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Make it Fun: The Application of Gamification in Earthquake Education for Foreigners

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Abstract: In this paper, we explore the application of gamification in earthquake education. Earthquakes occur frequently in Japan, so earthquake education is essential for foreigners who live in or intend to visit Japan. However, the earthquake education is neither compulsory for foreigners, nor is it engaging somewhat. To make the earthquake education more attractive, gamification is employed. An ICT-based system, including gamification thinking, is developed to improve foreigners' participation in the earthquake education.

Keywords: Earthquake education, foreigners, gamification, ICT-based earthquake education system

1. Introduction

Japan has frequent earthquakes every year. However, benefiting from systematic earthquake education, the casualties of earthquake and ensuing tsunami are relatively low in Japan. However, earthquake education in many countries is not satisfactory, which makes people lack necessary earthquake knowledge and survival skills. Or some countries have few earthquakes happening, and people have not experienced earthquakes, so they have no earthquake awareness. These foreigners may fail to survive the earthquake if they were in Japan. Therefore, earthquake education is extremely important and indispensable for these foreigners intending to visit Japan.

Taking account of the shocking destructiveness of strong earthquake and the possible ensuing tsunami, as well as the unsatisfactory situation of foreigners' earthquake education, our research work concentrates on foreigners' earthquake education, helping those foreigners who lack earthquake education but plan to go to Japan.

Our research work includes two phases according to the timeline that foreigners enter. The first one is preparation phase. In this phase, foreigners start their earthquake education in their own countries. They may make preparation in advance for their upcoming trip to Japan, building earthquake awareness and learning some earthquake knowledge by using our system. The second one is practical phase, which means learning in Japan. In this phase, foreigners will learn more earthquake knowledge and some practical evacuation skills. For example, foreigners should know the shelters situation nearby their home, so they can arrive at the suitable ones as fast as possible in case of earthquakes. They also need to know what emergent items they should prepare in advance.

At present, our research work is in the first phase, i.e. preparation phase. Gamification is introduced into our system, which makes the somewhat boring earthquake education more engaging to improve foreigners' participation.

The remainder of the paper is organized as three sections. The second section is brief introduction of gamification. The third section is the introduction of the ICT-based system, as well as the gamification applied in the system. The fourth section is the summary and future work.

2. Gamification: Make it more attracting?

2.1 Definition and application

In the GDC (Game Developer Conference) in 2011, gamification, as a new topic even without definition, was proposed and discussed its pros and cons. Some researchers and game makers harbored opposing views towards this term, but this did not hinder its rapid development. Gamification is defined as: the use of game design elements in non-game contexts (Deterding et al., 2011); the use of game elements and game-design techniques in non-game contexts (Werbach & Hunter, 2012). The definition currently has been reached a consensus and admitted by the majority of researchers.

The definition contains three key points: design elements, game mechanism, non-game context. In brief, gamification is learning from game. Kavin Werbach also said in his online open course at the University of Pennsylvania: Gamification is about learning from games, not just in the sense of learning about the games themselves but understanding what makes the games successful. Understanding what makes the games engaging. Understanding what games can do, why games have power. And then taking some of those techniques, and thoughtfully applying them to other situations which are not themselves games (Kavin Werbach).

Gamification is currently a hot spot and is being widely used in various fields, such as the Internet, medical/health, education, finance etc. (Cudney et al., 2015; Robson et al., 2016; Yang et al., 2017; Hiroyuki & Masami, 2017). Gamification may affect the users' psychological tendency, thereby increasing users' enthusiasm and participation, improving the users' experience. In short, gamification makes some 'boring' tasks more interesting, thus attract more users to complete them.

In educational field, gamification has also been playing a role (Hanus & Fox, 2015; Roy & Zaman, 2018; Yildirim, 2017; Tsay et al., 2018). Many researches and experiments have been done to prove gamification as an effective method in increasing engagement as well as learning motivation. By introducing game design elements and well-designed game mechanisms, traditional classrooms are becoming livelier and more attractive, making learning more interesting and easier, and most students' enthusiasm and participation can be significantly improved.

Our system introduces gamification to earthquake education for foreigners because although earthquake education is important in Japan, it is not compulsory for foreigners. Our research and system consider the characteristics of earthquake education and the ICT system, as well as our research objects. Besides the widely used game elements in traditional classrooms, like PBL (Points, Badges, Leaderboards), well-designed gamification mechanisms and some new game elements applicable to ICT system are introduced into our system.

