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NutriQuest game: User experience of Grades 2 and 3 children in two Philippine private schools

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ABSTRACT

Introduction: This study presents the user experience (UX) of Grades 2 and 3 schoolchildren with a nutrition mobile game, NutriQuest, developed by DOST-Food and Nutrition Research Institute. **Methods:** The evaluation of user experience was based on the UX Honeycomb framework developed by Morville (2004). For this study, four aspects of the UX Honeycomb, namely usefulness, usability, findability, and desirability, were determined among study participants through a guided, self-administered questionnaire. **Results:** Study results revealed that approximately two-thirds (33 out of 49) of children were unable to correctly identify the food groups due to unfamiliarity with food items. For usability, children found that the words used and instructions of the game were just right. For findability, the majority of students (76% or 37 out of 49) answered that the buttons were easy to find and the game was easy to use (78% or 38 out of 49). For desirability, the sound effects used were just right (86%), pictures were good (84%), and 88% liked the light colours used. Children cited the lesson or information (57%) learnt through experience or by playing the game. **Conclusion:** The NutriQuest game was acceptable to children; it can create awareness and knowledge on healthy eating. The findings provide vital inputs to game design, taking into account user interaction and experience when designing game interfaces. The impact of game-based learning on children's knowledge of healthy eating can be considered for future research. Additionally, studies can also examine the interplay between conventional teaching modes and game-based strategies.

Keywords: game-based learning, game interface, mobile games, schoolchildren

INTRODUCTION

Understanding nutrition and possessing food-related abilities empower people of all ages to adeptly manoeuvre complex food environments. This involves the ability to assess and comprehend nutrition information, hence enabling the selection of nutritious dietary options (Froome *et al.*, 2020). Establishing healthy dietary patterns at an early age is vital as it helps in providing the necessary nutrients required for optimal growth and sustained well-being and assists in the cognitive development of children. These habits play a pivotal role in triggering developmental shifts that substantially shape their overall health during the transition from adolescence

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to adulthood (WHO, 2020).

In the Philippines, malnutrition is a concern, of which undernutrition has been a problem for approximately thirty years now. Based on the recent Expanded National Nutrition Survey (DOST-FNRI, 2023) of the Department of Science and Technology-Food and Nutrition Research Institute (DOST-FNRI), two out of 10 schoolchildren are underweight and this is the same case for stunting. Furthermore, wasting occurs among one out of 10 school-age children and this is again the same case for overweight.

Insufficient and inadequate dietary intake in the early stages of childhood increases the risk of developing deficiencies and concomitant poor health conditions due to lack of essential vitamins and nutrients. Studies showed a link between early nutritional intervention and the role of a child's guardian in shaping his/her dietary preferences and habits. Parents and guardians have significant influence over a child's dietary behaviours; they lay the groundwork that fosters eating patterns that can positively contribute to the weight and nutritional status of a child (Suha, 2020; Anderson-Villaluz, 2021; Angeles-Agdeppa *et al.*, 2019). Additionally, teaching about health and nutrition has a beneficial impact on a student's dietary patterns, physical composition, and academic performance (Mukhamedzhanov *et al.*, 2023). However, simply providing children with information and visual exposure to nutrition information may be insufficient and fall short as a strategy in improving eating behaviours and habits.

With the widespread popularity of digital gaming among children 6-12 years old and potential gaps in the nutritional understanding of school-age children due to their cognitive level, utilising serious games can be an engaging and entertaining format for delivering nutrition information. This can also facilitate a more seamless acceptance of nutrition and health information (Chow *et al.*, 2020). According to Adaji (2022) and Lamas *et al.* (2023), serious games are designed for purposes other than pure entertainment. These games are usually applied in the fields of education, health, and training to engage users and enhance children's nutritional knowledge and dietary behaviours.

