evacuation to tsunami shelters using the app installed on prepared smartphones. We did not impose a time limit although they were informed that it would take approximately 1 h to visit the tsunami shelters. Following the gameplay, each participant completed a surprise test and a post-questionnaire. The surprise test was a recall test asking about the shelter locations and capacities. Showing whether they remembered the shelter locations, they marked the shelter locations on a blank map of an experimental area with no marked tsunami shelters. Furthermore, they wrote the shelter capacities on the map, showing whether they remembered the capacities. The questionnaire required them to itemize all their acquired knowledge from the gameplay, and they were tasked about the effects of the game they played.

The experimental area, covering a 700 m^2 area around the participant’s university campus, had sixteen tsunami shelters (buildings that met safety standards) and eight informative spots (e.g., alert signs against tsunami inundation). The extended game prototype recorded participant behavior, such as visiting shelters, registering knowledge, and exchanging knowledge.

4.2 Results

The mean gameplay durations of Groups A and B were 43.4 and 52.6 min, respectively. Table 1 presents the results of the surprise test for all participants and the number of visited shelters and informative spots. We considered a recalled shelter location to be correctly recalled if a participant correctly marked the shelter–building correspondence on the blank map. For the accuracy rate for all shelter locations (ARASL), the mean values of Groups A and B were 43.7% (31.2%–68.7%) and 33.7% (18.7%–56.2%), respectively. For the accuracy rate for visited shelter locations (ARVSL), the mean values of Groups A and B were 66.5% (41.6%–100%) and 59.3% (33.3%–100%), respectively. For the accuracy of a recalled shelter capacity, we evaluated the mean absolute value of the difference between the correct and recalled capacities for each participant (MAVDC). The mean values of Groups A and B were 86.9 (36.0–217.5) and 70.9 (47.0–141.6), respectively.

For the number of registered knowledges or collected digital creatures (NRK), the mean values of Groups A and B were 6.4 (3–11) and 4.4 (3–6), respectively. For the number of acquired knowledges (NAK), i.e., the knowledge that the participants itemized on the questionnaire, the mean values of Groups A and B were 3.4 (2–6) and 2.6 (2–3), respectively. For the number of exchanged knowledges (NEK) in Group B, the mean value was 2.0 (1–3). Table 2 presents the mean values and standard deviations of the questionnaire with five-point Likert scale questions. The mean values of Q1–Q3 were 4.0 or more in both groups. However, for Q4, the mean value in Group B was 1.2 points higher than that in Group A. The mean values of Q5–Q7, only given to Group B, were more than 4.0.

Table 1. *Quantitative Results for Learning Evacuation Between Groups*

Group A						Group B					
P	NVS	NVIS	ARASL	ARVSL	MAVDC	P	NVS	NVIS	ARASL	ARVSL	MAVDC
1	10	6	68.7%	100.0%	44.0	6	13	3	43.7%	53.8%	55.8
2	9	5	31.2%	55.5%	101.0	7	9	4	18.7%	33.3%	58.3
3	7	4	43.7%	85.7%	36.0	8	6	8	25.0%	66.6%	47.0
4	12	7	31.2%	41.6%	36.0	9	6	6	56.2%	100.0%	141.6
5	10	5	43.7%	50.0%	217.5	10	9	7	25.0%	44.4%	51.7
M	9.6	5.4	43.7%	66.5%	86.9	M	9.2	5.6	33.7%	59.6%	70.9

P: participant, NVS: number of visited shelters, NVIS: number of visited informative spots, ARASL: accuracy rate for all shelter locations (i.e., sixteen shelter locations), ARVSL: accuracy rate for visited shelter locations, MAVDC: the mean absolute value of the difference between the correct and recalled capacities of visited shelters, and M: mean

Table 2. *The Mean Values (and Standard Deviations) of the Five-point Likert Scale Questions*

Questions	Group A	Group B
Q1. Do you agree that this game was enjoyable?	4.6 (0.74)	4.6 (0.80)
Q2. Do you agree that this game increased your interest in disaster management of tsunamis?	4.0 (0.48)	4.4 (0.63)
Q3. Do you agree that this game is more effective for remembering tsunami shelters than looking at a tsunami hazard map?	4.4 (0.80)	4.6 (0.63)
Q4. Do you agree that registering the knowledge to digital creatures contributes to learning evacuation?	3.2 (1.01)	4.4 (0.40)
Q5. Do you agree that exchanging digital creatures with other players contributes to acquiring new knowledge?	N/A	4.2 (0.74)
Q6. Do you agree that exchanging digital creatures is effective for learning evacuation?	N/A	4.2 (0.74)
Q7. Do you agree that you want to actively exchange digital creatures?	N/A	4.4 (0.80)