2.2 General gamification taxonomies and elements

Currently, the most commonly used game elements are up to dozens. In general, gamification taxonomies vary according to the different perspectives or fields applied in. For example, table 1 shows one taxonomy. In educational field, some researchers classify these common elements into five dimensions, performance, ecological, social, personal, and fictional (Toda et al., 2019).

Table 1. A gamification taxonomy and common game elements

General	Tutorials, signposting, loss aversion, progress & feedback, theme, story, flow, curiosity, time pressure, scarcity, strategy, consequences, investment
Schedules	Random rewards, fixed reward schedule, time dependent rewards
Socialiser	Guilds & teams, social network, social status, social discovery, social pressure, competition
Free spirit	Exploration, branching choices, Easter eggs, unlockable & rare content, creativity tools, customization
Achiever	Challenges, certificates, learning & new skills, quests, levels, boss battles
Philanthropists	Meaning & purpose, care-taking, access, collect & trade, gifting & sharing, sharing knowledge
Disruptor	Innovation platform, voting & voice, development tools, anonymity, light touch, anarchy
Player	Points, physical rewards, leaderboards, badges, virtual economy, lottery & game of chance

In our system, the game design elements being used or going to be used include badges, points, leaderboards, mystery box, exploration, time-limited missions, Easter eggs, information sharing, etc. These elements are classified as reward mechanism, competition mechanism, free spirit mechanism, achievement mechanism, and challenge mechanism. Some mechanisms are overlap in elements, e.g., Easter eggs belong to free spirit mechanism, meanwhile, users get some rewards (reward mechanism) from the eggs. Table 2 shows game elements and mechanisms applied in our system.

Table 2. Game elements and mechanisms used in our system

Reward mechanism	Points, badges, mystery box
Competition mechanism	Leaderboards
Free spirit mechanism	Exploration, Easter eggs
Challenge mechanism	Time-limited missions
Achievement mechanism	Information sharing

In the current phase, i.e. preparation phase, the system includes some basic game elements, like point, badge, leaderboard, mystery box. In the second phase, i.e. practical phase, some new game elements, and game design mechanisms will be employed in the earthquake education system. The interpretation of how the gamification works in our system is given in section 3.

3. Earthquake education system applying gamification

The system includes two parts: server side and client side. Figure 1 illustrates the architecture of the system.

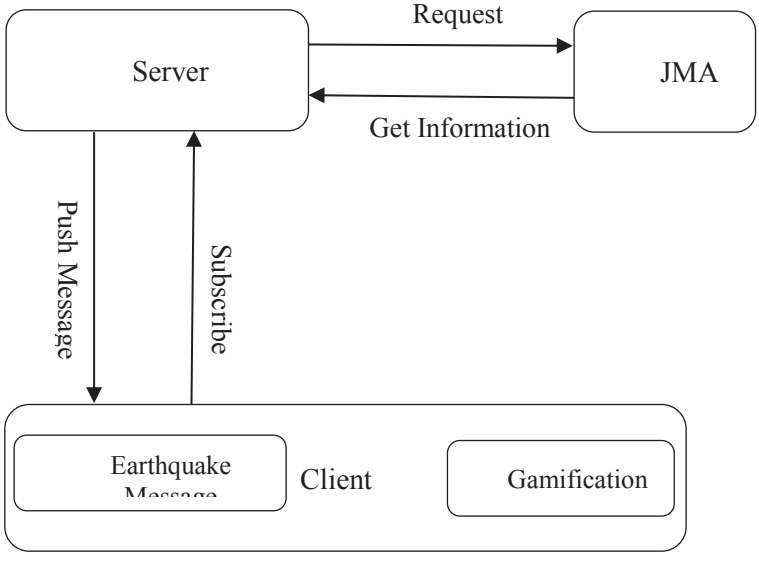

Figure.1 System Architecture

3.1 Server side

The server is designed and developed based on the Springboot framework and implemented using Java development language. Currently, it supports up to 200 concurrent accesses in this version.
The server requests earthquake information from JMA (Japan Meteorological Agency) in the pulling type, accessing the designated URL once a minute to fetch the XML format file. The server parses the XML file to check if new earthquake information is available. If there are some new earthquake information URLs, the server accesses the URLs respectively, and abstracts the earthquake information.

