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Public Safety: Escalator Safety Awareness through Game-Based Learning

Nurazian Mior Dahalan*, Zamlina binti Abdullah, Azlin Dahlan, Zainab Othman, Nur Zeti Akhtar Yahya & Mohamad Hafiz Khairuddin
School of Computing Sciences, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Cawangan Melaka Kampus Jasin Melaka, Merlimau, Melaka, Malaysia
nurazian@uitm.edu.my*, zamlinaabdullah@uitm.edu.my, azlindah@uitm.edu.my, zetiakhtar.y@gmail.com, hafizk@uitm.edu.my

Abstract: An escalator is a passenger transportation system in which passengers has direct contact with the machine's moving powered sections and travel by standing on the moving steps. They are known to be in shopping malls, office buildings, and public transport hubs. The news of the escalator mishap has been reported in the news every year. Human behavior is the leading cause of escalator accidents, with 90% of the victims being young children. This project aims to raise awareness among the public, especially children, regarding escalator safety awareness. This project creates a 2D game that implements a Game-Based Learning (GBL) model for the framework. This project also uses a System Usability Scale (SUS) questionnaire to check the game's usability. Based on the evaluation, the game got a high SUS score of 85.3. According to the SUS score, the score is classified as grade A with an excellent adjective rating. Thus, the game-based learning approach to safety education has great potential for escalator safety.

Keywords: *Escalator Safety, Game-based learning, public safety, 2D game, GBL.*

1. Introduction

An escalator is a passenger transportation system in which passengers have direct contact with the machine's moving powered sections and travel by standing on the moving steps (Chew et al., 2021). In Malaysia, there were 12,923 escalators as of 2018 (New Straits Times, 2018), and they are known to be in shopping malls, office buildings, and public transport hubs. However, due to construction or maintenance work, it is conceivable that this number has changed since then. Nevertheless, the news of the escalator mishap has been reported in the news (Amran, 2016; New Straits Times, 2018; The Star, 2016; The Sun Daily, 2016). For example, the Consumer Product Safety Commission (CPSC) reported that an average of 6,000 people per year are injured on escalators. Still, elevator injuries are more common, with approximately 10,200 elevator accidents involving injuries occurring each year in the United States (Penney and Associates, 2021). These accidents occur in many countries due to the development of skyscrapers that must have escalators and elevators as transport mediums.

Even though every escalator includes safety signage, users rarely read it because the journey is so short; the average estimated escalator travel time is between 20 and 35 seconds (Ibrahim et al., 2021). On the other hand, children are still too young to understand the rules thoroughly. To solve the raised issue, the purpose of this project is to design and construct a game that demonstrates suitable methods to ride the escalator safely. The game is designed specifically for children, making it easier to understand and remember important safety tips while using escalators. As a result, this technology can assist users in quickly comprehending escalator safety because this game aims to bring awareness to society and minimize accidents in this area.

