JOIV : Int. J. Inform. Visualization, 7(2) - June 2023 338-344

INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION

journal homepage : www.joiv.org/index.php/joiv

Adopting the eGameFlow Model in an Educational Game to Increase Knowledge about Vaccination

Nur Farahin Mohd Johari [a], Muhammad Amirul-Na'im Muhammad Ridzuan Lim [a], Norshahidatul Hasana Ishak [a], Hazrati Zaini [a,*]

[a] *Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Cawangan, Melaka, 77300 Merlimau, Malaysia*

Corresponding author: [*]hazrati_zaini@uitm.edu.my

***Abstract*— Vaccination is one preventive measure to prevent oneself from getting any diseases. Vaccinations work by training our immune system to produce antibodies and weaken the targeted disease. Unfortunately, the number of unvaccinated children has increased because some parents reject or doubt the effectiveness of vaccines. This skepticism could result in a resurgence of vaccine-preventable diseases. Additionally, some contribute to vaccine refusal due to other reasons like vaccine misinformation, religious convictions, and insufficient knowledge. The game aims to develop knowledge and awareness to enhance vaccine behavior and acceptance among individuals. eGameFlow model were used as the methodology for game development. This model was chosen as it focuses on the educational game environment, which addresses learning components in the game. There are eight criteria to be considered to evaluate enjoyment using this model. To measure the users' enjoyment, a set of questionnaires adopted from the eGameFlow model has been used for the evaluation. It is created explicitly to measure learners' enjoyment of e-Learning games. This game gathers positive feedback from 30 respondents and shows promising results to achieve the objective. All eGameFlow criteria were positive towards enjoyment, with knowledge improvement being the highest contributor. The overall average of the evaluation was at an agreeable level, with a score of 81%, considered as achieving the goal. For future enhancement in increasing player's enjoyment and game effectiveness, the game can be created in 3D environment to provide deep immersion and autonomy to the player.**

***Keywords*— eGameFlow Model; educational game; enjoyment evaluation; vaccination in Malaysia.**

Manuscript received 21 Mar. 2022; revised 16 Sep. 2022; accepted 12 Dec. 2022. Date of publication 30 Jun. 2023.

I. INTRODUCTION

According to the World Health Organization (WHO), vaccination is a simple and safe way to protect any living creature from harmful diseases. Vaccines act by weakening, and they will train our immune system to create antibodies. Although the vaccine effectively fights diseases, some people refuse to get vaccinated. For example, a study performed by Khoo et al. [1] discovered that the number of vaccine refusals among Malaysian parents had risen sharply. Parents who are skeptical of vaccination may cause their children to refuse vaccines, resulting in a doubled number of unvaccinated children. This, in turn, could result in a resurgence of vaccine-preventable illnesses like measles, mumps, rubella, and varicella.

Vaccine hesitancy presents a global health obstacle in managing the severity of pandemics as well as infectious diseases. It was named one of the WHO's top ten global dangers to general health, as cited by Asres and Umeta [2]. The frequency of vaccine hesitancy increases the vulnerability of highly susceptible groups, such as the elderly or those with pre-existing medical conditions, as observed during the COVID-19 outbreak [3] Resistance to vaccination and related issues are becoming more prevalent due to various factors. One significant reason for vaccine refusal may be religious beliefs [4], such as in the case of Muslims who are becoming more aware of vaccine components derived from animals. Another reason for vaccine anxiety is safety concerns [5], [6]. Parents are reluctant to vaccinate their infants because of concerns over vaccinations containing ritually unclean ingredients. Besides, the presence of wrong and irrelevant sources of information related to vaccines has also led to misinformation and misbelief about vaccination. This occurs because most young parents depend on the information they acquire from the internet, particularly social media platforms like Facebook and Twitter, as their primary source of information.

In a similar vein, the internet has also promoted the use of online games as a learning tool in recent years. Many prior studies have successfully proved that enjoyment is a factor that can affect a game's success and the learning of its players. In achieving this, the current study deployed the eGameFlow model throughout the design and development process. Vaccine information is based on official and credible sources such as the World Health Organization (WHO) and the Ministry of Health Malaysia (MOH). This project was carried out to create awareness and knowledge among the public on the importance of vaccination.