In digital gaming, user experience (UX) is important. Peter Morville's UX Honeycomb (2004) is often used for evaluating user experience in mobile applications, covering seven aspects - usefulness, usability, desirability, findability, accessibility, credibility, and valuability (Syahidi & Tolle, 2021). High user experience satisfaction in any educational video game equates to increased learning and knowledge (Espinosa-Curiel *et al.*, 2020). Various studies have demonstrated the potential of employing games in stimulating the consumption of a balanced diet and reshaping eating behaviours among children (Damasevicius, Maskeliunas & Blazauskas, 2023; Froome *et al.*, 2020; Espinosa-Curiel *et al.*, 2020; Chow *et al.*, 2020).

Considering this, the present study aimed to evaluate the UX of Grades 2 and 3 children with the nutrition mobile game "NutriQuest", developed by DOST-FNRI. The NutriQuest game was developed based on modules created for the project Public-Industry-Society Alliance A Program for Healthier Schoolchildren (PISO), specifically for children 6-9 years old and pre-tested among the same age group to ensure appropriateness in terms of attractiveness, comprehensibility, acceptability, and self-involvement.

NutriQuest is an interactive, educational mobile-based online game designed to enhance food and nutrition literacy among grade-school children. Through the gamification of food and

Table 1. Descriptions of four (4) aspects of user experience and the question items for the study

Aspects of UX Honeycomb	*Description of UX Honeycomb Aspect*	*Question Items for Children*
Usefulness	Helps the users of the game accomplish their objectives	1. Will you recommend the NutriQuest game to your friends? 2. What did you learn from playing the NutriQuest game? If yes, you can choose more than one answer per column.
Usability	Considers learnability of the game and clarity of content and instructions of the game	Clarity 1. Do you find words unfamiliar to you in the NutriQuest game? If yes, what are these? 2. How do you find the words used in the NutriQuest game? 3. How do you find the instructions of the NutriQuest game? Learnability 1. Is it easy to learn how to use the NutriQuest game?
Desirability	Relates to aesthetic aspect of NutriQuest game in terms of sound effects, pictures, colour combination and appropriate font design and size. It also relates to varied aspects of engagement like motives and time spent in playing	Aesthetic 1. How do you find the sound effects of the NutriQuest game? 2. How was the picture of the NutriQuest game? 3. How was the colour used in the NutriQuest game? 4. What do you like the most in the NutriQuest game? Engagement 1. Do you play mobile games? 2. How many minutes or hours per day do you spend in playing a mobile game? 3. How do you find the time allotted for playing the NutriQuest game? 4. Do you like playing the NutriQuest game? 5. How frequent will you play the NutriQuest game? 6. Are you willing to play the NutriQuest game?
Findability	Refers to the ease in navigating and locating the content or feature the user needs	1. Is the NutriQuest game easy to navigate? 2. Are the buttons easy to find?

nutrition concepts, the game encourages users to explore the principles of healthy eating and understand food groups in order to influence their eating habits and to help them make informed dietary choices. The NutriQuest game integrates science-based facts with engaging gameplay via mini-games and interactive quizzes to support behavioural change and knowledge acquisition.

METHODOLOGY

User experience framework

This study used the UX Honeycomb framework developed by Morville (2004) to evaluate the UX of Grades 2 and 3 children regarding the nutrition mobile game "NutriQuest". The UX Honeycomb has seven aspects, namely usefulness, usability, desirability, findability, accessibility, credibility, and valuability. However, in this study, only four aspects - usefulness, usability, desirability, and findability were measured through a guided, self-administered questionnaire. Descriptions of these four aspects and the question items used are shown in Table 1.

These four aspects of UX were prioritised and assessed to tailor-fit them for young children, because they are immediate observable manifestations of children's interactions with the NutriQuest game, particularly in terms of user interface, engagement, and navigation. The researchers believe that the other three aspects, which were not included in the study (accessibility, credibility, and valuability), can be better understood and answered by adolescents and adults, as these concepts may be difficult for children to grasp and articulate.

