Contemporary Educational Technology, 2023, **15**(2), ep419
ISSN: 1309-517X (Online)

OPEN ACCESS

Research Article

Comparison of the efficacy between game-based learning and pamphlet on enhancing recognition of common cutaneous malignancies in Thai younger adults

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Citation: Mettarikanon, D., Tawanwongsri, W., Wanchai, A., & Chookerd, N. (2023). Comparison of the efficacy between game-based learning and pamphlet on enhancing recognition of common cutaneous malignancies in Thai younger adults. *Contemporary Educational Technology, 15*(2), ep419. https://doi.org/10.30935/cedtech/13013

ARTICLE INFO

Received: 7 Jan 2023
Accepted: 26 Feb 2023

ABSTRACT

Cutaneous malignancy is one of the leading causes of cancer-related morbidities and mortalities. Patient self-screening is helpful for early detection. Among educational pedagogies, game-based learning (GBL) has received increasing attention in recent years. We appraised the effectiveness of GBL, using Wordwall, to enhance cognitive performances pertaining to fundamental knowledge of cutaneous malignancies and perspectives on the intervention compared with a digital pamphlet. This multi-center study utilized a quasi-experimental research design and was conducted between February and April 2022. Participants were recruited and randomly assigned into a game group and a pamphlet group with a 1:1 ratio. Fundamental knowledge of cutaneous malignancies was assessed with pre- and post-intervention tests consisting of ten multiple choice questions with four alternative answers. These tests asked about prominent or pathognomonic features of cutaneous malignancies. During the five-day intervention period, recognition scores of participants in the game group were recorded. Perspectives on the interventions were also collected for analysis. A total of 94 participants were included, 60 (63.8%) were female. The mean age was 19.8 years (standard deviation [SD]=0.8). The increase in knowledge scores of the participants in the game group and pamphlet group was 2.57 (SD=1.30) and 2.36 (SD=1.52), respectively. In the game group, the mean best recognition score (13.89, SD=2.83) was significantly higher than the mean first recognition score (9.53, SD=2.48) with a p-value <0.001. The overall satisfaction among the participants in the game group and pamphlet group was 4.41 (SD=0.57) and 4.23 (SD=0.59), respectively. This study suggests potentiality of GBL to enhance knowledge and recognition performances of common cutaneous malignancies with high satisfaction. Embedding this approach in the primary prevention of cutaneous malignancies might be a promising option to prevent cancer-related morbidities and mortalities.

Keywords: game-based learning, cutaneous malignancy, pamphlet, game education, skin cancer

INTRODUCTION

Cutaneous malignancies, the leading cause of morbidity and mortality, have recently increased in incidence worldwide (Urban et al., 2021). The three common forms of skin cancer include basal cell carcinoma, squamous cell carcinoma, and melanoma (Asgari et al., 2015; Erdei & Torres, 2010; Rogers et al., 2010). In Thailand, the age-specific incidence rate of skin cancer was 3.6–3.8 per 100,000 person-years. Basal cell carcinoma, squamous cell carcinoma, and melanoma account for 11–60%, 23–50%, and 6–33% of skin cancers, respectively (Insamran et al., 2018; Tiyawatanaroj et al., 2022). Ultraviolet radiation (UVR) has been recognized as the most important environmental risk factor for the development of skin cancers (Madan et al., 2010; Moan et al., 2015; Schadendorf et al., 2018). The main pathogenesis is considered to be UVR-induced mutagenesis and its immunosuppressive and immunomodulatory properties (Narayanan et al., 2010). Nonmelanoma skin cancer and melanoma skin cancer entailed a mortality rate of one and 2.5 cases per 100,000 persons, respectively (Barton et al., 2017; CDCP, 2019). Patients with early-stage cutaneous malignancies show a better survival rate than those with advanced-stage cutaneous malignancies (Allais et al., 2021; Tokez et al., 2021). Aside from skin cancer screening by physicians, knowledge and trainable skills in recognition of its characteristics–by patients–may also contribute to a decreased delay in diagnosis, proper management, and a better prognosis (Oliveria et al., 1999; Robinson et al., 2020). Traditional methods of delivery for patient education include didactic lectures, discussions, written material, audiovisual sources, verbal recall, demonstration, and role playing. However, gamification and game-based learning (GBL) have recently become novel and attractive methods and were found to be better than ad hoc teaching or generalized teaching (Friedman et al., 2011). Gamification is the application of game elements in a non-game context to enhance desired performance and achieve learning outcomes, while GBL is the use of games to scaffold a specific skill or drive a specific learning outcome (Al-Azawi et al., 2016; So & Seo, 2018). While both GBL and gamification have positive effects on learning, they have different objectives and outcomes (Hamari et al., 2014; Sardi et al., 2017). GBL is employed to increase memory capacity, encourage problem-solving skills, and facilitate a skill-building process–in which learners are motivated by in-game achievement (Al-Azawi et al., 2016; AlFarsi et al., 2020).