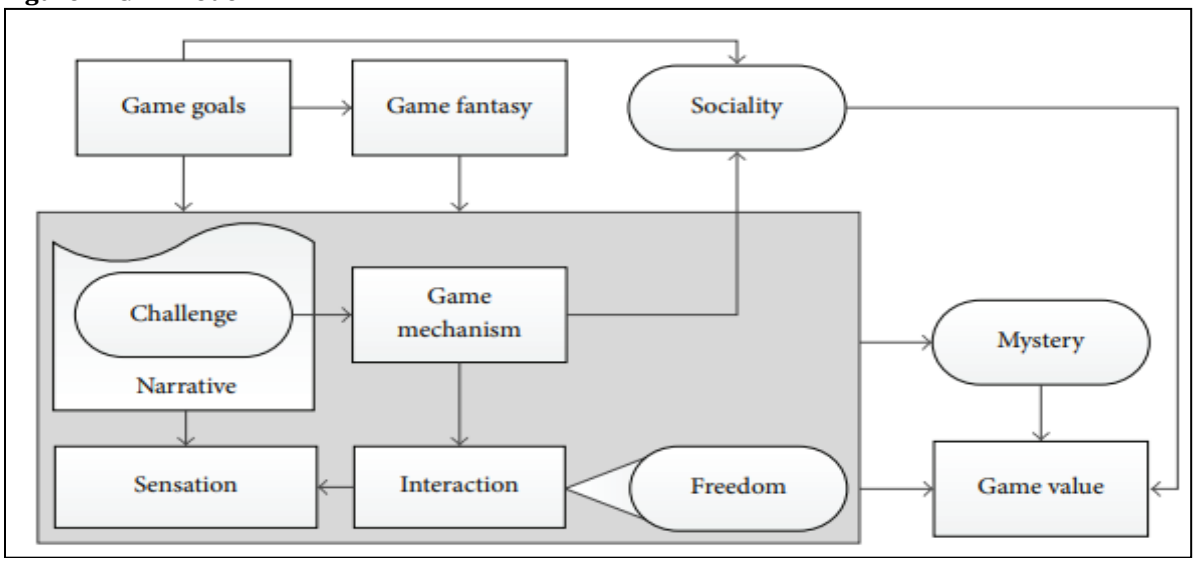
2. Methodology

Each learning approach has different criteria and has its pros and cons. Thus, game-based learning is preferable to serious games or gamification in the context of escalator safety awareness. Game-based learning (GBL) allows users to interact with the material in a fun and interactive way, improving retention and understanding. This can be especially effective for topics such as safety awareness that can be dry or monotonous when presented in a traditional training format. GBL is suitable for children. According to (Behnamnia et al., 2020), GBL can stimulate children's curiosity to find new ways to solve problems by making the visual space appealing, which in turn increases children's satisfaction. While serious games and gamification can be effective in some situations, they may not be the best fit for all. Serious games require

specialized development and resources, and gamification may lack the same level of engagement and immersion as game-based learning.

The Game-Based Learning (Figure 1) model begins by considering the game's goals, which involve teaching objectives and the experience players should have. The experience and the game's fantasy aspect are connected because they shape the virtual world and immerse players. However, in this project, the fantasy element is omitted because the focus is on creating a lifelike learning environment for understanding escalator safety. The goal is to enhance the game's educational value by emphasizing realism and enabling players to apply what they learn to real-life escalator safety situations.

Figure 1: GBL Model



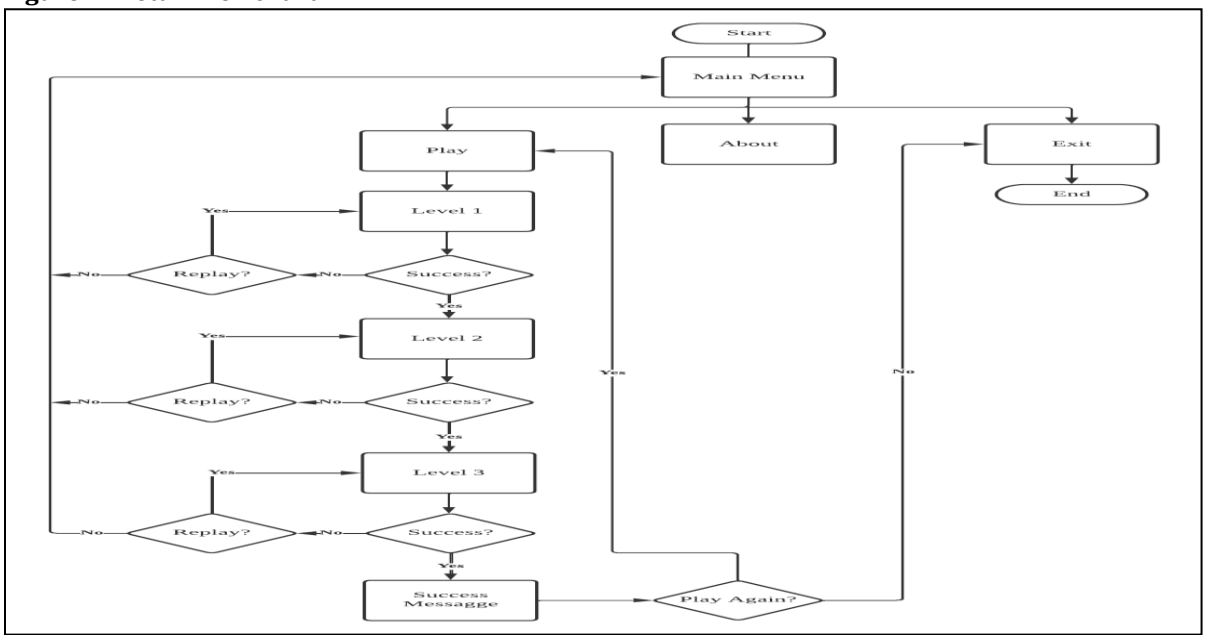
(**Source:** Shi & Shih, 2015)