Description of NutriQuest game

The NutriQuest game is an online food and nutrition game focusing on the importance of healthy eating, taught through the *Pinggang Pinoy*® (Healthy

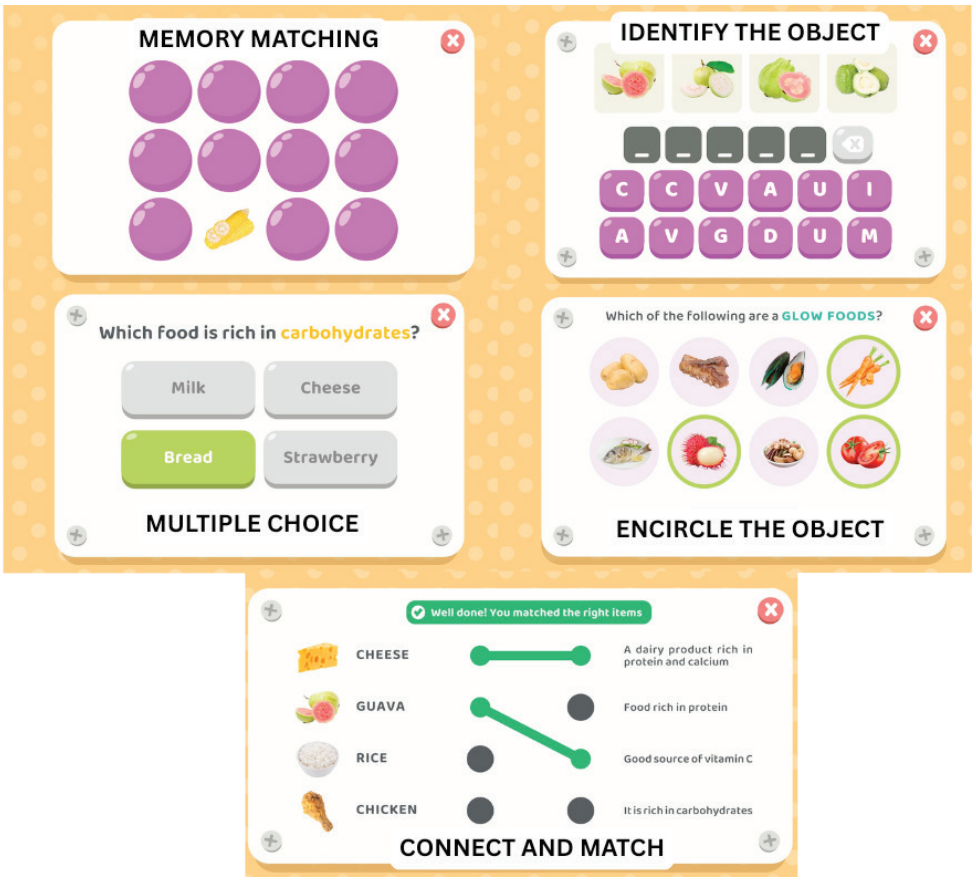

Figure 1. Sample screenshots of mini-games in NutriQuest

Plate for Filipinos) that shows Go, Grow and Glow Foods.

The contents of the NutriQuest game were based on the existing nutrition education modules that underwent two levels of pre-testing: 1st level among Grades 2 and 3 teachers and 2nd level among Grades 2 and 3 children. The authors are confident that the contents of the game were appropriate for Grades 2 and 3 children since these were lifted from existing nutrition education modules designed for this age group.

The game has five levels of difficulty. Each level contains five stages of mini-games, namely memory matching, identification, multiple choice, encircle the object, and connect and match. In 'Memory matching', a player had to match two blocks that were identical within the time limit of 60 to 100 seconds per level. The game had 12 to 32 identical blocks showing Go, Grow, Glow foods and different physical activities. In 'Identification', a player had to identify the name of the food item shown on the screen. The time limit for this mini-game was 30 seconds per level. In the 'Multiple choice' segment, a player had to choose one word (out of four choices of words) that best represented the statement shown on the screen within the time limit of 30 seconds. In 'Encircle the object', a player had to encircle the correct food item being described within the time limit of 30 seconds. Lastly, in 'Connect and match', a player had to connect the word to match the description. There was no time limit for this game. However, there was a 1-point deduction in the total score for every wrong attempt.