The server supports the WebSocket protocol. WebSocket enables the Client side to get new earthquake information in the push type. The client side makes a subscription to the server, and the server will push the new earthquake information to the client side, which reduces the client's polling times and http abuse.

In addition, the server provides some auxiliary functions, such as storing the user's personal profile, settings, and learning records, if this user is a registered user. The server will push remote notification when our client side is out of connection.

3.2 Client side

The client side is in the form of a cross-platform application that supports iOS and Android operating systems. The App is developed by Flutter toolkit and Dart development language. The App fetches earthquake information from the server through subscription, and then displays them according to seismic magnitude and epicenter.

Gamification is a complement when the learning motivation is not sufficient. All game elements are related to intrinsic or extrinsic motivation (Ryan & Deci, 2000; Huang & Hew 2018). In this paper, besides the basic game elements PBL (points, badges, leaderboards), mystery box was employed. Points and badges belong to reward mechanism and relate to extrinsic motivation. Mystery box belongs to reward mechanism, but it is related to intrinsic motivation. Leaderboards belong to competition mechanism and relates to intrinsic motivation.

In the early stage of earthquake education, extrinsic motivation is thought to quickly attract more users. As mentioned above, earthquake education itself is a relatively boring thing, nor a compulsory course, which means extrinsic motivation may be an effective way to attract users' attention. An engaging beginning may motivate more foreigners to access the earthquake education. Intrinsic motivation is an important factor to maintain users' long-term engagement. In the follow-up work, some game elements and game mechanisms integrating intrinsic motivation and extrinsic motivation will be employed in our system.

The App supports various learning methods and materials. It enables users to learn anytime and anywhere. It provides learning materials including URL, video, text, picture, etc. Users can get rewards according to their study. The figure 2. shows some snapshots related to learning in the App.

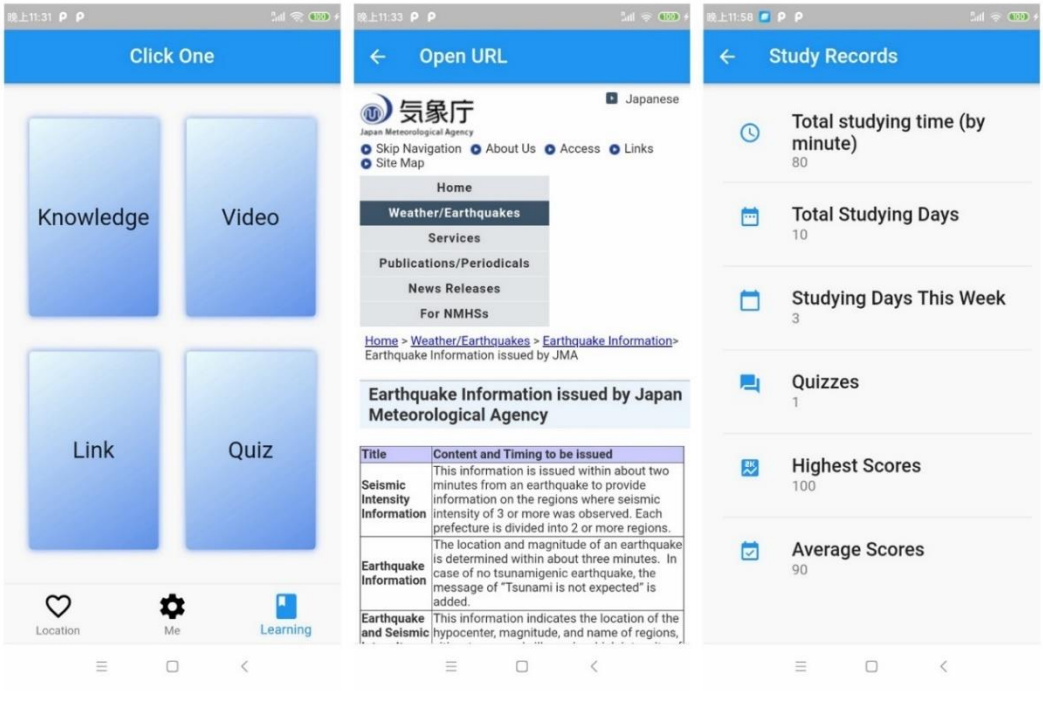

Figure 2. Snapshots of learning in App

In details, the rules of applying game elements in the system are that the more users use the system, the more points they obtain, the larger number and more types of badges they gain, as a result their rank is higher. Users may get a mystery box containing a random number of points. The specific rules are as follows:

1) awaking the app gets one point, no more than one point per day.

