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The VaccineLand: An Interactive Digital Board Game to Educate Public about Vaccines

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Abstract— The invention of the COVID-19 vaccines has resulted in various viewpoints and reactions from the public. The vaccines are guaranteed to be safe and clinically proven to enhance human antibodies preventing the virus from spreading. However, disseminating facts and truth about vaccines to the public is challenging due to many factors, including vaccine hesitancy and skepticism. Besides, some individuals are still concerned about vaccines' adverse effects and safety. Plus, the presence of various misleading online discussions promoted by anti-vaccine activists that spread false information about vaccines has worsened the situation. Therefore, in this paper, we proposed a digital board game, the VaccineLand, that provides information about vaccines in terms of their history, reasons for taking them, and the adverse effects on the public. Thus, VaccineLand was established based on the Game-Based Learning (GBL) model by its goal, which is to provide the public with facts and knowledge about vaccines in an interactive way. GBL is known as a type of gameplay with specific learning outcomes. Interactive GBL corresponds to the use of educational game applications for learning. This study investigates a usability evaluation consisting of four variables (usefulness, ease of use, ease of learning, and satisfaction) involving a total of 40 respondents. The finding indicates that the usability of this game was highly acceptable. We believe that VaccineLand can be a helpful tool to educate the public about vaccines.

Keywords— Interactive game; game-based learning; vaccines; usability evaluation.

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I. INTRODUCTION

Most countries advise their citizens to vaccinate to prevent infectious disease outbreaks, and most studies cited vaccination as one of the effective strategies to control the spread of infectious diseases. In Malaysia, vaccination is given following the National Immunization Program (NIP) once a baby is born after getting the parent's consent. As cited by Wong et al. [1], while most people vaccinate according to the recommended schedule, this success is being challenged by individuals and groups who choose to delay or refuse vaccines.

This statement is consistent with a study by Voo et al. [2] that found that only 6.8 percent of 405 parents in Sandakan, a district in Sabah, Malaysia, were concerned about vaccines. There have been worries that this figure may be about to continue to rise. Nevertheless, these estimates can be deceptive and may not reflect an accurate picture of under-or unvaccinated communities. Several vaccine-preventable diseases (VPDs) outbreaks, including measles, poliomyelitis, diphtheria, and pertussis, have been linked to under-

vaccinated or unvaccinated communities in various parts of the developed world. Since the COVID-19 outbreak passed in 2019 and the invention of coronavirus vaccines, debates about vaccines continue, and the public has become more concerned, considering that the vaccines are relatively new. Although most people follow the prescribed vaccination schedule, individuals and organizations that delay or reject vaccinations have somehow put this achievement at risk [3]. Some factors contributed to the vaccine hesitancy, such as the influence of the Internet, social media, conspiracy theory, religious reason, and alternative medicine as vaccine replacement [4].

In this new norm era, most children or adults have their hands on computers, smartphones, and other gadgets. Digital games are a great medium to transfer and spread information since they can create interest and high involvement from the players. The game-based learning (henceforth, GBL) model is followed throughout the design process. According to Garris et al. [5], the (GBL) model has eleven elements. In this study, only nine elements were adopted and excluded the game mystery element and the social element since this study is catered for the offline mobile game platforms. The next section of this paper discusses the issues regarding vaccines, game design, evaluation, results, and conclusion of this study.

II. MATERIALS AND METHODS

A. Background Study

People in Malaysia believe vaccine anxiety is affected by hearsays or anti-vaccination mislead information, leading to negative vaccine perceptions through social media and word of mouth. This community typically lacks vaccine knowledge and is easily influenced by friends or social media. According to Wong et al. [1], health professionals generally agree that vaccines effectively curb the spread of diseases, but at the same time, they also admit that mild reactions can occur occasionally. Because of these mild reactions, some people take the chance to say that taking the vaccine is dangerous and start to raise doubts among the community. For example, parents claimed their children were given vaccines but acquired the disease the vaccine intended to prevent. Also, when parents hear about an individual's experience with adverse events following immunization (AEFI) and vaccine effectiveness, they become more hesitant about vaccines and attempt to prevent them. When people begin to be hesitant about vaccinations, this community of Traditional Complementary and Alternative Medicine (TCAM) practitioners are not vaccine-averse persons but rather opportunists who appear to help disseminate anti-vaccination ideas while also promoting the selling of traditional and herbal remedies or vitamin supplements as alternatives to vaccines [1]. TCAM believers believe that natural immunity gives better protection than vaccination. Vaccine skeptics believe vaccination is a Western conspiracy against Muslims or some other anti-Muslim plot. According to Kusnin [6], the refusal rate because of the halal-haram issues in Malaysia has increased from 311 in 2014 to 468 in 2016. This reason may be because they are unaware of the manufacturing process [1].