Each stage had a time limit ranging from 30 to 100 seconds. If a player was unable to finish a particular stage, the game proceeded to the next stage. After each stage, a nutrition trivia was shown on the screen. For a player to proceed to the next level of difficulty, he/she needed to score at least two stars.

Study sites and participants

The study was conducted in two private schools in Taguig City, a highly urbanised city in the National Capital Region of the Philippines. It has 28 barangays or villages. The city is located alongside the northwestern shores of Laguna de Bay in Metro Manila, Philippines.

To start the recruitment process, softcopy and hardcopy versions of the informed consent forms (ICFs) were sent to the school representatives (school principal and Grades 2 and 3 teachers), who were tasked to disseminate these among the parents or guardians of the children. Only those with signed ICFs were considered for the study.

Study participants were Grades 2 and 3 children aged 7-9 years old from these two private schools. Faulkner (2003) suggested 15–20 users to be appropriate for more in-depth thematic analysis or diversity across user groups. Hence, a sample size of 49 was sufficient to ascertain user experience.

Instrument

The instrument underwent pre-testing among Grades 2 and 3 children before it was administered. Children who participated in the pre-testing were not included in the actual implementation of the study. The instrument consisted of three to five items per user experience aspect, answerable by only ticking the appropriate answer or with emoticons to make the questionnaire kid-friendly. Moreover, the instrument's pre-testing results showed that the instrument was comprehensible and acceptable among Grades 2 and 3 children. Cronbach's alpha was calculated to assess the internal consistency of the instrument, which was 0.7, indicating minimal acceptability of the instrument.

Implementation

Before the actual conduct of the study, the DOST-FNRI research team

explained the mechanics of the activity to the teachers. Thereafter, the children were asked to play the NutriQuest, with assistance from the research team. While children were playing the NutriQuest, the research team observed and noted the non-verbal cues of the children, including facial expressions or emotions, body movements or gestures while playing, which part(s) of the game they needed assistance with and other observations.

After playing the game, the children were asked to answer a questionnaire regarding the mobile game's usefulness, clarity, learnability, ease of use, and engagement, with assistance from teachers and the research team. Basic information such as name, age, grade level, and duration of playing the game was also gathered.

Informed consent

Informed consent was obtained from all Grades 2 and 3 children and their parents, as per approved protocol set by the FNRI-Institutional Ethics Review Committee (FIERC), with Protocol Code FIERC-2022-017. All eligible children participated and returned their consent forms.

RESULTS

Results of the user experience of the NutriQuest game among Grades 2 and 3 children (7-9 years old) are presented in Tables 2, 3 and 4. A total of 49 children (26 for Grade 2 and 23 for Grade 3) participated in the NutriQuest game on February 16 and 27, 2023. Nearly half (47%) of the children were eight years old.

With regards to the identification of food groups, 67% (33 out of 49) of children correctly identified rice as a Go food, while more than 71% (35 out of 49) of children identified fish as a Go food. Also, 67% (33 out of 49) of children

Table 2. Usefulness, usability, findability of the NutriQuest game (*N*=49)

Aspects of UX Honeycomb	*n*	*%*
Usefulness		
Will recommend the game		
Yes	45	92
No	1	2
Don't know	3	6
No answer	0	0
Learnt from the game		
Yes	46	94
No	1	2
Don't know	2	4
No answer	0	0
Usability		
Found unfamiliar words		
Yes	25	51
No	20	41
Don't know	4	8
No answer	0	0
Words used		
Easy	15	31
Just right	24	49
Difficult	10	20
No answer	0	0
Instruction used		
Easy	20	41
Just Right	23	47
Difficult	6	12
No answer	0	0
Game is easy to learn		
Yes	43	88
No	6	12
Don't know	0	0
No answer	0	0
Findability		
Buttons are easy to find		
Yes	37	76
No	7	14
Don't know	5	10
No answer	0	0
Others[†]		
Easiness to use		
Yes	38	78
No	7	14
Don't know	4	8
No answer	0	0

