

## ORIGINAL RESEARCH

# Exploring Malaysian schoolchildren's perception of the advantages and disadvantages of the ToothPoly board game: a qualitative study

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**Abstract**

The effectiveness of children's oral health education (OHE) is determined by the appropriateness of the educational materials used, which can influence their attitude towards oral health. However, there is a lack of studies exploring the benefits of OHE materials from the perspective of schoolchildren. This study aimed to explore schoolchildren's opinions on the newly developed ToothPoly board game as an OHE tool. A qualitative approach using focus group discussions (FGDs) was conducted among 44 schoolchildren aged 12 years old from a public school in Malaysia. Convenience sampling was employed to recruit the schoolchildren. The ToothPoly board game was playtested and FGDs were conducted after the playtesting session ended. Data collection and analyses were performed concurrently until data saturation was reached. The data were transcribed and coded using Atlas.Ti software version 9.1.3 followed by the framework method analysis. Mixed opinions were observed among the schoolchildren with a majority expressing favourable opinions on the advantages of the ToothPoly board game as an OHE tool. Five themes emerged from the advantages aspect, *i.e.*, fun and enjoyable, promote focus, attention and oral health-related learning, attractive board game features, and enhance peer interaction. Meanwhile, two themes emerged that were related to the disadvantages of the board game, *i.e.*, "competition with online games and media" and "not practical for a large group activity". The findings showed that the ToothPoly board game was perceived as a useful, interactive, and enjoyable tool to learn about oral health in small groups. The findings of the study highlight the importance of tailoring OHE activities to fulfil the needs of specific target groups to ensure its acceptance and future success.

**Keywords**

Dental health education; Oral health; Children; Pediatric dentistry

## 1. Introduction

Oral health (OH) is crucial to an individual's overall health and well-being. Oral diseases are a health burden, impacting almost 3.5 billion people worldwide [1]. Poor oral hygiene can lead to various dental problems, including dental caries, gum disease, and tooth loss. Approximately half a billion children worldwide are affected by untreated caries in their primary teeth [1]. In many countries, oral health education (OHE) activities have been advocated to increase awareness and improve children's OH status. Common methods of conducting OHE are lectures, demonstrations, and simulation activities. However, evidence has shown that these methods improved children's OH knowledge but lacked long-term impact on children's OH practices [2, 3]. A recent systematic review conducted by Anwar (2022) reported that conventional

approaches, such as OH talks, were less engaging and had minimal impact on children's OH behaviours [4]. With the rapid advancement of technology and evolving society, there is a need to move from a passive lecture-based approach to a more interactive OHE activity [5]. The World Health Organization (WHO) has recommended a shift from the conventional strategy towards a modern, sustainable, and effective digital platform method for delivering OHE. However, online technology may not always be feasible, especially in areas with limited resources [1].

In Malaysia, OHE is an established initiative in school-based health promotion strategies. The Malaysian school dental service (SDS) has been conducting OHE in schools since 1948. According to the latest SDS guidelines, the school dental team will visit primary schools annually and conduct OH talks, toothbrushing drills, dental exhibitions,

and video presentations to the schoolchildren [6]. Although annual OHE talks have been incorporated into the existing SDS programme for the past 75 years, OH problems such as caries and gingivitis are still relatively high among primary schoolchildren in Malaysia. This is reflected in the recent data where caries prevalence among 12-year-old schoolchildren was 33.3% (mean Decayed-Missing-Filled-Teeth (DMFT) score = 0.78) and a higher prevalence of oral disease was observed among schoolchildren from low socioeconomic status [7]. A recent local study involving schoolchildren in Malaysia reported that the conventional approach for delivering OHE was deemed boring, has minimal impact, and lacked a sustainability element. This is partly due to the fact that the OHE is only provided once a year [8]. Despite being considered less attractive and lacking sustainability, the conventional OHE talks continue to be the predominant approach for delivering OHE to primary schoolchildren in Malaysian school settings due to the lack of resources [6].