In dermatology, game-based interventions promoted learner motivation, enjoyment, and favorable performances (Szeto et al., 2021). Jia et al. (2020) demonstrated the effectiveness of the gamified intervention in order to educate young participants on the visual identification of melanoma. It also proved its effectiveness among the elderly (Maganty et al., 2018). Nevertheless, previous studies did not cover all common types of skin cancers, particularly basal cell carcinoma, the most common type. In addition, studies focusing on GBL in skin cancer education in Asian populations remains very limited. Western countries tend to be more individualistic in comparison to East Asian countries, which have more collectivistic cultures (Kim et al., 1994; Tafarodi & Swann Jr, 1996). Previous studies found that culture significantly contributed to different reasons for playing games and in-game behavior (Lee & Wohn, 2012). Ngai (2005) revealed that Japanese players preferred cute female characters showing their strength and endurance and the games with complex cognitive structures. In contrast, Western players preferred masculine sex-appeal characters and entertainment media with a strict dualism of good and evil (Ngai, 2005). Additionally, Dong and Mangiron (2018) disclosed that Chinese players preferred multiplayer team games because of their collectivist society. Compared with Western players, they tended to quit games more easily (Dong & Mangiron, 2018). Generalization of previous study findings, therefore, would require proof of GBL's effective in different cultural contexts. We initially began with the broad research question (RQ): "What is the effectiveness of GBL for patient education in dermatology among Asian populations?" Following a team discussion with patient and public involvement (PPI), the following specific RQs were developed:

1. **RQ1:** Is GBL more effective than a pamphlet for health education on skin cancer recognition among Thai younger adults?
2. **RQ2:** What are the participants' perspectives on both educational materials–the GBL and the pamphlet–for enhancing skin cancers recognition?

We developed a game-based intervention to enhance the recognition of common cutaneous malignancies, including melanoma, basal cell carcinoma, and squamous cell carcinoma. While playing the game, the intervention was designed for scaffolding learners' recognition performances by helping them home in on

what they should identify as worrisome lesions. We aimed to evaluate and compare cognitive performances pertaining to fundamental knowledge of cutaneous malignancies and their perspectives between the participants in the game group and those in the pamphlet group.

METHODS

Patient and Public Involvement

PPI helped at various stages of the research process including focusing the questions, study design, and dissemination. We invited PPI participants via posters in the dermatology waiting room at Walailak University Hospital to join the social media closed group (on Facebook). They were consulted about research topics and priorities for them as service users. We proposed the design of the research study. After discussion, they made suggestions and refined the inclusion and exclusion criteria. They agreed that the methods and interventions were appropriate since they lived in an area where the UV index is high and GBL tended to fit well with young adults, particularly university students who might readily learn from games. This also brought an early awareness of the importance of sun protection. They then helped to distribute the results within their informal groups.