A total of 30 respondents ranging from 18 - 38 years old were recruited for this study. They completed a session of playing this educational game. After the gaming session, the user's enjoyment was evaluated using the eGameFlow questionnaire. The findings from this evaluation discovered that the knowledge improvement factor recorded the highest score with an average mean of 4.25. From this result, we conclude that this educational game had successfully achieved its goal: to help the public improve their knowledge about vaccines while having fun playing the game. Hence, it would also decrease the vaccine hesitancy rate. However, the number of respondents is considered small. Due to some limitations, we only collected data from 30 respondents. Future improvement of the game version with other models is also expected.

II. Materials and Method

A. Literature Review

Vaccination has been a popular topic among the public since the emergence of COVID-19. Vaccination is proven to be effective in controlling the disease's spread. According to La Torre et al.[7], achieving high vaccination coverage is the primary method for avoiding vaccine-preventable infectious diseases. Vaccination generates people with hope for survival, and different diseases have different vaccination strategies. There is potential for dengue surveillance to be enhanced through the use of Dengue Serology Rapid Diagnostic Tests (RDTs). These RDTs rely on biosensors that can detect both recent and past dengue infections. By using such tests, it is possible to conduct seroepidemiological surveys and improve dengue vaccination strategies [8]. Healthcare professionals and specialists acknowledge that vaccines are generally effective but also recognize that mild reactions can occur occasionally. However, because of these mild reactions, some individuals use this as an opportunity to claim that vaccinations are dangerous and create uncertainty in the community [9]. Consequently, some people begin to question the safety and necessity of vaccines. A common scenario is when they try to delay, and some resist the vaccination. In addition, the emergence of the anti-vaccination movements has caused a commotion and made things worse as they spread false information, especially the claim that vaccines contain hazardous ingredients. Lack of right vaccine information will cause a negative influence on the community since the anti-vaccination movements will easily dupe individuals.

Malaysia is a developing, middle-income, multi-cultural, and Muslim-majority country with an outstanding public healthcare system. Major vaccinations are free to all Malaysians, and the coverage for Bacillus Calmette–Guérin (BCG) and Diphtheria, Tetanus, Pertussis (DTP) vaccines was as high as 97–99 percent in 2014. This includes the COVID-19 vaccination, which is offered for free regardless of citizenship [10]. In Malaysia, vaccinations are given to children as soon as they are born. This is because young children have limited disease resistance and can get serious illnesses if they become infected with bacteria and are unvaccinated. Even so, some groups still reject vaccines and disagree with the vaccination program. According to data from the Malaysian Ministry of Health (MOH), the number of parents who refused vaccines increased from 470 in 2013 to 1,541 in 2015 [11]. A News report by Ridauddin Daun in 2021, as cited by Jafar et al. [3], further supports this statement by claiming that national COVID-19 Immunisation Programme (PICK) registration (in Malaysia remains below the desired level.

As reported by Singh et al. [12], low education level, especially among middle and older mothers, has contributed to the failure to adhere to the vaccination schedule. They are reported to have doubts about the vaccine, especially the status of the vaccine's contents. Their study also discovered a significant relationship between mothers' educational level knowledge and their attitude toward child vaccination. In general, people with a higher level of education are more aware of the necessity of childhood immunization, and they are a key population in preventing the spread of vaccine-preventable diseases [12]–[15].

A game not only offers an innovative approach to delivering information but also serves as an engaging and enjoyable tool that encourages audience participation [16], [17]. In addition, educational games can make the learning process more engaging, inspiring, and effective by improving knowledge retention, enhancing attention, fostering peer communication, and promoting social skills [18]. The foundation of the eGameFlow originated from the Gameflow model. The GameFlow model has been used to measure player enjoyment, which is relevant to all games. The model provides eight criteria that must be considered to assess the enjoyment level. These criteria are (1) concentration, (2) clear goals, (3) feedback, (4) challenge, (5) control, (6) immersion, (7) player skills, and (8) social interaction [19]. Meanwhile, the flow itself brings its meaning. According to Chen, Wu, and Dennison [20], flow is described as the experience gained when participating in the activity by following the activity's flow. Based on their research, it was found that most of the elements used in flow are (1) a challenging activity requiring skill, (2) a merging of action and awareness, (3) a task with clear goals, (4) a task that provides direct, immediate feedback, (5) concentration on the task at hand, (6) a sense of control, (7) a loss of self-consciousness, and (8) an altered sense of time. It can be concluded that each of the elements is related to each other in measuring the individual's enjoyment.