Efforts have been made to overcome challenges in delivering conventional OHE to schoolchildren. A game-based approach is one of the options to educate children about OH. The popularity of board games as a learning tool could be attributed to their potential benefits, such as fostering interactions, a sense of competitiveness, and enjoyment for children. Additionally, board games allow knowledge transmission possible in a pleasant and relaxed environment among the players [9, 10]. Some countries, such as Italy and Indonesia have reported the benefits of board games in improving health knowledge and behaviours from the perspectives of the study participants [11, 12]. The game content is usually modified to suit the target population [5]. However, the impact and acceptability of using the board game approach as an OHE tool for Malaysian schoolchildren are seldom explored. This study has developed a new approach for delivering OHE to primary schoolchildren using an interactive board game called ToothPoly. This study aimed to explore the schoolchildren's opinions on the advantages and disadvantages of ToothPoly as an OHE tool in the school setting.

## 2. Materials and methods

The reporting of this study adhered to the guidelines outlined in the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [13].

### 2.1 Study design and development of the semi-structured topic guide

This study employed a qualitative approach to explore the opinions of 12-year-old schoolchildren on the use of the ToothPoly board game as an OHE tool. Focus Group Discussion (FGD) was used as the data collection method after the children have played the newly developed ToothPoly at school. Before the FGD, a semi-structured topic guide was developed incorporating leading and probing questions aimed to address the study objectives [14]. The leading questions were related to ToothPoly's advantages and disadvantages in delivering OHE to schoolchildren. The probing questions were: "What do you gain from playing this board game?, What do you think

about this board game?, What do you like or dislike about this board game?, Do you have any suggestions for improvement?". Questions related to the participant's interests and preferences in OHE were also included. The topic guide was prepared in English and translated into the Malay language. An independent expert in bilingual translation verified the accuracy of the translation and the clarity of the language for schoolchildren. The FGD topic guide underwent face and content validation by two dental public health specialists for the assessment of its appropriateness and comprehensiveness according to the aim and objectives of the study. Subsequently, the topic guide was piloted with a group of schoolchildren who were not involved in the main study (Table 1). Following the expert assessment and pilot FGD, improvements to the topic guide were made accordingly before it was finalised. The final semi-structured topic guide is shown in Table 2.

**TABLE 1. Demographic characteristics of the participants in the pilot FGD (n = 8).**

Variable	n (%)
<b>Gender</b>	
Male	4 (50)
Female	4 (50)
<b>Race</b>	
Malay	8 (100)
<b>Total</b>	<b>8 (100)</b>

### 2.2 Recruitment and participants

This study used a convenience sampling [15]. The study population was primary schoolchildren from Tampin District, in the state of Negeri Sembilan, Peninsular Malaysia. A public primary school which gave the earliest permission to conduct the study from the school principal was chosen. Due to the restrictions and limited access to schools resulting from the COVID-19 pandemic, data collection for this study was conducted at a single school. The 12-year-old children were selected as they were in early adolescence, a stage marked by significant cognitive, emotional, and social development. Children at this stage have developed sufficient verbal communication skills to express their thoughts and feelings to provide detailed insights during FGDs [16]. Moreover, due to the fluctuating number of COVID-19 cases, the school authority imposed restrictions that limited participation to 12-year-old schoolchildren only during the data collection period.

A list of 12-year-old schoolchildren was obtained from the school's office. A teacher was assigned by the school to facilitate the recruitment of the participants and data collection process. The teacher was informed of the inclusion and exclusion criteria. The inclusion criteria were children aged 12 years, willing to participate, able to communicate and understand the Malay language, and with consent from their parents. Schoolchildren with learning disabilities were excluded. Next, the teacher randomly selected a group of 12-year-old schoolchildren with different socioeconomic backgrounds and academic achievements from different classes to be included

**TABLE 2. FGD semi-structured topic guide.**

Aspect	Leading question	Probing questions
Advantages of playing the board games	What are the advantages of playing this board game?	1. What do you think about this board game? 2. What do you gain from playing this board game? 3. What do you like about this board game?
Disadvantages of playing board games	What are the disadvantages of playing this board game?	1. What do you dislike about this board game? 2. Do you have any suggestions for improvement?
Conclusion	What are your interests and preferences in terms of oral health education approach? Do you have other opinions to discuss in today's session? Summary of today's discussion session.	

in the study. All the schoolchildren who fulfilled the inclusion criteria were invited to participate. The sample size was determined by the data reaching saturation level during FGD. This was achieved when the subsequent FGD had not produced new information from the participants [17]. Data collection was stopped once data saturation had been achieved. In terms of the recommended sample size for FGD, 4 to 8 focus groups would have been sufficient for the data to reach saturation level [18].