Participants

This study utilized a quasi-experimental research design, and was conducted at Walailak University and Hatyai University, Thailand between February and April 2022. In the recruitment process, we posted online announcements about this study and asked for volunteers on our academic websites in February 2022. To minimize undue influence, we had our co-investigators organize the registration process and the withdrawal process. We determined the research sample by using a clustering purposive sample by taking non-medical students from School of Informatics and Faculty of Science and Technology. The inclusion criteria included:

(1) being 18 years or older,

(2) living for at least five years in the southern part of Thailand, and

(3) being able to read, write, and understand Thai and English and having the capacity to consent.

The exclusion criteria included:

(1) having ever studied dermatology or dermatopathology,

(2) having a history of color-blindness or severe visual impairment, and

(3) being unwilling to participate in the study.

We obtained written informed consent from all participants. They were able to withdraw without consequence at any time for any reason. After eligible participants were voluntarily recruited, they were randomly assigned to one of two groups using Excel 2019 (Microsoft, USA): group 1 (game group) and group 2 (pamphlet group).

Intervention and Study Design

Wordwall is the online game made by a team comprised of game-based specialists, an education specialist (NC), a game specialist (KC), and a clinical dermatologist (WT) at Walailak University. The game has 16 items as is played online through a web-based applet on smartphones, tablets, laptops, and desktops. During the game, the participants were instructed to respond as quickly as possible with a true (malignant skin lesion) or false (benign skin lesion) answer as illustrated in **Figure 1** (Mettarikanon, 2021). Instant feedback and rewards were given after participants submitted their answers. Both the benign and malignant skin lesions were diagnosed by a dermatologist. The images were collected and then selected based on clinical and dermoscopic findings along with microbiologic or pathologic investigations depending on their standards for confirmation. These samples were taken with the informed consent of the participants and were under the creative commons license. The game was eventually composed of eight malignant and benign images.

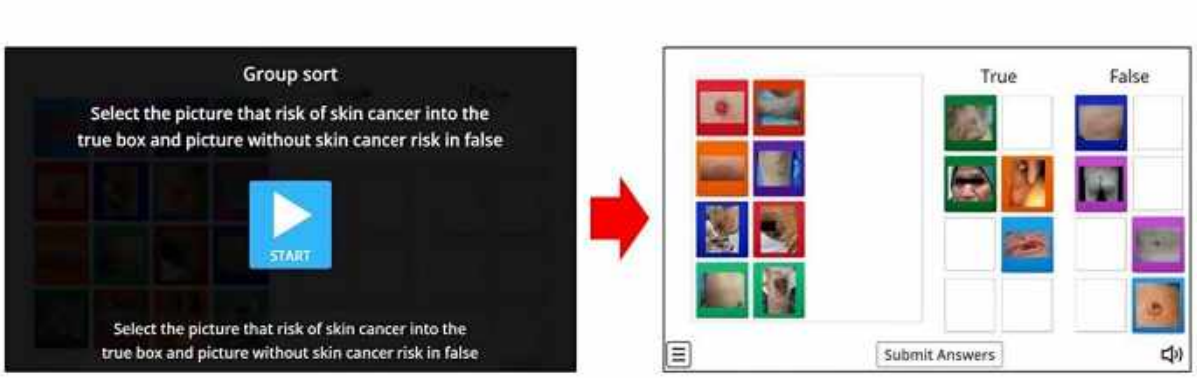

Figure 1. A screenshot of Wordwall game used as the intervention in this randomized clinical trial (Source: https://wordwall.net/resource/26850479/select-the-picture-that-risk-of-skin-cancer-into-the-true-box)

Baseline characteristics were collected including age, gender, and education level. Cognitive performance pertaining to fundamental knowledge of cutaneous malignancies was assessed with online pre- and post-intervention tests, via the Socrative program, consisting of up to ten multiple choice questions with four alternative answers. These tests asked about prominent or pathognomonic features of probable cutaneous malignancies without showing any images. Participants in the game group were linked and instructed to play Wordwall. Their recognition scores through repetitive game playing were also recorded. Participants in the pamphlet group were given a digital pamphlet with information about skin cancers (Institute of Dermatology, 2020). The post-intervention knowledge test was carried out in both groups five days after the intervention. The pre- and post-intervention knowledge scores from both groups were collected for statistical analysis.