The eGameFlow model is one of the adjustment models derived from the GameFlow model. It is created explicitly for measuring learners' enjoyment of e-Learning games. Some of the criteria are similar to the GameFlow model, with an additional criterion of Knowledge Improvement. This criterion is replacing the player skill criterion used in the GameFlow Model [21].

Concentration refers to a player's capacity to concentrate on the game task at hand, which can be attained when the game task has clear objectives and offers timely feedback. The key factor in an educational game is enhancing knowledge, and the game should capture the player's focus on the learning activities while also providing a sense of control over the game and engaging them in the gaming environment to aid the player in learning. Moreover, goal clarity, feedback, and social interaction in the game may interact to affect learning outcomes [22]. Immersion is considered a critical element in game-based learning, which promotes learner engagement. Table 1 shows the definition of the criteria in the eGameFlow model.

TABLE I
CRITERIA AND DEFINITION IN THE EGAMEFLOW MODEL [23]–[26]

Criteria	Definition
Concentration	Games should require concentration and the player should be able to concentrate on the game.
Goal Clarity	Games should provide the player with clear goals at appropriate times.
Feedback	Players must receive appropriate feedback at appropriate times.
Challenge	Games should be sufficiently challenging and match the player's skill level.
Autonomy	Players should feel a sense of control over their actions in the game.
Immersion	Players should experience deep but effortless involvement in the game.
Knowledge Improvement	The game should increase the player's level of knowledge and skills while meeting the goal of the curriculum.
Social Interaction	Games should support and create opportunities for social interaction.

Considering the nature of this game, which does not include any social interaction, all eGameFlow elements were applied to it (except social interaction).

B. Related Studies

This study involved 1024 respondents from Sabah (East Malaysia) to identify the factors influencing vaccine hesitancy among their community. The authors focused their study on Sabah since its population contributed to the low number of PICK registrations in Malaysia. The participants were recruited randomly, and a 5-points Likert scale questionnaire on Google Forms was distributed.

From this study, it was found that the factors varied according to regions in Sabah. To those who lived in rural areas, the issues of authority, mainstream media, and social media influenced their decision to vaccinate[27]. Residents in rural areas tend to believe in vaccine conspiracy. One of the factors was the education level of rural communities which is commonly lower than urban communities. People or communities with lower education levels are more prone to fall for fake rumors, false news, or negative influence [28].

ARTé: Mecenas is an educational tool supporting student art history learning. This study adopted the eGameFlow scale to analyze students' knowledge and understanding of learning. There were 127 undergraduate students involved in the study. ARTé: Mecenas allowed users to experience the 15th and 16th century Italian Renaissance virtually.

They included 24 items from 6 factors in the eGameFlow scale and extra 16 items for the player's overall learning experience from the gameplay. The six factors included are Concentration, Goal Clarity, Challenge, Autonomy, Immersion, and Knowledge Improvement. This study found that Knowledge Improvement was the most significant factor in an educational game. To accomplish this factor, designers should design a game that is able to catch the player's attention to the learning task provided, as well as engage players in the gaming as much as they can to make sure there will be a great improvement while playing the game [23]. This study concluded that eGameFlow is meaningful in educational games which can help in learning.

C. Methodology

The components of the eGameFlow model are utilised in this game development to enhance the player's enjoyment during gameplay. Each criterion is displayed and highlighted in Table 1. A total of 7 criteria are included in the interface design. Those criteria are concentration, goal clarity, feedback, challenge, autonomy, immersion, and knowledge improvement. The criteria included in the interface design are presented in Fig. 2, Fig 3, Fig. 4a, Fig. 4b, Fig. 5, Fig. 6, Fig. 7, and Fig. 8, respectively.