2) browsing the pushing-message add one point, no more than 3 points per day.

3) reading learning materials for at least five minutes can get one point, at most 3 points per day.

4) completing a quiz can get one point, at most one point per day.

5) a high correctness over 90% will gain an extra point.

6) using the app for at least five days in a week will win a bee-badge for hard working.

7) full marks in test gains a clever monkey-badge.

8) each week, according to the number of badges, the first place on the leaderboard will gain the title of master, and a mystery box including a random number of points between 1 to 5.

9) users may get a mystery box containing points between 1 to 5 during using the system, and the possibility is calculated based on a random number, and users' overall performance is considered too, as shown in the third snapshot in figure 3.

The snapshots related to gamification are shown in figure 3.

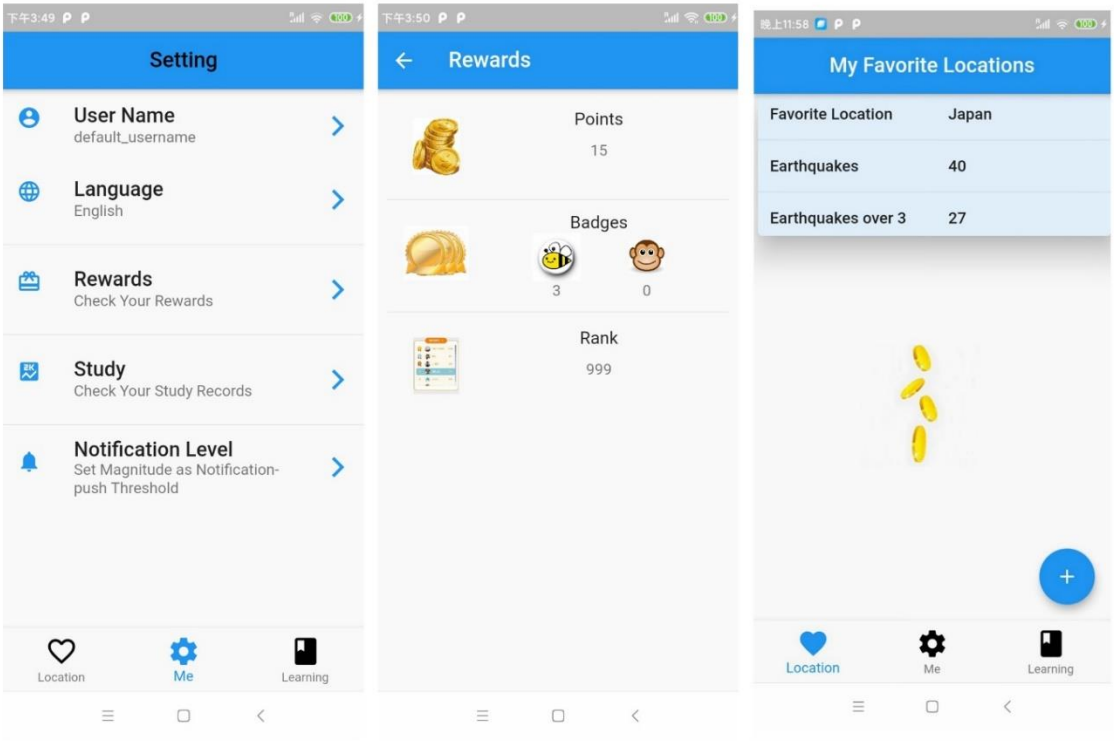

Figure 3. Gamification snapshots

4. Summary and future work

In brief, the popularity of foreigners' earthquake education is unsatisfactory. Lacking earthquake awareness results in low engagement in earthquake education, which may be a negative factor for foreigners intending to Japan. To improve this situation, gamification is adopted in our earthquake education system. By using some game elements and mechanisms, gamification makes the earthquake education more engaging, which is a complement of learning motivation.

The follow-up is to enter the second phase - practical phase. In this phase, our system will support users to obtain some practical earthquake knowledge and skills, such as real scenario learning shelter map. Moreover, some new gamification elements and mechanisms based on the shelter map,

will be introduced into the system, such as exploration, time-limited missions, Easter eggs, and information sharing.

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