The validity and reliability of the test were validated by an education specialist (NC). After designing the test, we evaluated the internal consistency reliability–using Cronbach's alpha coefficient, with a resulting value of 0.91–through a pilot test with participants (n=10) recruited from university students to assess its clarity, accuracy, and readability. At the end of the study, a post-intervention survey asked the participants in both groups about the intensity of the intervention–including frequency and length of time spent on the intervention–and their perspectives including satisfaction, joyfulness, and its impacts on learning outcomes. Joy, a distinct positive emotion, is a response to a good object. It can be assessed reliably by means of self-reports (Watkins et al., 2018). The scores representing the level of agreement were rated on a 5-point scale ranging from 1 (completely disagree) to 5 (completely agree).

The sample size calculation was based on a previous study (Maganty et al., 2018), with an alpha of 0.05 and a power of 80%. Accounting for a potential loss to follow-up of 20%, the sample size calculation required approximately 30 subjects to be recruited in each arm. The Walailak Ethical Committee considered and complied with the laws of Thailand including personal data protection act (PDPA). The study complied with the International Conference on Harmonization of Good Clinical Practice and the principles of the Declaration of Helsinki. The study was registered with the Thai Clinical Trials Registry (TCTR20220223002). All data files and sensitive personal information were encrypted, password protected, and saved to a secure computer that was only accessible to the study coordinators to ensure confidentiality. Participants could access their own data by contacting the study coordinators directly. No information that could link an individual to the data was revealed. 12 months after completion of the study, all data were deleted.

Statistical Analysis

For the descriptive statistics, mean and standard deviation (SD) or median and range were used to describe the continuous data. Frequency and percentages were used for categorical data. For the inferential statistics, differences were evaluated by paired t-test or Wilcoxon test, depending on the shape of the distribution curve. In the game group, the pre- and post-intervention accuracy of individuals in correctly identifying the malignant skin lesions and benign skin lesions was compared. A p-value of <0.05 in the two-tailed tests was considered statistically significant. The statistical analysis was performed using SPSS software version 17 (SPSS Inc., Chicago, IL, USA).

Table 1. Intensity of intervention & cognitive performances in game group compared with pamphlet group (n=94)

	Game group (n=47)	Pamphlet group (n=47)	p-value
Frequency, n (%)			0.727
1-2 times per day	42 (89.4%)	43 (91.5%)	
3-4 times per day	5 (10.6%)	4 (8.5%)	
Length of time, n (%)			0.022[a]
<5 minutes per day	13 (27.7%)	5 (10.6%)	
5-10 minutes per day	31 (66.0%)	35 (74.5%)	
11-15 minutes per day	3 (6.3%%)	7 (14.9%)	
Knowledge scores			
Before intervention	3.21 (SD=1.76)	2.83 (SD=1.57)	0.618
After intervention	5.79 (SD=1.70)	5.19 (SD=1.81)	0.591
Increased scores	2.57 (SD=1.30)	2.36 (SD=1.52)	0.913

Note. [a]p<0.05 & SD: Standard deviation

RESULTS

A total of 100 participants were enrolled in the study, and three were excluded (game group: n=1; pamphlet group: n=2) because they were unwilling to participate. Further, three participants were withdrawn during the intervention period because of internet problems (game group: n=2; pamphlet group: n=1). A total of 94 participants were included for statistical analysis; 60 (63.8%) were female. The mean age was 19.8 years (SD=0.8). All of them were undergraduate non-medical students including 45 (47.9%) first-year students, 25 (26.6%) second-year students, and 24 (25.5%) third-year students. A majority, in both groups, played games 1-2 times per day and spent 5-10 minutes on the intervention as detailed in **Table 1**.