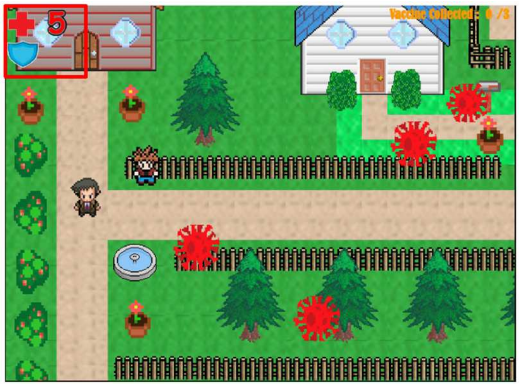

Fig. 2 Concentration element

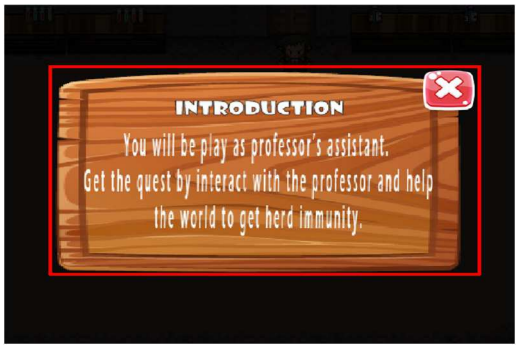

Fig. 3 Goal clarity element

The game has a health navigator, as shown in Fig. 2, and the player needs to focus and concentrate on surviving until he finishes the game. The player has to make sure not to collide with the enemy to maintain their health, which acts as their life. Fig. 3 shows the game goal provided at the beginning of the game to ensure players understand their tasks before playing this game. According to Fig. 4a and Fig. 4b, this educational game gives the player feedback on whether they successfully completed the mission. In a game, feedback

is essential so players are continuously informed of their progress.

Fig. 4a Feedback element

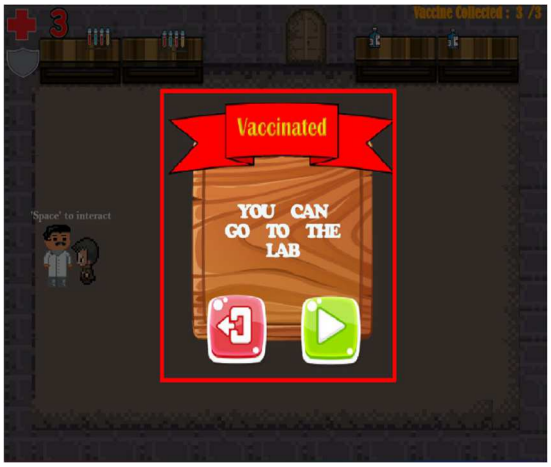

Fig. 4b Feedback element

Viruses will act as enemies to the player. Fig. 5 shows an example of a challenge. The challenge in this game is when the virus moves faster each time the player collects an item, and the virus may chase the player.

Fig. 5 Challenge element

The player has control over the main character and the game's flow as shown in Fig. 6. They can pause or quit the game whenever they want to. A setting button is provided to allow players to customize the game to their preferences.

Fig. 6 Autonomy element

Since it is a 2D game, a simple immersion element, as displayed in Fig. 7 is included. This educational game provides sound effects and background music throughout the game. Each time the player collects an item, a sound effect will appear. This also happens when the player collides with an enemy. A sound effect will appear to give a feeling of "Oh, no! I bumped into an enemy."

Fig. 7 Immersion element

This educational game also provides vaccine information after the user accomplishes a certain task. Some of the information provided includes the side effects after vaccination and different contents for different vaccines, as shown in Fig. 8.

