Serious Game For Training to Escape from Disasters and Deal with Accidents

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Abstract: The purpose of this study is to consider training methods to increase the ability to respond to disasters and accidents, conduct experiments, and verify their effectiveness. Based on this method, we decided to develop a serious game. The serious game developed in this project focuses on learning how to respond to disasters and accidents. Players encounter disasters and accidents in their daily lives. Consequently, the protagonist is portrayed as having bad luck and experiencing various unfortunate events. To facilitate learning, a time limit is set, and the time limit is extended to encourage players to continue playing. Specifically, the game begins with a fortune teller informing the protagonist that they will face an unfortunate event, and if they do not successfully navigate it, they will die within a month. If the protagonist overcomes the event, they will receive a lucky item. Collecting ten lucky items will extend their life by one month. To motivate players, unique and numerous lucky items are provided to encourage continued play. To give players an incentive to play the game, we decided to provide unusual lucky items and numerous lucky items to encourage them to continue playing. To verify the effectiveness of this game, a control group experiment will be conducted at the end of the game development.

Keywords: Serious game, Learning

1. Introduction

Japan is a region highly susceptible to earthquakes, often resulting in severe damage. Examples include the Great Hanshin-Awaji Earthquake in 1995 and the Great East Japan Earthquake in 2011, both of which led to significant destruction. The extent of damage varies by region; for instance, fires caused the most harm during the Great Hanshin-Awaji Earthquake, while the tsunami was the most damaging aspect of the Great East Japan Earthquake.

In addition to major disasters like earthquakes, numerous everyday accidents have occurred in recent years, leading to minor injuries and occasionally necessitating emergency medical treatment. According to data from the Disaster Prevention and Safety Division of the Disaster Prevention Department of the Tokyo Fire Department, the number of individuals transported to emergency services between 2014 and 2018 increased annually, reaching 144,548 in 2018, the highest figure in the past five years. Approximately half of these accidents took place in residential buildings and other domestic locations.

The aim of this study is to propose training methods that enhance the ability to respond to disasters and accidents effectively.

2. Serious Game

2.1 Serious Game

Serious games are simulation games that address real-world issues, such as natural disasters, with the goal of mastering abilities beyond mere game completion. The term "serious games" originated in the United States around 2002, emphasizing the importance of achieving goals outside the game.

2.2 Related Research

Serious games have been employed in various domains, with cases where competence has been increased through training and education. Disaster risk awareness, the understanding of the dangers posed by disasters when they occur, has been targeted by researchers. Urano et al. developed a game system that allows individuals to learn about disaster risk while having fun and practicing disaster drills. The evaluation experiment confirmed that the system improved disaster risk perception. Kikuchi et al. developed a serious game for preliminary learning of evacuation behavior during disasters and verified its learning effectiveness. Comparative experiments with text-based learning showed that the game's learning effect was slightly inferior to text-based learning, but the game's inherent features made learning enjoyable, and learning outcomes could be further improved by increasing the allocation of game elements.

3. Games Development

3.1 Methodologies

Caserman et al . assert that a serious game consists of a serious part and a game part, and maintaining a balance between the two is crucial. In the serious part, ensuring the accuracy of learnable knowledge and providing appropriate feedback are important. In this study, the accuracy of knowledge is ensured by creating learning materials from specialized books and other sources. Additionally, for each action the player selects in the game, it is presented whether the action was correct and an explanation is provided regarding the appropriateness of the chosen action.

In the game part, it is essential to provide players with an incentive to play and a mechanism for continued gameplay. Rewarding players for making correct choices and offering unique items that cannot be found in everyday life should motivate players to engage with the game. Also, offering a large number of items and designing the game to encourage collection can promote continuous play.

3.2 Game Background

The serious game developed in this project focuses on learning how to respond to disasters and accidents. Players encounter disasters and accidents in their daily lives. Consequently, the protagonist is portrayed as having bad luck and experiencing various unfortunate events. To facilitate learning, a time limit is set, and the time limit is extended to encourage players to continue playing. Specifically, the game begins with a fortune teller informing the protagonist that they will face an unfortunate event, and if they do not successfully navigate it, they will die within a month. If the protagonist overcomes the event, they will receive a lucky item. Collecting ten lucky items will extend their life by one month. To motivate players, unique and numerous lucky items are provided to encourage continued play.

3.3 Game Operation and Overall Flow

The game begins when the player presses the "Game Start" button. An introductory video explains how the main character met the fortune teller and presents the game settings to the player. The game starts with the player character waking up in the morning at home. A tutorial screen is displayed, explaining the game controls. Specifically, the 'W', 'A', 'S', and 'D' buttons are used to move the character, while the 'E' button displays the in-game player character's smartphone screen. The 'I' button provides a list of lucky items acquired so far.