In the game group, the pre- and post-intervention knowledge scores were 3.21 (SD=1.76) and 5.79 (SD=1.70), respectively. After playing the games, the post-intervention knowledge scores were significantly higher than the pre-intervention knowledge scores, with a mean difference of 2.57 (SD=1.30, p<0.001). In the pamphlet group, the pre- and post-intervention knowledge scores were 2.83 (SD=1.57) and 5.19 (SD=1.81), respectively. After reading the pamphlets, the post-intervention knowledge scores were significantly higher than the pre-intervention knowledge scores, with a mean difference of 2.36 (SD=1.52, p<0.001). The overall increase in the knowledge scores was not significantly different between the game group and pamphlet group (p=0.913).

In the game group, the mean of participants' best recognition scores (13.89, SD=2.83) was significantly higher than that of participants' first recognition scores (9.53, SD=2.48) with a p-value <0.001. The median recognition score significantly increased at the second round (p<0.001) with continuous improvements; after the fifth round, it remained unchanged, as illustrated in **Figure 2**.

The median accuracy (median, 100.0; IQR, 75.0-100.0) of the highest-score round was significantly higher than that (median, 62.5; IQR, 50.0-75.0) of the first round (p<0.001). At the end of the study, participants were asked to fill out a satisfaction survey pertaining to the intervention. The detailed survey results are shown in **Table 2**.

DISCUSSION

This study was conducted to scrutinize the effectiveness of GBL in enhancing the recognition of common cutaneous malignancies, including basal cell carcinoma, squamous cell carcinoma, and melanoma among adult Thai populations. The incidence–UV exposure relationship for all common cutaneous malignancies has been well documented (Moan et al., 2015). Therefore, for the study site, we included two centers in the southern part of Thailand where the UV index was the highest (Sudhibrabha et al., 2006). To our knowledge, our study is the first to address the impacts of this learning approach in recognition of these three common cutaneous malignancies.

Bloom's taxonomy is one of the most commonly used taxonomies in education (Irvine, 2021). It is comprised of three learning domains: cognitive, affective, and psychomotor. In the revised version, it categorizes the cognitive domain into six levels–including remembering, understanding, applying, analyzing,