Fig. 8 Knowledge Improvement element

1) Evaluation Procedure: This game can be accessed using a personal computer (PC) or laptop because it is web-based. The participants were briefly explained the procedure in the questionnaire. An instruction and link for the game were also provided. Each participant took approximately 5-9 minutes to test the game. Once the participants had completed the game, they had to answer a questionnaire distributed through Google Forms. The questionnaire was modified into a simple language and written bilingually (in Malay and English) that could be easily understood. A total of 30 participants ranging from 18 to 38 years old were involved in this evaluation. This age range is considered appropriate for assessing the vaccine game because it is based on basic vaccination knowledge. Since this is a web-based game, this age group was best suited because they are the most active users on social media. This conclusion is supported by a study conducted by Hua et al. [29] which looked at social media users. 69.0% of their total respondents were between the ages of 21 and 30. By playing this game, young adults would learn better about the need for immunization.

2) Instrument: In this study, we adopted the game eGameFlow scale to measure the player's level of enjoyment while playing a knowledge game. Seven eGameFlow criteria were included in this evaluation: concentration, difficulty, goal clarity, feedback, autonomy, immersion, and knowledge improvement. Social interaction was excluded due to the nature of this game. Table 2 represents the seven main scales for eGameFlow and 28 sub-scales included for the overall evaluation.

TABLE II
THE EGAMEFLOW SCALE

Scale	Code	Sub-scale
Concentration	C1	The game grabs my attention.
	C2	The game provides content that stimulates my attention.
	C3	I can remain concentrated throughout the game.
	C4	Most of the gaming activities are related to the learning task.
Goal Clarity	GC1	Overall game goals were presented in the beginning of the game.
	GC2	Overall game goals were presented clearly.
	GC3	Intermediate goals were presented in the beginning of each scene.
	GC4	Intermediate goals were presented clearly.
Feedback	F1	I receive feedback on my progress in the game.
	F2	I receive immediate feedback on my actions.
	F3	I am notified of new tasks immediately.
	F4	I receive information on my success (or failure) of intermediate goals immediately.
Challenge	CH1	The game provides ‘‘hints” in text that help me overcome the challenges.
	CH2	The game provides video or audio auxiliaries that help me overcome the challenges.
	CH3	I enjoy the game without feeling bored or anxious.
	CH4	The game provides new challenges with an appropriate pacing.
Autonomy	A1	The game does not allow players to make errors to a degree that they cannot progress in the game.
	A2	I feel a sense of control and impact over the game.
	A3	I know next step in the game.
	A4	I feel a sense of control over the game.
Immersion	I1	I forget about time passing while playing the game.
	I2	I become unaware of my surroundings while playing the game.
	I3	I can be involved in the game.
	I4	I feel emotionally involved in the game
Knowledge Improvement	K1	The game increases my knowledge.
	K2	I catch the basic ideas of the knowledge taught.
	K3	The game motivates the player to integrate the knowledge taught.
	K4	I want to know more about the knowledge taught.

III. RESULTS AND DISCUSSION

A. Demographic Summary

Table 3 shows the respondents' demographic information based on the online survey findings.

TABLE III
DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Characteristics	Item	No. of respondents (N)	Percentage (%)
Gender	Male	15	50
	Female	15	50
Age	18 – 21	10	33.3
	22 – 25	5	16.7
	26 – 29	5	16.7
	30 – 34	10	33.3
	35 - 38	0	0
Current employment	Student	5	16.7
	Employed	15	50
	Unemployed	10	33.3
How many hours do you spend to play computer games in a week?	0 hour per week	0	0
	1 - 3 hour per week	10	33.3
	4 - 6 hour per week	5	16.7
	7 - 9 hour per week	0	0
	More than 10 hour per week	15	50
I play computer games (you may tick more than 1)	To learn something	15	50
	For challenge	0	0
	For fun	20	66.7
	To fulfil my leisure time	25	83.3
I feel that I am a/an	Experienced gamers	0	0

	Moderate experiences gamers	5	16.7
	Less experienced gamers	15	50
	Novice gamers	10	33.3