### 2.3 The toothpoly board game

The ToothPoly Board Game is a newly developed OHE tool designed for primary schoolchildren in Malaysia. It is based on the Monopoly gameplay concept (Fig. 1). The ToothPoly board game was initially developed by a multidisciplinary team of oral health academicians and specialists, game experts, early childhood specialists, and relevant stakeholders (*i.e.*, parents, teachers and schoolchildren) [19]. The game's objectives are to improve children's knowledge, attitudes, and practices related to OH. The content of the game was developed in the Malay language and was based on key oral health messages and common oral health issues affecting children. Specifically, the ToothPoly board game comprises four themes: *Jom Jaga* (Let's Care), *Jom Makan* (Let's Eat), *Jom Periksa* (Let's Check), and *Jom Rawat* (Let's Treat).

The ToothPoly game is based on chance and players are required to collect 32 teeth and four *Jom* cards to win the game. Each *Jom* card presents various OH messages that are relevant to children's daily lives. The game board is composed of various zones including chance, penalty, truth or dare, fact and myth, and bonus, each with its own game cards that contain questions, instructions, or statements for the players to follow.

During gameplay, the player's turn is determined by the rolling of the dice. The players are instructed to follow the instructions on the game cards, based on the zones they land on. Correct answers or successful completion of assigned tasks are rewarded with teeth, *Jom* cards, or monetary gains. Conversely, failure to adhere to the instructions accurately will incur penalties. For instance, if a player lands on a penalty zone, he or she is obligated to pay for the dental treatment of a tooth affected by cavities. The game is designed for 3 to 4 players at a time.

### 2.4 Data collection procedure and analyses

The playtesting and FGD sessions were conducted at the school hall. First, the schoolchildren were divided into small groups of four. The parental consent form, along with the participant information sheet was distributed to the parents through the teacher's assistant prior to the game testing session. In addition, the schoolchildren's assent was sought before they were allowed to play the board game. Then, each group of schoolchildren was instructed to fill out their demographic information (*e.g.*, gender, race) in a standardized form. They were briefed by the researcher (FS) about the aim and objectives of the research, ToothPoly board game, playtesting and the subsequent FGD sessions. No prior relationship with the participants was established before the commencement of the study. The participants were aware that the board game was created by a group of researchers (including the interviewer), who conducted the study. A note taker (SK) was present during all sessions to capture for non-verbal cues and contextual details. The playtesting session was held using the ToothPoly board game and ended once the first player won the game. Then, students were given a 10-minute break, followed by an FGD session. The researcher (FS) is a female dentist (DDS, MCOH) and postgraduate candidate in dental public health programme from a public local university and has undergone qualitative research training prior to the conduct of study. The researcher (FS) served as a moderator and conducted the interview. The moderator began the session with an ice-breaking session with the participants. Next, the moderator gave a brief overview of the FGD objectives. The moderator asked the first open-ended question to the children and they were allowed to give their opinions based on their experience with the ToothPoly board game. The children were encouraged to be honest and actively involved in the group discussion until no further points were raised. The process was repeated with the second question until all the questions were asked and discussed by the children. The probing questions from the topic guide were used to stimulate discussions if necessary. The sessions were recorded using an audio recording tape. A note taker recorded the key findings from the FGD and observed the dynamics of the children and the environment during the FGD using field notes. Both the playtesting and FGD sessions had an average duration of 90 minutes (excluding the 10-minute break between the game playtesting and FGD session). At the conclusion of each session, the moderator provided a comprehensive summary



**FIGURE 1. ToothPoly board game set.** (a) Teeth set, (b) Game token, (c) Instruction pamphlet, (d) FAQ pamphlet, (e) ToothPoly game board, (f) Bonus cards, (g) ToothPoly money, (h) *Jom* cards, (i) Game cards.

of the key findings derived from the discussion. To ensure the credibility and accuracy of the data, verification of the findings was also obtained from the participants following the completion of each FGD session. Each child was given a voucher (MYR 10) as a token of appreciation. The FGD was continued with the next group of children until data collection reached saturation level. At this point, the FGD was stopped and data collection was deemed completed.