4.3 Discussion and Limitations

Because of the small number of participants, statistical tests were not applied. Group B participants learned approximately 10 min longer than those in Group A. However, participants in both groups visited a similar number of shelters (NVS) and informative spots (NVIS). Group B participants may have needed more time for KE. This means that Group A participants visited shelters and informative spots more efficiently than Group B participants. Additionally, Group A participants remembered more shelter locations (ARASL and ARVSL) and more accurate shelter capacities (MAVDC) than those in Group B. This means that they learned more successfully than the Group B participants. Although the reasons are unknown, these results may have been caused by participant characteristics, such as motivation, physical condition, and learning style. Thus, the characteristics of the participants may not have been normalized between Groups A and B. The results of the surprise test indicated that Group A was superior to Group B but the differences between the groups were unremarkable. Without or with the KE function, these results may indicate that KE takes time but does not remarkably prevent learning evacuation.

For NRK, the mean value of Group A was 2.0 points higher than that of Group B. However, there was no remarkable difference in NVS and NVIS between the groups. These results indicate that Group A participants collected digital creatures more eagerly than those in Group B when visiting informative spots. However, for the NAK, there was no remarkable difference between the groups. For both groups, and in results that may indicate that by focusing on the NRK and NAK, knowledge registration did not significantly affect knowledge acquisition, participants were expected to acquire shelter-related knowledge in the walk and VO phases and tips (knowledge) for the successful evacuation in the VC phase. For the NEK, under a certain conditions (i.e., five participants in a 700 m^2 area within an average of 52.6 min), it may be reasonable that meeting another player and exchanging knowledge was infrequent. We found one case where KE may have successfully affected knowledge acquisition. On the pre-questionnaire, a participant itemized the two pieces of knowledge that had already been acquired before the experiment:

- *My apartment was assigned as a tsunami shelter. During the earthquake, I evacuated to a higher floor of my apartment.*
- *The tsunami may reach fast. So, I evacuated quickly.*

On the post-questionnaire, the participant itemized the four knowledge acquired through the gameplay:

- *A three-meter-high tsunami may come to the Suketobashi area.*
- *The Abestate building is a shelter.*
- *The Suketobashi area had fewer shelters.*
- *Tokushima University can accept 1,800 people per shelter.*

Before the gameplay, the participant did not know that Tokushima University was a tsunami shelter. However, the participant remembered that the university is a 1,800-person-capacity shelter after the gameplay. They received the following knowledge from another player through KE:

- *Tokushima University is a big-capacity shelter.*
- *I recommend Gym (in Tokushima University) because it is large (as a shelter).*

The participant accurately remembered the shelter location and capacity, as they visited and observed the university campus after receiving this knowledge. Although it is insufficient to clarify the effects of KE, the successful case shows that it should be extensively explored.

For the questionnaire results, the mean values were favorable except for Q4 in Group A. These results indicate that introducing a game element like Pokémon GO for learning evacuation was accepted. Group A participants actively registered their knowledge to the collected digital creatures, but they disagreed on the contribution of knowledge registration. This indicates that knowledge registration is a burden to players due to emphasizing learning rather than gaming. The balance between learning and gaming is a very crucial agenda in Shelter GO, as is often discussed in the field of game-based learning. For all questions, the mean values of Group B were favorable. Group B participants strongly evaluated the game element, knowledge registration, and KE (transfer). Based on the above results, we see that the single and multiplayer modes have merits and demerits, and Shelter GO can allow players to choose the mode based on their learning style and purpose, concluding that Shelter GO is effective in learning evacuation.

5. Conclusion

This study described a multiplayer location-based game (Shelter GO) for learning evacuation by not only remembering shelter locations, capacities, and features but also acquiring shelter-related and general knowledge for successful evacuation. The game prototype (a geofencing mobile app) adopts a game element similar to Pokémon GO and prompts players to visit and observe shelters by enabling them to collect digital creatures. In the multiplayer mode, players must register knowledge to the collected digital creatures and can exchange the registered knowledge (a corresponding creature) with the encountered players. We see that the small-scale experiment had some limitations and was insufficient to clarify the effect of KE. Therefore, we must conduct large-scale experiments involving a diverse range of participants. Additionally, we will refine the visual design of the app (e.g., more attractive digital creatures) to make it more appealing to the public. We concluded that, through the preliminary experiment with few participants, KE does not remarkably prevent learning evacuation, and it is effective in learning evacuation, as knowledge registration and exchange motivate players and enhance knowledge acquisition from the encountered players.

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