TABLE IV
TOTAL AVERAGE VALUE FOR EACH SUBSCALE AND OVERALL AVERAGE VALUE

Scale	Code	Mean
Concentration	C1	4.17
	C2	3.67
	C3	3.33
	C4	4.03
Average mean for Concentration		3.80
Goal Clarity	GC1	4.17
	GC2	4.33
	GC3	4.50
	GC4	3.67
Average mean for Goal Clarity		4.17
Feedback	F1	4.17
	F2	4.33
	F3	3.83
	F4	3.33
Average mean for Feedback		3.92
Challenge	CH1	4.50
	CH2	4.67
	CH3	4.00
	CH4	3.67
Average mean for Challenge		4.21
Autonomy	A1	3.83
	A2	3.33
	A3	3.33
	A4	4.00
Average mean for Autonomy		3.62
Immersion	I1	4.33
	I2	3.33
	I3	4.00
	I4	3.97
Average mean for Immersion		3.97
Knowledge Improvement	K1	3.67
	K2	4.67
	K3	4.00
	K4	4.67
Average mean for Knowledge Improvement		4.25
Average mean for overall elements		4.06
Percentage of overall average		81%

The survey received responses from an equal number of men and women. The study was primarily conducted by employed individuals, followed by unemployed and students not currently seeking employment. This corresponds to the result of the respondents' age where most of them were between 22 – 25 years old (16.7%), 26 – 29 years old (16.7%), and 30 – 34 years old (33.3%). Only a number of students participated in the study (16.7%), and they were considered to come from the age group of 18 – 2 years old (33.5%). This survey was participated by young adults, who were the target users for this educational game.

Most respondents (50.0%) played online games for more than 10 hours per week, and none did play online games at all in a week. 83.3% of the respondents stated that they played online games to fulfill their leisure time, while 66.7% played online games for fun and 50% to learn something. This shows that online games can be helpful tools for giving information and knowledge. Half of the respondents claimed that they were less experienced gamers (50.0%), followed by novice gamers (33.3%), and moderately experienced gamers (16.7%). No gaming skill is required to play this educational game since it is a simple 2D game only.

B. Enjoyment Evaluation Summary

The mean value for each of the sub-factors from this game's evaluation is shown in Table 4. For each dimension, the overall mean was calculated, which shows the degree of agreement on a particular subscale. The total mean of the Knowledge Improvement Dimension is 4.25, with the highest average value. This demonstrates that the game has successfully increased the player's knowledge. We believe that a game incorporating knowledge will give the player a big advantage. Challenge represents the second-highest score, with a mean value of 4.21. This shows that the game is challenging for the player. One of the most crucial factors in a game that motivates players throughout the game is the challenge. Among the elements, autonomy has the lowest average, with a mean of 3.62. From our point of view, this is due to the nature of this game, which is a simple 2D game. It is a very straightforward game, and the player has less control over the game. The percentage from the overall average of the evaluation is at an agreeable level of 81% which is considered as achieving the goal.

IV. CONCLUSION

From the results discussed, this educational game successfully provided an enjoyable experience in gaining knowledge about vaccines. This game could benefit anyone, especially young adults, to enhance their knowledge of vaccines. An advantage of using the eGameFlow model is the fact that it focuses on the educational game environment, which actively addresses learning components in the game. For future enhancements, we suggest this game be developed in 3D to provide deep immersion and autonomy to the player. A time limitation may also be provided to give players more challenge and time pressure. A study by Cox et al. [30] shows that time pressure significantly impacts the players' immersion.

ACKNOWLEDGMENT

The researchers express their heartfelt gratitude to UiTM Cawangan Melaka for funding this study through the TEJA Internal Grant numbered GDT2021/2-10. Also, we express our gratitude and appreciation to everyone involved in this study, directly or indirectly.

REFERENCES

[1] Y. Khoo, A. Ghani, A. Navamukundan, R. Jahis, and A. Gamil, "Unique product quality considerations in vaccine development, registration and new program implementation in Malaysia," *Hum Vaccin Immunother*, vol. 16, pp. 1–9, Oct. 2019, doi: 10.1080/21645515.2019.1667206.

[2] F. Asres and B. Umeta, "COVID-19 vaccines: awareness, attitude and acceptance among undergraduate University students," *J Pharm Policy Pract*, vol. 15, no. 1, p. 32, 2022, doi: 10.1186/s40545-021-00397-6.