The situation should not be allowed to spread among the citizens. Thus, Malaysia has started to create a strategy to counteract vaccine hesitancy in Malaysia. Most health professionals recommended that vaccine-hesitancy organizations that are affected by hearsays or negative rumors actively perform communication programmed to include clear information on vaccination, the importance of protecting individuals against vaccine-preventable disease (VPDs), and to demonstrate to the public their responsibilities to prevent others from acquiring these diseases [1]. If a child reacts to vaccination, a health practitioner may provide proper guidance regarding the results of the AEFI investigation to clear up any misconceptions for the parent. [1] claimed that doctors and other medical professionals, particularly in clinical settings, play an important role in counseling vaccinehesitant parents to promote vaccine acceptance and more knowledge about the vaccine. This is one of the reasons why physicians and other medical practitioners should be prepared with extensive expertise and excellent communication skills when confronted with vaccine-hesitant patients to persuade them to consider vaccines. Furthermore, health professionals advise the Malaysian government to halt anti-vaccination messages and misinformation until they gain widespread public support because misleading and anti-vaccination facts are disseminated in the media. In short, health professionals must react aggressively to the anti-vaccine message on social media.

Games have been used as a learning tool for centuries. The term educational game refers to the merging of education with gaming and the educational benefit that comes organically from playing games, which are "a sort of computer gaming software that creates an educational impact via the use of interest" [7]. Learner interest and involvement may be increased through educational games. Furthermore, an educational game can improve student learning progress, increase student motivation, and provide a setting for students to experience that is similar to a real-world situation. Few terms have been used, like educational game that is serious games, edutainment, and Light game.

There are numerous ways to improve learning to increase people's interest in vaccination knowledge. Implementing enjoyable elements (games) in the learning process is one method for improving the learning process [8]. An enjoyable element can elicit new positive emotions, which result in positive outcomes in the learning process. Furthermore, this learning process can motivate them to continue learning and obtaining the required information.

According to most definitions, game-based learning (GBL) is a form of gameplay with specific learning outcomes 9]. The use of educational game applications for learning is referred to as interactive GBL. According to Fatta et al. [10], there are two important reasons why learning should be combined with games, as per Prensky, which are drastic shifts in the learner and how to inspire these types of learners. Video games provide an engaging and interactive learning environment for a specific learning target, experience, and outcome. GBL engages the player by incorporating a video game into a learning aid, teaching improvement, and student assessment. GBL involves playing a real game to gain expertise and knowledge. They claim that GBL is often used as a one-period educational event in the classroom as well as online to provide structured learning [10].

Game elements are the design elements used or applied in the game [11]. A study by Beck et al. [11] applied game elements such as narrative, feedback, avatars, reputations, competition, teams, time pressure, and marketplaces in their review of an energy app. Meanwhile, another study put their game design into action by categorizing the game elements into three groups: dynamics, mechanics, and components [12]. Leaderboards, badges, points, challenges, narrative, rewards, teams, and other game elements are used. However, the three categories are frequently used separately depending on how developers intend their games to be [13].

An educational computer game can provide students with a learning environment in which gaming elements such as comedy, tension, and drama are incorporated into the plot throughout the learning process of overcoming difficulties, increasing students' desire to study [14]. The game can encourage players to recover prior knowledge by requiring them to apply previously learned information to improve their game score, and it provides rapid feedback, allowing players to test different hypotheses and learn from their actions [15]. Computer games can improve students' enjoyment of studying and their desire to learn. For example, the video game Stop the Spread was created to examine behavior, cognition, and usability effects [16]. As a result of the game, players begin to alter their health habits. After playing, the player gained a greater understanding of sneeze habits, and their vaccination rate improved considerably.