The game's flow, as shown in Figure 1, involves the protagonist experiencing various unfortunate events, with the player choosing a response from a list of options within a limited time frame. If the correct response is chosen, the player receives a lucky item; if not, the player loses life points. The correct response and its explanation are also presented at that time. Depending on the player character's location, various events will take place. Throughout a month, there are a total of 15 opportunities to obtain items.

After the tutorial, the player character's smartphone alarm sounds. Simultaneously, the screen displays 'Press E to see your smartphone'. When the player presses the E button, the smartphone screen shows 'I'm leaving now', and the player moves to the front door.

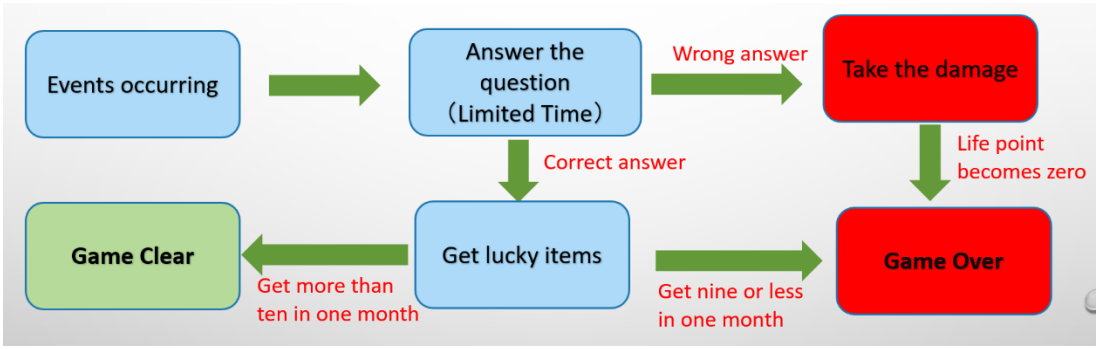

Figure 1: Game Flow

Upon approaching the front door, the 'Destination' selection screen appears, allowing the player to choose between 'home, school, shopping street, park, mountain, or beach'. In this case, a "!" is displayed at the location of an event. The player can select a destination by hovering the cursor over it.

If the player selects 'Home', the question "Would you like to spend the day at home?" is displayed, and selecting 'Yes' returns the player to the room. If there is a house event, the event will occur. If there is no event, the player is free to spend the day at home. When approaching the bed, the player is asked, 'Do you want to end the day?', and if they select 'Yes', the day concludes.

If another location is chosen, the player is teleported to that location, and an event occurs if applicable. If there are no events, the player is free to explore the chosen location. To return home, the player must go back to the teleportation point and select 'Go home'. The events occurring in the game and their locations are listed in Figure 2. There are two bonus events, during which players are guaranteed to receive lucky items.

Order of events	Incident	Location
First	Locked in an elevator	Shopping district
Second	Mercury products cracked	School(laboratory)
Third	A person was found with a broken bone	Mountain Trail
Fourth	A student drowned (knowledge of cardiac massage).	Beach
Fifth	Park Cleanup (Bonus Event)	Park
Sixth	A lens-effect fire	Home
Seventh	Heatstroke	Park
Eighth	My friend's throat got stuck	School(Classroom)
Ninth	Prevention before typhoon	Home
Tenth	Walking on the beach (Bonus Event)	Beach
Eleventh	Fire Evacuation	School
Twelfth	The stampede	Shopping district
Thirteenth	Bites from poisonous insects	Park
Fourteenth	Oil pan on fire	Home
Fifteenth	A fallen man was found (Knowledge about the use of AEDs)	Shopping district

Figure 2: In-game events

3.4 Game Demo

Next, I'll choose one of the above events to demonstrate how the game works.

Figure 3 show the game event as the 'oil pan ignition.' The ignition is caused by the oil temperature being too high. Using cooking utensils with safety features, such as stoves equipped with overheat protection, can be effective. However, most importantly, once the stove is lit, it is crucial never to leave it unattended.

The event begins with the player controlling the character and moving to the front door. By selecting 'Kitchen' from the map list, the player is teleported to the kitchen. Following that, a conversation UI is displayed, as shown in Figure 3. The text on the picture should read: 'What should I have for lunch? Let's make tempura. '

Figure 3: Game event

After the conversation begins, the player is tasked with making tempura, and a pot appears on the stove. Approaching the stove, as shown in Figure 4, triggers the ignition of the oil in the pot. The text on the picture should read: "The oil temperature is too high, and the pot is on fire. What will you do?" The choices are "Cover the pot with a lid" and "Pour water into the pot."