[†]Other answers specified by the students: confused at level 4 and failed the first part of level 5

Table 3. Desirability of the NutriQuest game (*N*=49)

Desirability	*n*	*%*
Sound effects used		
Loud	2	4
Just right	42	86
Low volume	5	10
No answer	0	0
Pictures used		
Good	41	84
Just right	7	14
Poor	1	2
No answer	0	0
Colour used		
Dull	3	6
Light	43	88
Dark	3	6
No answer	0	0
Time allotted		
Easy	10	20
Just right	27	55
Difficult	12	24
No answer	0	0
Liked playing the game		
Yes	47	96
No	1	2
Don't know	1	2
No answer	0	0
Do they play mobile games		
Yes	45	92
No	4	8
No answer	0	0
Frequency of playing game		
Everyday	21	43
Once a week	16	33
2-3 times a week	6	12
Others[†]	4	8
No answer	2	4
Minutes or hours per day playing a mobile game		
15 minutes	16	33
15-30 minutes	6	12
30 minutes – 1 hour	7	14
> 1 hour	18	37
No answer	2	4
Willingness to play the game		
Yes	43	88
No	1	2
Don't know	5	10
No answer	0	0

[†]Other answers include: Once, when they want to

Table 4: Themes and sub-themes emerged from the observations of non-verbal cues among Grades 2 and 3 learners while playing the NutriQuest game

Observed non-verbal cues	*Themes*	*Sub-themes*
Facial expressions/ emotions	Engagement and focus	Most players were actively engaged in the game and exhibit positive emotions such as attentiveness, determination, and enjoyment.
	Challenges and frustrations	Some players experienced challenges during their gameplay. Confusion, frustration, annoyance, and feeling challenged were the observed emotions.
	Excitement and achievement	Players showed excitement and sense of satisfaction whenever they obtained a correct answer and when the game progressed to higher levels.
	Expressive and interactive behaviours	Some players expressed their emotions in a more visual and interactive manner which included hand gestures and facial expressions.
Body movements/ gestures while playing	Engagement and concentration	Body movements of the players varied during the gameplay experience. Some played calmly and quietly, using one or both hands for control. Scratching the head may reflect deep thought or confusion and thinking gestures such as hand-over-face or hand-over-chin were also highlighted.
	Interactive behaviour	Most of the players showed interactive and expressive behaviours during their gameplay experience. Fidgeting and looking around may suggest restlessness and/or curiosity. Clapping and raising hands as the game progressed signified emotional responses to success. Biting nails may reflect anticipation.
	Impatience and random actions	Some players leaned on the screen, clicked random buttons, and tapped the screen aggressively.
	Reading and instruction behaviours	There were various behaviours observed on the players' approaches towards the content of the game. Some waited for the trivia answers, which may indicate a willingness to engage with the additional content, while others skipped instructions and trivia.
Which part of the game do they seem to have trouble playing?	Difficulty in content comprehension	Some players had difficulties in relation to content comprehension, especially when it involved nutrition-related questions or terminologies.
	Spelling and object recognition	Spelling and object recognition during the gameplay showed that some experienced difficulties with spelling certain words, clicking specific letters or objects (which may be related to their knowledge and abilities), and recognising objects based on their visual representations.
	Memory challenges	Memory-related challenges were also evident. Players faced difficulties in memory games, specifically in higher-level stages with time constraints.
	Trial-and-error strategy	Some players relied on a trial-and-error approach to overcome game levels.
	Lack of understanding of messages and mechanics	Some players struggled with understanding in-game messages and mechanics, which hindered their ability to navigate the game effectively.

to be continued...