Another example is Land of Secret Gardens [8]. Both preteens and parents agreed that feedback on the game design and viewpoint on the game concept was appropriate. The game appealed to preteens because of the combination of fun, educational elements, and the incentive to advance levels, while parents relied on accurate responses to HPV awareness questions. Parents are beginning to see games as a motivating tool for children who have indicated reluctance. This game has a reputation for improving HPV communication between preteens and their parents.

B. Game Design

This section presents the implementation of the game elements in this game, called the VaccineLand. This game design includes game elements such as a goal, challenges, rewards, feedback, motivation, and knowledge improvement. Most of the elements were adapted from Sweetser and Wyeth [17]. Fig. 1 represents the first interface for this game.



Fig. 1 The main interface for the VaccineLand

1) Goal: A game should provide a clear goal on what needs to be done to make sure the players understand the flow at an appropriate time. In this game, a goal is presented at the beginning to ensure the players are aware of tasks to undertake throughout the game. Fig. 2 shows the goal of the VaccineLand.



Fig. 2 The game's goal

2) Challenges: A game should provide challenges to the player to motivate them, and ges should be sufficiently tricky and suitable for the player's skill level [17]. To give challenges to the players, we provide a timer in the VaccineLand. Fig. 3 shows a timer that the player needs to deal.



Fig. 3 Game timer (challenge)

To add more challenges and to reflect the real Monopoly game, we allow players to buy sites at a particular price. If the player landed at their opponent's site, they would be charged. This is another exciting challenge adopted in this game. Fig. 4 and Fig. 5 show the buying and penalty processes in VaccineLand, respectively.



Fig. 4 Offer to buy a site (challenge)



Fig. 5 Penalty (challenge)

3) Knowledge improvement: This element represents the knowledge and information provided while players play the game. The VaccineLand offers well enough facts about vaccines that should be highlighted to educate the public. Examples of knowledge improvement are represented in Fig. 6a, Fig 6b, and Fig. 6c, respectively.



Fig. 6a Knowledge improvement



Fig. 6b Knowledge improvement



Fig. 6c Knowledge improvement

4) Control: The players ought to have a sense of control over their actions and strategies and should be free to play the game wherever they want. In the VaccineLand, players can pause or exit the game whenever they want.

5) Motivation: According to the Cambridge dictionary, motivation is something that causes such willingness or a reason to do something. The VaccineLand provides motivation elements in a way that the players feel a need to do better. Fig. 7 shows the example of motivation in the VaccineLand.



Fig. 7 Knowledge improvement

6) Reward: Players should be appropriately rewarded for their efforts or skill development in a game. In the VaccineLand, since it is a kind of luck game, the players might get a bonus round if they land in a particular area. Fig. 8 represents the reward in this game which is important to keep the players motivated to play more and more.



Fig. 8 Knowledge improvement

7) *Feedback:* In the VaccineLand, feedback is given to players by using sound effects. For example, when the players answer a question wrongly, a sound effect will appear, notating that their answer was wrong, and a cheerful sound effect will appear if they answer correctly.

8) Social interaction: As an interactive game, the VaccineLand encourages and facilitates social interaction, which represents the social interaction element. The social interaction allows the players to compete, and the players need to take turns rolling the dice. The implementation of the social interaction element is presented in Fig. 9.



Fig. 8 Social interaction

C. Usability Evaluation

Usability evaluation has been developed as effective feedback widely used in Human-Computer Interaction to

improve the user experience. The VaccineLand has undergone usability testing with a total of 40 participants. Usability testing is classified into four categories: usefulness, ease of use, ease of learning, and satisfaction. Table 1 represents the usability scale that was applied in the evaluation [18].