3. Results and Discussion

This section discussed the system's design, development, and testing in designing and developing "the escalator safety awareness game."

a) System Design: A good game design system reflects how the system will deliver the overall content of the system without letting the user interfere with any of the technical defects. This subsection will further explain the details of the game design starting with the game flow. Figure 2 shows the overall flow chart of the game flow of the game. The flowchart also tells how the gameplay starts from the beginning until the game is ended.

Figure 2: Detail Flowchart



A high-fidelity storyboard, shown in Figure 3, is a detailed visual representation of a game's key moments and scenes, consisting of high-quality graphics and illustrations that closely resemble the appearance and feel of the final game. It provides a detailed and refined visual representation of the game's flow and user experience, serving as an important guide during the development process.

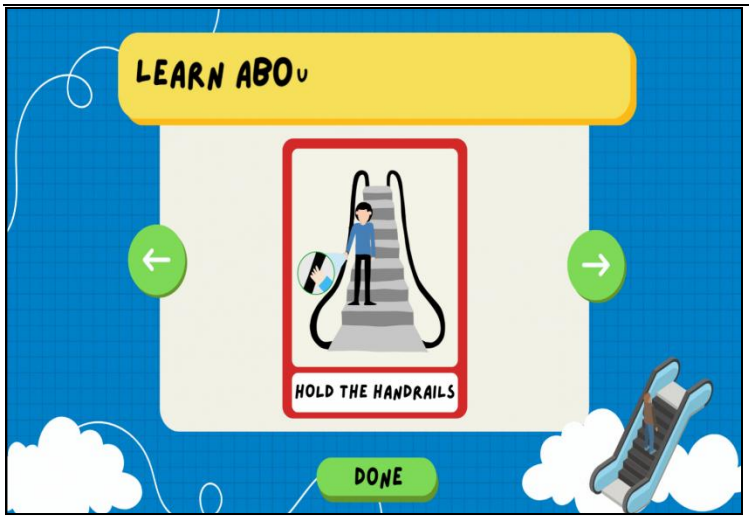
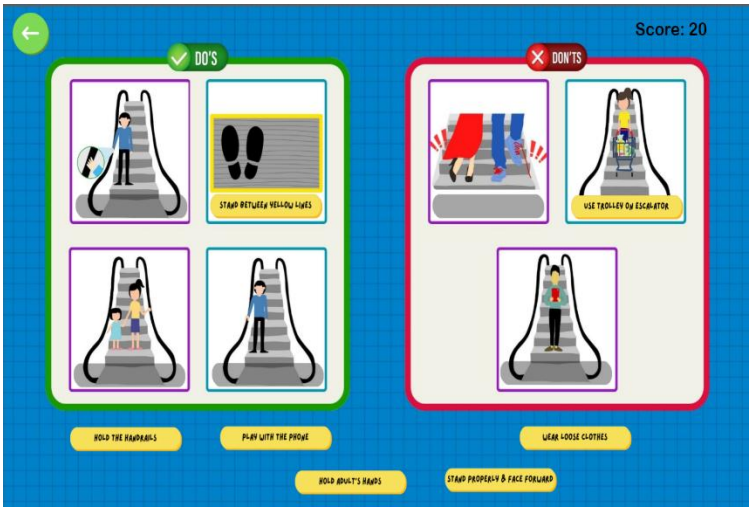
Figure 3: High-Fidelity Storyboard