Table 4: Themes and sub-themes emerged from the observations of non-verbal cues among Grades 2 and 3 learners while playing the NutriQuest game (continued)

Observed non-verbal cues	*Themes*	*Sub-themes*
Which part of the game do they seem to need assistance?	Difficulty in specific game levels	Players expressed difficulty in successfully passing game levels, specifically levels 4 and 5. To overcome these levels, players sought assistance from the teachers and/or researchers.
	Spelling challenges	Spelling difficulties were also experienced by some players. Most struggled with correctly spelling the words related to nutrition and food groups, specifically fruits and vegetables, requiring assistance or correction from the teachers and or researchers.
	Content comprehension and identification	Some players had difficulties related to content comprehension and object identification. They had difficulties recognising specific objects, some had a hard time understanding the game's prompts.
	Misinterpretation and confusion	There were instances that the players misinterpreted visual cues or made incorrect assumptions about the flashed objects or words, hence, assistance from the teachers and or researchers were needed.
	Engagement with in-game prompts	Some players engaged with in-game prompts like *"Did you know*" messages. These prompts offered valuable information and enhanced the player's understanding of the game.
	Independence and exploration	Despite encountering challenges, some players showed the ability to play independently and explore the game. They sought assistance only when needed but could navigate the game on their own.
	Difficulty in specific game levels	Players expressed difficulty in overcoming game levels, specifically levels 4 and 5. To overcome these levels, players sought assistance from the teachers and/or researchers.
Other observations	Attention span and distraction	There were players with limited attention span hence they were easily distracted by their surroundings while playing. This situation also influenced their focus and performance in the game.
	Reading difficulties	One of the most apparent observations was the difference in the reading abilities of the players. Some players struggled to comprehend specific terms related to nutrition and their wrong spellings which influenced their ability to overcome the game levels.
	Game preferences and competitive spirit	Players' game preferences and level of competitiveness were also observed. Some thrived on competition, others disliked the game or felt frustrated by it. Some engaged in bragging about their progress while others experienced jealousy regarding the progress of their peers.
	Learning styles and adaptability	Players exhibited diverse learning styles and adaptability levels. There were players who re-tried the level and learnt from their mistakes. Others showed satisfaction with their progress. Some exhibited negative emotions when faced with difficult levels.

identified guava as a Grow food and 50% of children (26 out of 49) identified egg as a Glow food. The incorrect identification of guava as a Grow food and egg as a Glow food was due to unfamiliarity with food groupings.

A total of 45 out of 49 (92%) children answered that they would recommend the game. In terms of learning from the game, 94% (46 out of 49) learnt from it, as shown in Table 2. In addition, Table 2 shows the usability of the NutriQuest game. According to the children, there were some unfamiliar words (51% or 25 out of 49) like guava, squash, *malunggay*, and avocado. Unfamiliarity with the word guava supports the earlier finding of its wrong food grouping by the children. The words (49% or 24 out of 49) and instructions (47% or 23 out of 49) used were just right for the children. The majority of children found the game easy (88% or 43 out of 49) to learn. The findability of the NutriQuest game in Table 2 showed that the majority of children (76% or 37 out of 49) answered that the buttons were easy to find and the game was easy to use (78% or 38 out of 49).

As shown in Table 3, the desirability of the NutriQuest game showed that the sound effects used were just right (86%), pictures were good (84%), and the colours used were light (88%). When asked about the things that they liked the most about the NutriQuest game, they cited the lesson or information (57%) learnt through the experience of playing the game. Table 3 also showed the second set of desirability features of the NutriQuest game, of which the time allotted was just right (55%). The majority of children answered that they liked playing the game (96%) and were willing to play the game (88%) if it was publicly available for use. Almost all of the children answered that they played mobile games (92%), with 18 students mentioning that they spent more than one hour per day playing mobile games. Nearly half of the children frequently played games every day (43%).

Table 4 shows the non-verbal cues of children while they were playing the NutriQuest game, which were recorded by the research team. These observations included a diverse range of facial expressions and emotions displayed by the children during their gameplay experience. It ranged from curiosity and passivity to negative emotions such as frustration. In terms of body movements and gestures, children exhibited engagement, focus, and interactive behaviours while playing the game. Various challenges encountered by the children during their gameplay experience varied from content comprehension, spelling, memory, and physical interactions within the game. Areas where children required assistance included spelling, content comprehension, memory, and engagement with in-game prompts. There were diverse children characteristics, behaviours, and reactions during gameplay. Other observations recorded included the children's attention span, reading difficulties, competitiveness, learning styles, and interactions with the game's content.