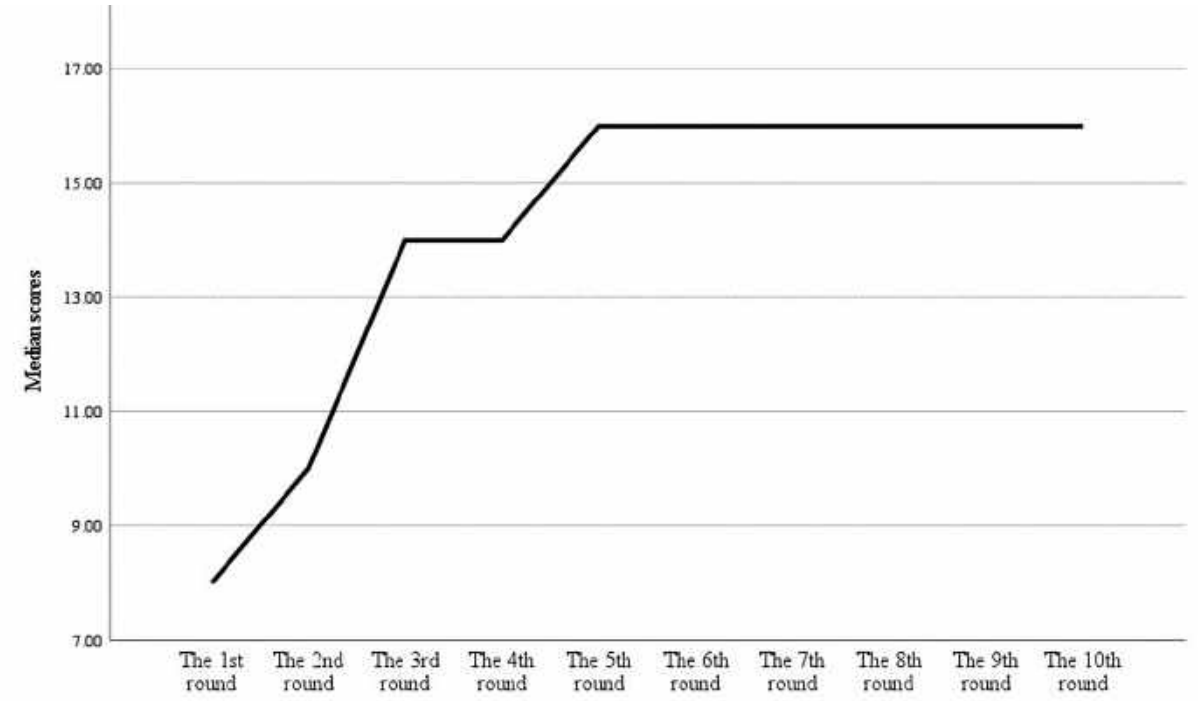

Figure 2. Changes in recognition performance scores, ranging from 0 to 16, during playing Wordwall games (n=47) (Source: Authors' own elaboration)

Table 2. Participants' perspectives on educational materials (n=94)

	GP (n=47)		PG (n=47)		P
	M	SD	M	SD	
The educational materials were interesting and easily understood.	4.17	0.66	4.08	0.58	0.256
Game characteristics with true or false questions were suitable for learning contents.	4.31	0.60	NA	NA	NA
Appropriateness of educational materials used for learning common cutaneous malignancies.	4.45	0.63	4.23	0.60	0.291
The clarity of the given images.	4.31	0.66	4.12	0.77	0.686
An adequate amount of time for learning common cutaneous malignancies.	4.45	0.63	3.92	0.63	0.142
The game was challenging enough.	4.07	0.70	NA	NA	NA
Improvement in recognition skills about common cutaneous malignancies after intervention.	4.52	0.57	4.23	0.59	0.416
Appropriateness of educational materials for learning common cutaneous malignancies.	4.41	0.57	4.31	0.62	0.916
The joyfulness of playing the game compared to that of reading the pamphlet.	4.21	0.77	NA	NA	NA
Overall satisfaction with educational materials for learning common cutaneous malignancies.	4.41	0.57	4.23	0.59	0.474

Note. GBL: Game-based learning; NA: Not applicable; GP: Game group; PG: Pamphlet group; M: Mean; & P: p-value

evaluation, and creating (Anderson & Krathwohl, 2001). This useful tool facilitates educators in establishing learning objectives, creating appropriate activities, monitoring the learning process, and evaluating what has been acquired (Armstrong, 2016).

Our study demonstrated that both intervention modules remarkably improved knowledge scores–representing a level of understanding of the prominent characteristics of common cutaneous malignancies. Also, participants in the game group significantly developed their skills in recognition of cutaneous malignancies through repetitive practice. Their accuracy was dramatically improved from approximately 60-100%. It reflected that this GBL approach effectively boosted the participants' favorable performance, which was categorized into a level for analyzing.

According to this higher order thinking, the intervention enabled them to better compare and contrast as well as predict the likelihood of cutaneous malignancies. This GBL approach could therefore be promising for preparing individuals in a real-practice situation. Furthermore, the post-intervention survey in the game group demonstrated a high degree of satisfaction, particularly in self-reported joyfulness of playing the game compared to that of reading the pamphlet.

Our findings are similar to those reported in previous studies, which found that participants gained remarkable skills with high accuracy in the visual identification of malignant melanoma via GBL (Jia et al., 2020; Maganty et al., 2018). However, accuracy rates ranging from 60.6% to 74.2% have been reported. It is conceivable that different participant characteristics and backgrounds, as well as the different programs and assessment methods used in studies might explain the differences in the results.