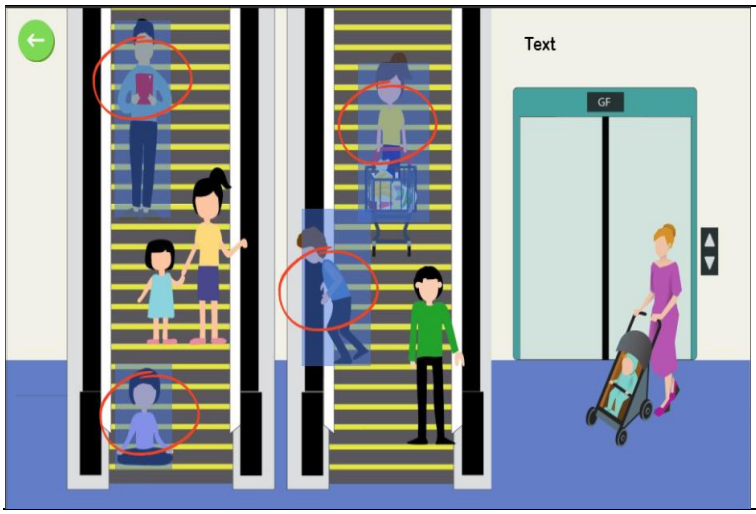
Scene 1: Main Menu
Description
The main menu has three buttons. Firstly, the PLAY button will bring the user to the gameplay mode, and the ABOUT button will display the information about the game. If the user clicks the EXIT button, the user will exit the game.
Multimedia Elements: T (Text), B (Button), G (Graphic), A (Animation), S (Sound)

T1: Game title
B1: Sound button
B2: Game button
G1: Background image
S1: Background music

b) System Development: The system development can only be started after the design works were completed. During this phase, a step-by-step development and implementation would be performed on the system. The activities involved are developing an application system. Table 1 shows the description of the user interface design of the proposed game. The development process involves using MediBang Paint for illustrations, Canva for graphics, Audacity for audio, and Construct 3 game engine for interactive games. These tools enable the efficient creation of visually appealing and engaging games. The powerful combination of this software can create an exciting and useful game.

Table 1: Final Version of the User Interface Description

Interface	Description
	**Level 1: Learn the Basics** The primary goal is to introduce players to the fundamental safety guidelines associated with escalators. The level is designed as an informative slideshow, with players clicking on arrows to navigate various safety behaviors
	**Level 2: Match the Behaviors** The players are presented with a drag-and-drop interaction-based matching game. By dragging and dropping the words into the appropriate boxes, they must connect the proper dos and don'ts of escalator behaviors.



Level 3: Identify the Unsafe Behaviors
The objective here is to identify unsafe behaviors on the escalator. The environment offers a variety of scenarios, and players must actively seek out and call attention to unsafe behaviors. They will circle the correct response to indicate their selection. This level encourages critical thinking and situational awareness by requiring players to assess escalator usage in a realistic setting.

c) Usability Testing: The usability testing evaluates the effectiveness and user-friendliness of the escalator safety awareness game using the System Usability Scale (SUS). Participants interact with the game while performing tasks to identify usability issues and gather feedback. The SUS questionnaire quantifies user satisfaction and perceptions of the game's usability, enhancing its design and functionality. This approach ensures the game effectively promotes escalator safety awareness among users.

i. Demographic of Participants: The evaluation's demographics reveal that the largest age groups were 11 and 12-year-olds (38.9% and 36.1%, respectively), followed by 10-year-olds and 9-year-olds (8.3%), 8-year-olds (5.6%), and 7-year-olds (2.8%). Table 2 shows the demographic information of the participants.

Table 2: Participants Demographic

		Frequency (n=36)	Percentage (%)
Gender	Male	19	52.8
	Female	17	47.2
Age	7 years old	1	2.8
	8 years old	2	5.6
	9 years old	3	8.3
	10 years old	3	8.3
	11 years old	14	38.9
	12 years old	13	36.1

ii. Usability Testing: A questionnaire on the game's usability in the escalator safety awareness game will be collected. The test will be conducted once the game session finishes. The System Usability Scale (SUS) will be used for the game evaluation test. There will be ten questions, five positive and five negative. The positive and negative questions will be asked one after the other. Table 3 describes the questions about game usability (Mohamad Marzuki et al., 2018).

Table 3: System Usability Scale (SUS) Questionnaire in Malay

No.	Questions
1	Saya rasa saya ingin kerap menggunakan permainan ini.
2	Saya rasa permainan ini sesuatu yang rumit.
3	Saya rasa permainan ini mudah untuk digunakan.
4	Saya memerlukan bantuan daripada orang lain untuk menggunakan permainan ini.
5	Saya mendapati fungsi-fungsi dalam permainan ini saling bersepadu (berhubungkait) dengan baik.
6	Saya rasa terdapat banyak kandungan di dalam permainan ini yang tidak konsisten antara satu sama lain.
7	Saya membayangkan bahawa kebanyakan orang akan cepat belajar menggunakan permainan ini.