DISCUSSION

This study aimed to evaluate the UX of Grades 2 and 3 schoolchildren regarding the NutriQuest game. Learning through such platforms is achieved through children's enjoyment and user experience satisfaction. Factors, such as distinct objectives, influencing players's emotions, stimulating imagination and inquisitiveness, and incorporation of visually appealing elements, aid in increasing learning through user experience satisfaction among children (Espinosa-Curiel *et al.*, 2020).

Findings of this study showed that approximately two-thirds (33 out of 49) of children aged 7-11 years old were unable to correctly identify food groups due to unfamiliarity with food items. This can be attributed to the existing K to 12 curriculum in the Philippines, wherein food and nutrition lessons are only given limited time and discussed during the first quarter of the school year. Hence, educational strategies must be enforced by integrating them into Math, Science, and English subjects, as recommended by Glorioso, Gonzales & Malit (2020). Furthermore, authors Mann & Lohrmann (2019) suggested increasing the duration of lessons to at least 50 hours per year to effectively influence knowledge, attitude, and practices.

In a study by Laroza & Amada (2024), it was revealed that the age of children was significantly related to reading comprehension levels. The implications of the participants' difficulty in content comprehension in this study may affect their eating habits and food choices. This may be due to various factors that influence their capacity to comprehend (Roque *et. al,* 2023) and the need for guidance in understanding the messages they were reading (Maguilimotan *et.al*, 2024). Several studies found that nutrition education via games could promote healthy eating habits and had a positive effect on knowledge, attitude and behaviour (Rosati, 2024; Froome, 2020). This implies that NutriQuest should have future iterations and improvements in terms of nutrition content that should be aligned with children's ages. The improvement of icons and provision of additional pictures of unfamiliar food items and simpler explanations will be beneficial to lessen cognitive challenges and achieve a good user experience (Lee & Lee, 2014).

In this study, the research team observed the non-verbal cues of learners while they were playing the NutriQuest. Changes in reactions and emotions were noticeable, whether these effects were positive or negative. These observations included a diverse range of facial expressions and emotions, which were displayed by the children during their gameplay experience. It ranged from curiosity and passivity to negative emotions such as frustration and shock. Consistent with the findings of Van Amelsvoort *et al.* (2013), children are still developing their verbal communication skills and may not be able to express themselves fully and fluently. Thus, non-verbal cues are an alternative way of providing valuable insights for the enhancement of the NutriQuest mobile game.

Changes in reactions and emotions while playing the game may be attributed to game difficulty and user interface. Findings of the study by Ahmad *et al.* (2017) showed that game interface design can produce positive and negative factors in a user's game experience. To effectively promote user interaction and enhance UX, the design of a mobile game interface should have interactive interfaces and apply design principles like simplicity and ease of use, harmony in design style, and user-orientated design (Li, 2023). The user interface design is highly relevant in educational settings, as children tend to take notice of the games' interface designs when they first play mobile games. It can stimulate the children's imagination through its well-structured layout (Anugerah & Budiyanto, 2017). Moreover, as highlighted in the study of Faudzi *et al.* (2024), the interface design directly influences UX; a well-designed interface must be user-friendly, clear, and simple to navigate to lessen cognitive load. Cognitive load is the amount of mental effort required to process elements and perform a task before actual learning can start (Paas, Renkl & Sweller, 2004).

Children need to focus on learning the nutrition messages rather than struggle with a complex interface.

NutriQuest has five levels of difficulty embedded in five mini-games: memory matching, identification, multiple choice, encircle the object, and connect and match, which are the strengths of the game. These difficulty levels made the game engaging and interactive for children, measuring the four aspects of user experience in the game. But the study of Aponte, Levieux & Natkin (2011) showed that games should have precise definitions of difficulty, as well as tools to measure difficulty levels. The limitation of this study was that only four aspects of UX were explored, namely usefulness, usability, desirability, and findability. In addition, the study was conducted only in two private schools in Taguig City. Public schools and other highly urbanised cities may be considered for future studies to further assess the effect of the NutriQuest game on children's eating habits and food choices.