TABLE I USABILITY SCALE [18]

Category	Question		
Usefulness	Items related to the perceived usefulness of the application to a user. It might ask if the application is helpful to them, make them more		
	effective, etc.		
Ease of Use	It represents how easy or complicated is the application to a user.		
Ease of	Ease of learning asks if a user can use the		
Learning	application quickly without any written instructions.		
Satisfaction	Satisfaction is usually an overall feeling towards		
	the application, whether the user is satisfied or		
	not.		

III. RESULTS AND DISCUSSION

A. Demographic Summary

The total number of respondents involved in this evaluation was 40 consisting of 26 (65.0%) female and 14 (35.0%) male respondents. As per data gathered, most of the participants are between 20 to 24 years old (97.5%). This study mainly involved students (92.5%), employed (full-time/permanent), and self-employed. This result reflects the respondents' age, where most of them are aged between 20 - 24 years old. All the respondents were Malay (100%).

 TABLE II

 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Demographic characteristic s	Item	No. of respondent s (N)	Percentag e (%)
Gender	Female	26	65
	Male	14	35
Age	10 - 19	0	0
	15 - 19	0	0
	20 - 24	39	97.5
	25 - 30	0	0
	31 - 35	1	2.5
	36 and above	0	0
Race	Malay	40	100
	Chinese	0	0
	Indian	0	0
	Others	0	0
Current Employment	Employed (Full Time/ Permanent)	2	92.5
	Employed (Part-Time/ Temporary)	0	0
	Self-employed	1	2.5
	Business owners	0	0
	Unemployed	0	0
	Student	37	92.5

Highest level	High/Secondar	1	2.5
of education	v school	1	2.3
of equedition	Diploma	4	10
	Daphalar's	т 24	25
	degree	34	0.3
		1	2.5
	Master's degree	1	2.5
	Doctorate	0	0
Time spent on	Less than 1	15	37.5
computer	hour a week		
games in a	1-3 hours (s) a	4	10
week	week		
	4-6 hours a	7	17.5
	week		
	7-9 hours) a	7	17.5
	week		
	More than 10	7	17.5
	hours a week		
Game	Experienced	8	20
experience	gamer		
level			
	Moderate	16	40
	experienced		
	gamer		
	Novice gamer	16	40

Thirty-four respondents (85.0%) have bachelor's degree certificates, 4 (10.0%) have diploma certificates, and one has high/secondary school certificates and master's degree certificates. Most respondents (37.5%) said they play games for less than one hour per week. The exact number of respondents (7 respondents) admit they play games 7 - 9 hours per week and more than 10 hours per week. Six respondents (15.8%) spend 4 - 6 hours playing games every week, and four respondents (10.0%) spend at least 1 - 3 hours a week playing games. Sixteen respondents (40.0%) stated they are novice gamers; another 16 respondents claim they are moderately experienced gamers, and only 8 (20.0%) are experienced gamers. The demographic details of the respondents are presented in Table 2.

B. Validity and reliability of USE questionnaire

The acceptable value of Cronbach's alpha in reliability analysis is 0.7 [19]. Cronbach's Alpha values and mean values for all usability elements are summarized in Table 3. The Cronbach's alpha values obtained indicate that the internal consistency among all variables (usefulness, ease of use, ease of learning, and satisfaction) are high and above the acceptable level (> 0.7). Hence, we conclude that Cronbach's alpha values for all variables are within the acceptable range.

TABLE III RELIABILITY STATISTICS			
Cronbach's Alpha	No. of Items		
0.847	5		
0.938	8		
0.919	4		
0.948	4		
	TABLE III ELIABILITY STATISTICS Cronbach's Alpha 0.847 0.938 0.919 0.948		

C. Usability Measurement Score

The mean values for all elements are above average (> 3). According to the findings of this study, the mean scores on usefulness, ease of use, ease of learning, and satisfaction are 0.85, 0.94, 0.92, and 0.95, respectively, on a five-point Likert scale. The mean and total USE score result is summarized in Table 4.