[3] A. Jafar, R. Dambul, R. Dollah, N. Sakke, M. T. Mapa, and E. P. Joko, "COVID-19 vaccine hesitancy in Malaysia: Exploring factors and

identifying highly vulnerable groups," *PLoS One*, vol. 17, no. 7, pp. e0270868-, Jul. 2022, [Online]. Available: https://doi.org/10.1371/journal.pone.0270868

[4] N. Manaf, A. Omar, and F. Suib, "Vaccine hesitancy and implications on childhood immunisation in Malaysia," *International Journal of Health Governance*, vol. ahead-of-print, Dec. 2021, doi: 10.1108/IJHG-05-2021-0055.

[5] I. Montagni, I. Mabchour, and C. Tzourio, "Digital Gamification to Enhance Vaccine Knowledge and Uptake: Scoping Review," *JMIR Serious Games*, vol. 8, no. 2, p. e16983, 2020, doi: 10.2196/16983.

[6] K. Fatima and N. Syed, "Dengvaxia controversy: impact on vaccine hesitancy," *J Glob Health*, vol. 8, Oct. 2018, doi: 10.7189/jogh.08.020312.

[7] G. La Torre *et al.*, "ImmunizziAMO: A School-Based Field Trial to Teach New Generations the Importance of Vaccination through Games and to Fight Vaccine Hesitancy in Italy," *Vaccines (Basel)*, vol. 8, p. 280, Jun. 2020, doi: 10.3390/vaccines8020280.

[8] Z. Chong, H. J. Soe, A. Ismail, T. Mahboob, S. Chandramathi, and S. Sekaran, "Evaluation of the Diagnostic Accuracy of a New Biosensors-Based Rapid Diagnostic Test for the Point-Of-Care Diagnosis of Previous and Recent Dengue Infections in Malaysia," *Biosensors (Basel)*, vol. 11, p. 129, Apr. 2021, doi: 10.3390/bios11050129.

[9] L. P. Wong, P. F. Wong, and S. AbuBakar, "Vaccine hesitancy and the resurgence of vaccine preventable diseases: the way forward for Malaysia, a Southeast Asian country," *Hum Vaccin Immunother*, vol. 16, no. 7, pp. 1511–1520, Jul. 2020, doi: 10.1080/21645515.2019.1706935.

[10] N. E. A. Hamdan, M. L. Fahrni, and A. I. Lazzarino, "COVID-19 Vaccination Prioritization Strategies in Malaysia: A Retrospective Analysis of Early Evidence," *Vaccines (Basel)*, vol. 11, no. 1, 2023, doi: 10.3390/vaccines11010048.

[11] J. Rumetta, H. Abdul Hadi, and Y. K. Lee, "A qualitative study on parents' reasons and recommendations for childhood vaccination refusal in Malaysia," *J Infect Public Health*, vol. 13, Aug. 2019, doi: 10.1016/j.jiph.2019.07.027.

[12] H. K. Balbir Singh *et al.*, "Assessment of knowledge and attitude among postnatal mothers towards childhood vaccination in Malaysia," *Hum Vaccin Immunother*, vol. 15, no. 11, pp. 2544–2551, Nov. 2019, doi: 10.1080/21645515.2019.1612666.

[13] K. Thomas and J. Darling, "Education Is Now a Bigger Factor Than Race in Desire for COVID-19 Vaccine," *UCS University of Southern California*, 2021.

[14] J. Y. H. Voo, Q. Y. Lean, L. C. Ming, N. H. Md. Hanafiah, Y. M. Al-Worafi, and B. Ibrahim, "Vaccine Knowledge, Awareness and Hesitancy: A Cross Sectional Survey among Parents Residing at Sandakan District, Sabah," *Vaccines (Basel)*, vol. 9, no. 11, 2021, doi: 10.3390/vaccines9111348.

[15] H. Eren, "The Relationship Between COVID-19 Awareness and Vaccine Hesitancy among University Students," *Journal of Basic and Clinical Health Sciences*, Mar. 2022, doi: 10.30621/jbachs.1066123.