For future study, the research team will consider looking at the remaining three aspects of user experience, namely accessibility, credibility, and valuability, since educational games would have grown in scale and user diversity by then. These will also contribute to the understanding and evaluating of user satisfaction that can provide useful feedback to designers and developers in terms of user interface elements and design, leading to a desirable user experience. Moreover, examining these three aspects in relation to an individual's cognitive load may provide other insights into mobile game development.

As defined by the International Organization for Standardization (ISO), UX is a collection of an individual's impressions and reactions expected from the application, product, service, or system (The Interaction Design Foundation, n.d.). User experience in mobile platforms is often evaluated using the UX Honeycomb approach by Morville (2004). This approach entails the assessment of seven aspects: (1) usefulness – focuses on the functionality and relevance of the application, which means the product must fulfil the user's needs; (2) usability – relates to the ease of user when interacting with the application, involving factors like efficiency and learnability; (3) desirability – pertains to the emotional response elicited by the application, which means it must appeal to the users aesthetically and on an emotional level; (4) findability – involves the ease of locating information and/or features within the application; (5) accessibility – ensures that the application is usable by individuals with varying abilities; (6) credibility – refers to the reliability and trustworthiness of the application; and (7) valuability – covers the overall value users derive from the application, encompassing factors like meeting users' goals, enhancing the users' experience, and providing a meaningful interaction (Syahidi & Tolle, 2021).

Proof of the effectiveness of utilising serious games and gamification in fostering health problems has emerged. Serious games and gamification strategies can be a successful platform in encouraging positive health results such as increased physical activity, adopting healthy eating habits, and smoking cessation (Damasevicius *et al.*, 2023). With this, it is advantageous to mix traditional teaching methods with game-centred techniques. Past studies have indicated the capabilities of utilising games to encourage the intake of a balanced diet and modify the eating habits of children (Chow *et al.*, 2020). By leveraging the engaging and interactive nature of games, nutrition interventions can effectively influence a child's eating habits and behaviours.

CONCLUSION

The present study showed that aspects of UX, namely usefulness, usability, desirability, and findability, were considered positively by study participants in "NutriQuest". The nutrition mobile game "NutriQuest" was acceptable to children and can be used as a teaching option in classrooms to help increase nutrition knowledge acquisition. However, game design and mechanics should be improved to address diverse children's characteristics and negative emotions and reactions during gameplay. Results of the study can provide vital inputs to game design, taking into account user interaction and experience in designing game interfaces. The impact of game-based learning on a child's knowledge of healthy eating can be considered for future research. Likewise, other studies can examine the interplay between conventional teaching modes and game-based strategies. Future studies can also examine the other three aspects of user experience, namely accessibility, credibility, and valuability, among much older children.

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Authors' contributions

Glorioso IG, principal investigator, conceptualised and designed the study, prepared the questionnaire, conducted data collection, prepared the draft of the manuscript, revised the manuscript based on comments and suggestions of editor, finalised the manuscript and submitted the final manuscript to the Malaysian Journal of Nutrition; Arevalo SFQ, co-investigator, assisted in conceptualising and designing the study, assisted in the preparation of questionnaire, conducted data collection, prepared the results of the study, assisted in the preparation of the draft and final manuscript, assisted in reviewing the final manuscript before submission; Gonzales MS, co-investigator, gave comments on the design of the study, edited the questionnaire, reviewed the draft manuscript; edited the draft and final manuscript before submission to the Malaysian Journal of Nutrition; Bayalas CLT, co-investigator, conducted review of related literature on online games, conducted data collection, assisted in the preparation of study results, assisted in the preparation of draft manuscript, and proofread the final manuscript.

Conflict of Interest

The authors declare no conflict of interest in this study.

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