8	Saya mendapati permainan ini leceh untuk digunakan.
9	Saya berasa yakin menggunakan permainan ini.
10	Saya perlu belajar terlalu banyak perkara sebelum boleh menggunakan permainan ini.

Table 4 shows the overall findings for each participant. From these scores, the calculation was made using the SUS score and as a result, the average SUS score for the escalator safety awareness game is 85.3. Based on the final SUS score, this score is classified as grade A with an excellent adjective rating.

Table 4: The Overall Findings for Each Participant

	Question											
Participants	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Raw Score**	**Final Score**
P1	4	3	4	2	2	3	4	2	4	1	27	67.5
P2	5	1	5	2	5	2	5	1	5	2	37	92.5
P3	5	3	5	3	5	1	5	1	5	3	34	85
P4	5	2	5	2	5	2	5	1	4	3	34	85
P5	5	2	5	1	5	2	5	1	5	4	35	87.5
P6	5	1	5	2	5	1	5	1	5	2	38	95
P7	3	1	5	1	5	2	5	1	5	1	37	92.5
P8	4	1	3	1	5	2	4	1	3	2	32	80
P9	5	4	5	4	5	3	5	2	3	2	28	70
P10	4	1	5	2	5	2	5	1	5	1	37	92.5
P11	4	2	5	4	5	2	5	2	5	4	30	75
P12	5	1	5	5	2	2	4	3	5	3	27	67.5
P13	5	2	5	2	5	1	5	1	5	3	36	90
P14	4	1	5	1	5	1	5	1	5	5	35	87.5
P15	4	2	5	2	5	1	5	1	5	2	36	90
P16	4	2	5	1	5	1	4	1	5	3	35	87.5
P17	4	3	5	2	5	2	5	1	5	2	34	85
P18	4	1	5	1	5	1	4	1	5	5	34	85
P19	5	2	4	2	4	1	5	1	4	3	33	82.5
P20	4	1	4	1	4	1	5	1	5	3	35	87.5
P21	4	2	5	3	5	1	5	1	5	3	34	85
P22	4	2	5	2	5	2	5	1	5	3	34	85
P23	5	1	5	2	5	1	5	1	4	2	37	92.5
P24	4	1	5	1	5	1	5	1	5	2	38	95
P25	5	2	4	2	5	1	5	1	5	2	36	90
P26	4	1	5	2	5	1	4	1	5	2	36	90
P27	4	2	5	2	5	1	4	1	5	1	36	90
P28	4	2	5	1	5	1	5	1	5	1	38	95
P29	4	2	5	3	5	1	5	1	5	2	35	87.5
P30	5	2	5	5	4	2	5	2	5	2	31	77.5
P31	4	1	5	1	5	1	5	1	5	2	38	95
P32	4	1	5	1	5	1	5	2	5	1	38	95

P33	5	2	5	1	4	1	5	1	5	1	38	95
P34	4	2	5	3	4	1	5	2	5	2	33	82.5
P35	2	2	4	2	3	1	5	2	4	4	27	67.5
P36	2	1	5	3	3	2	4	3	4	3	26	65
										Average SUS Score:		85.3

Based on the average SUS score of 85.3 from the System Usability Scale assessment, the escalator safety awareness game exhibits a favorable level of usability and user satisfaction. The SUS score, which ranges from 0 to 100, indicates that the game performed well in terms of usability and user experience. A SUS score of 85.3 is considered quite high. It indicates that the participants found the game user-friendly, easy to use, and effective in promoting escalator safety awareness. This score suggests that users were generally satisfied with the game's interface, interactions, and overall usability

4. Conclusion

Escalator safety awareness is a critical aspect of promoting public safety and preventing accidents in busy public spaces. The development of the 2D escalator safety awareness game has emerged as an effective solution to overcome the limitations of traditional educational methods in conveying essential safety information. By implementing an age-specific approach, guided by the GDLC model, the game successfully engages users of different age groups, ensuring that the safety message is tailored to their specific needs and learning capabilities. Its interactive and informative gameplay has demonstrated the potential to enhance knowledge retention and user satisfaction, as evidenced by positive results from the SUS questionnaire. This GBL approach to safety education holds great promise for future initiatives, not only in escalator safety but also in other areas, making significant contributions to creating a safer and more informed society overall.

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