The GBL pedagogy has received abundant attention as a result of its potential to meet the needs of the learner in the digital generation (Ding et al., 2017). It encourages learners to participate in learning while playing and scaffolds the learning process more amusingly and effectively with an organized and safe environment for learners to construct cognitive skills and confidence, without real-world impacts (Al-Azawi et al., 2016; Szeto et al., 2021). This process, the so-called game cycle, consists of learner judgment, behavior, and feedback in order to compose a highly motivated learning experience and favorable learning outcomes (Garris et al., 2002). Together with engagement in gameplay, feedback and meta-reflection are the cornerstones of effective learning (Ke et al., 2016). Nevertheless, it is considered time-consuming to gain competence in creating proper designs (Greipl et al., 2020). We therefore developed the game with the assistance of an education expert (NC). While the skin cancer screening program using whole-body examinations in Thailand has not been well established (Insamran & Sangrajrang, 2020), the incidence of certain cancer types–for instance, basal cell carcinoma–has tended to rise over the past decades (Tiyawatanaroj et al., 2022). The number of reported cases may therefore be less than the number of actual cases. A well-constructed national campaign for primary prevention would provide positive reinforcement for detecting underreported cases in Thailand and might later alleviate the related morbidity and mortality (Breitbart et al., 2012; Choudhury et al., 2012).

The strengths of our study are, first, that it is the first study in younger population to focus on the effectiveness of GBL in enhancing recognition of common cutaneous malignancies. Second, our study included all three common cutaneous malignancies (basal cell carcinoma, squamous cell carcinoma, and melanoma). It thus encompasses the wider spectrum of cutaneous malignancies compared to previous studies (Jia et al., 2020; Maganty et al., 2018). However, several study limitations deserve mention. First, the majority of the participants were young adults, mostly college students under the age of 25. Despite the suggestion from PPI, they might not represent the digital generation and others who are at a high risk of skin cancer–the elderly. Therefore, it may be a challenge to generalize these results to a wider population. However, it remains possible that there might be a benefit to be derived from game-based interventions in the health domains including physical, cognitive, social, and emotional health (Koivisto & Malik, 2021; Martinho et al., 2020). Future studies will need to include a wider range of age levels as well as educational and socioeconomic backgrounds to ascertain the generalizability of the findings. Second, de facto specific skills to distinguish cutaneous malignancies from benign lesions might be challenging given the two-dimensional images used in the game. A precise diagnosis is not only based on inspection but also on palpation, which is a critical component of skin assessment. Third, this study did not have a long follow-up period to ascertain retention of knowledge and their recognition performances. Fourth, although skin self-examination aided early detection of skin cancers, its impacts on behavioral changes and clinical prognosis remained unclear (Ersser et al., 2019). A similar study with a longer follow-up period would further enrich the findings of this study in order to illustrate the knowledge retention rate, long-term recognition performances, and the bona fide benefits, in particular with respect to decreased morbidity and mortality.

CONCLUSION

GBL was a promising method for enhancing recognition of common cutaneous malignancies. With repetitive practice, the participants significantly gained favorable skills with a high level of satisfaction. Further studies with a longer follow-up period are needed to clarify the actual clinical significance. Our findings underpin the significance of GBL in reinforcing the recognition of common cutaneous malignancies. The game provides an organized and safe environment for learners to construct cognitive skills and confidence without real-world impacts. Healthcare providers can render health information via this digital tool for targeted larger populations while saving time and human efforts. Embedding GBL in the primary prevention of cutaneous malignancies might present an auspicious way to decrease the related morbidity and mortality.

Author contributions: DM: investigation, formal analysis, writing–review, & editing; **WT:** conceptualization, funding acquisition, methodology, & writing–original draft preparation; **AW:** data curation, formal analysis, & editing; & **NC:** investigation, writing–review, & editing. All authors approve final version of the article.

Funding: The study received a grant from Walailak University (WU65210).

Acknowledgements: The authors would like to thank Dr. Kannattha Chaisriya, game specialist, who provided her thoughtful comments and fruitful suggestions to help tremendously about the game development.

Ethics declaration: Authors declared that the study received ethical approval from the Walailak Ethical Committee (WUEC-22-043-01). It was registered with Thai clinical trials registry (TCTR20220223002).

Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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