[16] Z. A. Zulkifli, M. N. Mohamad Noor, and N. F. Johari Mohd, "The VaccineLand: An Interactive Digital Board Game to Educate Public about Vaccines," 2022. doi: http://dx.doi.org/10.30630/joiv.6.2-2.1118.

[17] A. Messina *et al.*, "Developing a Video Game as an Awareness and Research Tool Based on SARS-CoV-2 Epidemiological Dynamics and Motivational Perspectives," *Transbound Emerg Dis*, vol. 2023, p. 8205408, 2023, doi: 10.1155/2023/8205408.

[18] S. Cheung and K. Ng, "Application of the Educational Game to Enhance Student Learning," *Front Educ (Lausanne)*, vol. 6, Mar. 2021, doi: 10.3389/feduc.2021.623793.

[19] S. B. Mohd Rozaidi and I. Ismail, *Enjoyment Of Learning Biology Through Mobile Game Based Learning For Form 5 Students: Kidney Rush*. 2018.

[20] S.-H. Chen, W.-Y. Wu, and J. Dennison, "Validation of EGameFlow: A Self-Report Scale for Measuring User Experience in Video Game Play," *Computers in Entertainment*, vol. 16, pp. 1–15, Sep. 2018, doi: 10.1145/3238249.

[21] F.-L. Fu, R.-C. Su, and S.-C. Yu, "EGameFlow: A scale to measure learners' enjoyment of e-learning games," *Comput Educ*, vol. 52, pp. 101–112, Jan. 2009, doi: 10.1016/j.compedu.2008.07.004.

[22] K. Chan, K. Wan, and V. King, "Performance Over Enjoyment? Effect of Game-Based Learning on Learning Outcome and Flow Experience," *Front Educ (Lausanne)*, vol. 6, Jun. 2021, doi: 10.3389/feduc.2021.660376.

[23] W. Weng, H. Ramadan, and A. Thomas, *Understanding Enjoyment in ARTé: Mecenas with EGameFlow*. 2020. doi: 10.1109/CoG47356.2020.9231662.

[24] N. H. Mat Zain, A. Jaafar, and F. H. Abdul Razak, "The Components of Enjoyable Game Design for Motor Impaired Users: Expert Evaluation," *Indian J Sci Technol*, vol. 9, Dec. 2016, doi: 10.17485/ijst/2016/v9i47/92361.

[25] P. Sweetser and P. Wyeth, "GameFlow: A Model for Evaluating Player Enjoyment in Games," *Comput. Entertain.*, vol. 3, no. 3, p. 3, Jul. 2005, doi: 10.1145/1077246.1077253.

[26] N. H. Mat Zain, "Learning Through Games: An Approach for Children with Autism Spectrum Disorder During COVID-19 Pandemic," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, vol. 12, pp. 1820–1829, Apr. 2021, doi: 10.17762/turcomat.v12i5.2196.

[27] L. P. Wong, P. F. Wong, and S. AbuBakar, "Vaccine hesitancy and the resurgence of vaccine preventable diseases: the way forward for Malaysia, a Southeast Asian country," *Hum Vaccin Immunother*, vol. 16, no. 7, pp. 1511–1520, Jul. 2020, doi: 10.1080/21645515.2019.1706935.

[28] M.-I. Pop and I. Ene, "Influence of the educational level on the spreading of Fake News regarding the energy field in the online environment," *Proceedings of the International Conference on Business Excellence*, vol. 13, pp. 1108–1117, May 2019, doi: 10.2478/picbe-2019-0097.

[29] L. Y. Hua, T. Ramayah, T. A. Ping, and C. J. H. (Jacky), "Social Media as a Tool to Help Select Tourism Destinations: The Case of Malaysia," *Information Systems Management*, vol. 34, no. 3, pp. 265–279, Jul. 2017, doi: 10.1080/10580530.2017.1330004.

[30] A. L. Cox, P. Cairns, P. Shah, and M. Carroll, "Not doing but thinking: The role of challenge in the gaming experience," in *Conference on Human Factors in Computing Systems - Proceedings*, 2012, pp. 79–88. doi: 10.1145/2207676.2207689.