TABLE IV
MEAN SCORE

Variable	Mean
Usefulness	4.37
Ease of Use	4.39
Ease of Learning	4.50
Satisfaction	4.31
Average	4.47
USE Score	86

The overall USE score from the evaluation conducted is 86%. According to [20], any score between 80-89 is considered Good to Excellent. Thus, we conclude that this game is highly accepted. Pearson Product Moment Coefficients were calculated to identify and analyze the correlation among all usability scales [21]. Cohen [22] suggested that r .10 to .29 indicates a small or weak correlation, r = .30 to .49 shows medium or moderate correlation, while r = .50 to 1.0 indicates a strong correlation between variables. The result shows a strong, positive correlation between ease of learning and ease of use (r=0.92). It is coherent that ease of learning will positively impact the ease of use. There was also a strong, positive relationship between ease of use and satisfaction (r=0.86). This result is what had been predicted because ease of use positively impacts users' satisfaction. From this finding, we assume that if the players find the game easy to learn, they will probably find it easy to use. According to Joo et al. [23], ease of use refers to the degree to which a user thinks using a certain technology would be effortless. These two variables might result in user satisfaction.

We found a positive correlation between ease of learning and usefulness (r=0.58), and between satisfaction and usefulness (r=0.65). From these findings, we assume that, even though an application is highly accepted and usable, some respondents might find that this application is less practical or maybe, some parts of this application do not function well. Hendra et. al [24] found that the ease of learning variable partially significantly affects user satisfaction. The Pearson Product Moment Coefficients results are presented in Table 5.

 TABLE V

 CORRELATION MATRIX FOR USABILITY SCALE

Variable	Usefulness	Ease of Use	Ease of learning	Satisfaction
Usefulness	1			
Ease of Use	0.66	1		
Ease of	0.58	0.92	1	
learning				
Satisfaction	0.65	0.86	0.71	1

D. User open-ended feedback

In addition, we also collected user feedback in the form of comments and suggestions in the form of open-ended feedback. By using open-ended feedback, we believe that respondents could express how they felt while using this application. However, only nineteen (19) respondents provided feedback on this game. Most of the respondents leave positive comments, such as:

- "An excellent implementation of elements in the game to understand more about the vaccine."
- "Good. Giving me so much knowledge about Covid-19 and Vaccination."
- "Nice application suitable for kids also to learn about vaccination."

Several respondents wrote both positive and negative as well as suggestions to improve this game as described by the following comments:

- "Maybe make the game screen size suit the mobile screen size because the font and screen are too small to read on the phone."
- "Maybe change the tutorial to be more interactive and shorter, it takes an effort to read that tutorial."
- "Used a lot of words in instructions. Could be better if it is simple and compact. Overall, it is a good game. Good job!"

We conducted a thematic method by Braun and Clarke [25] to analyze the open-ended question. From the responses, we identified five themes that were regularly mentioned by the respondents, namely knowledge improvement, enjoyment, target user, usability, and user interface. Most respondents see this game as a good platform to increase their knowledge about vaccines. Some also mentioned the enjoyment they felt during gameplay, and some even stated that this game is suitable for kids. We assume that the user interface of this game suits kids the best. However, a few users mentioned the text they needed to read throughout this game. According to the respondents, this game contains too much text. We see that there is room for improvement in the future.

Even though most comments indicated that they approved of this game, some weaknesses were discovered. One respondent mentioned an error when they tried to play the game. This error could be syntax problems, run-time errors, or logical errors [26]. Nevertheless, the developer verified that this game had undergone functionality testing and worked well. One student leaves a recommendation to include a penalty when a player answers a question wrong. All the recommendations should be considered for future works.

IV. CONCLUSIONS

This game was built with GBL in mind, making it suitable for both play and learning. The evaluation was done using the USE Questionnaire, which includes four variables: usefulness, ease of learning, ease of use, and satisfaction. Based on the evaluation conducted, we believe that this board game is beneficial for the public in terms of understanding and learning because it provides them with a wealth of knowledge about vaccines.

Although the usability results show a promising score, there are still some concerns. Our test sample is mostly young adults and students. The number of respondents might be satisfactory, but a larger sample size may generate more significant, valid, and reliable results. In the future, it is suggested that this game be improved by adding more features like the actual Monopoly game to provide players with more enjoyment. Further study might consider other variables or models such as the enjoyment model or engagement model to be adapted to compare the results in designing a more effective educational game that exposes the public to the vaccines.

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