Figure 4: Above Event Question

The correct response for this accident event is to "Cover the pot with a lid." The reason is that this can extinguish the fire by cutting off the air supply. Using a wet sheet, bath towel, or similar items instead of a lid can also be effective, but there is a risk of reignition if the cover is removed too quickly. Therefore, it's important to wait until the oil temperature has sufficiently cooled down. In the case of a correct response, the fire will stop, a lucky item will appear, and the player can collect the lucky item.

4. Game Validation

First, before conducting the experiment, the subjects are given a small test about responses during accidents or disasters. This test aims to assess the participants' current knowledge of the topic. After completing the test, their scores are recorded. The test consists of a total of 10 multiple-choice questions, all related to accident events that occur within the game. The test questions are provided in Figure 5.

Q1. When trapped inside an elevator, what is the correct course of action?
A. Tap on the elevator door
B. Press all the buttons for different floors
C. Climb up the elevator shaft to inspect the cause of the malfunction
D. Stomp your feet in the elevator
Q2. What should you not do when a mercury product breaks?
A. Open windows to ensure air circulation
B. Sweep up the fragments with a broom
C. Wear gloves and collect the fragments
D. Evacuate the crowd
Q3. When dealing with a fracture, what should you not do?
A. Transport the injured person directly
B. Observe the wound to determine the type of fracture
C. Immobilize the fractured area
D. Stabilize the injured person
Q4. How many compressions should be performed in one minute during cardiopulmonary resuscitation (CPR)?
A. 80-100 B. 70-90 C. 100-120 D. 120-140
Q5. In which season is house fire most likely to occur?
A. Spring B. Summer C. Autumn D. Winter

Q6. What is the name of the rescue method when someone is choking?
A. Kremlin Emergency Method
B. Ihumrick Method
C. Heimlich Maneuver
D. Muhairrick Method
Q7. What should you not do if you encounter a train accident?
A. Bend down to pick something up
B. Leave the scene immediately if something like that seems likely to happen
C. Look for something hard
D. If you accidentally fall, lie down sideways.
Q8. What should you not do after being stung by an insect?
A. Wash the wound
B. Take a photo of the venomous insect
C. Cut open the wound to remove the venom
D. Go to the hospital
Q9. What should you not do when a pot catches fire?
A. Put water into the pot to extinguish the fire
B. Cover the pot with a lid to extinguish the fire
C. Turn off the gas stove
D. Put a wet cloth over the pot
Q10. What is incorrect about using an AED (Automated External Defibrillator)?
A. Touching the patient during heart rate analysis
B. Moving away from the patient during defibrillation
C. Performing CPR on the patient before using the AED
D. Performing CPR on the patient after using the AED

Figure 5: Test Qu Question

Following the test, the subjects are asked to play the game, and after finishing, I will record their gameplay results. Subsequently, they will respond to a questionnaire regarding the game. I will ask questions from various domains and draw conclusions from the questionnaire's outcomes. The questionnaire's contents are as outlined in Figure 6.

① Survey about Increased Knowledge of Relevant Information:
1. After completing the game, my knowledge about everyday life accidents has increased.
2. There were many things I didn't know before.
3. After finishing the game, I feel well-acquainted with the specific applications of the related knowledge points.
4. I believe that in the future, I can solve similar problems effectively.
② Survey about Superiority Compared to Other Training Methods:
1. Studying within the game was more engaging than using books.
2. Studying within the game provides a greater sense of presence compared to studying from books.
3. Training methods within the game are more diverse compared to real disaster preparedness training.
4. I didn't experience much motion sickness (3D sickness) during game progression.
5. I was able to learn while enjoying the game.
③ Survey about Enjoyment of the Game:
1. Did you complete the game?
2. When playing the game, did you actively think about the problems?
3. It was enjoyable to collect lucky items in the game.
4. I felt happy when I obtained a lucky item I had never seen before.
5. The game was fun.
6. If there were similar games, I would like to try them again.

Figure 6: Questionnaire after the experiment

Finally, the test is administered once more, and the results of the two tests are compared, alongside the questionnaire responses. This combined data will be used to evaluate the effectiveness of the game.

5. Summary

The purpose of this study is the development of a serious game aimed at enhancing response capabilities to disasters and accidents. Through investigation and analysis of related research and existing games, considering the background of the planned serious game and the flow of the game, all the scenarios for accident events within the game and the game stages have been completed. Furthermore, the implementation of necessary game systems and accident events within the game has also been finalized. Looking ahead, bug resolution within the game and improvements to the questionnaire will be conducted. Subsequently, subject experiments will be carried out to validate the effectiveness of the developed serious game.

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