The framework method was used for data analysis. This method was chosen as it allowed the researcher to organize, analyze, and synthesize data in a systematic and structured manner, which is essential for developing rich and nuanced insights into the research topic [20]. The recorded audio was transcribed verbatim and coded using an open-coding approach with Atlas.ti software version 9.1.3 (Scientific Software Development GmbH, Berlin, Germany). Other sources of data including the field notes were also used to compare and validate the findings. The codes were then organized into a coding tree prior to categorization into themes and sub-themes. The coding tree was refined until no new themes emerged. Then, triangulation of data was performed involving another expert (IA) who was not involved in the research team. A second assessor validated the framework (ZY), and the data were charted into a matrix for transparency. Any differences were discussed with the research team and any disagreements were resolved until a consensus was reached before finalizing the themes. The final data were translated into English and checked by a linguistic expert who was not involved in data collection.

### 3. Results

A total of eleven FGDs were conducted until the data reached saturation level. Data collection expanded over five school days involving 44 schoolchildren who participated in the board game playtesting sessions. Each game lasted between 30–60 minutes. The duration of each FGD lasted between 30 to 45 minutes. Table 3 shows the demographic profile of the participants. The majority of the participants were Malay (75%) and male (75.5%) followed by Indian ethnicity.

**TABLE 3. Demographic characteristics of the participants (n = 44).**

Variable	n (%)
Gender	
Male	31 (70.5)
Female	13 (29.5)
Race	
Malay	33 (75)
Indian	11 (25)
Total	44 (100)

The results were categorised into two main categories in line with the research objectives: the advantages and disadvantages of playing the ToothPoly board game as a tool for OHE. Five themes emerged under the advantages aspect: (i) Fun and enjoyable; (ii) Promote focus and attention; (iii) Promote learning; (iv) Attractive board game features; and (v) Enhance

peer interaction. In terms of the disadvantages aspect, two themes emerged: (i) Preference towards online games and media; and (ii) Not practical for large group activities. A summary of the themes is depicted in Fig. 2.

### 3.1 Advantages of playing the toothpoly board game as an oral health education tool

#### 3.1.1 Fun and enjoyable

The schoolchildren provided positive feedback about the ToothPoly board game, describing it as a fun and enjoyable way to learn about OH. They valued this board game as an alternative to the current OHE delivery method. They commented that the game created a positive atmosphere for the children to learn alongside their peers. Most children said that they enjoyed the “action cards” element which required them to perform selected actions as written on the card when they landed on the designated square.

*“I liked it much more than I anticipated, and I learned a lot about oral health and had a great time playing it with my friends.”* (Participant 35)

*“This type of learning is enjoyable. When I’m playing, I like to watch my friend’s expressions when they read the game card or do the action. They were sporting and just followed the instruction. It’s funny.”* (Participant 26)

#### 3.1.2 Promote focus and attention

Another advantage of the board game as mentioned by the participants was that it taught them to focus and pay attention

in class. They preferred to play the board game over the conventional OHE method of listening to talks, citing difficulties in focusing during talks due to noise interferences and information overload. One participant said:

*“Playing games like this is easier to remember and learn than when I listened to oral health talk in the hall. Usually, other students will make noise at the back, so I can’t listen to what the nurse is saying.”* (Participant 21)

Another participant commented that playing the ToothPoly board game in a small group allowed them to stay focused, enhance their concentration, and attentively engaged with the game content. The participants reported that the dynamic playing process of the game encouraged active participation of the players rather than passive observations.

*“I can learn better in this fun and chill environment. Everyone is not serious. I am not afraid to ask questions. It was a different kind of learning experience.”* (Participant 43)

#### 3.1.3 Promote learning

Most schoolchildren agreed that the board game activity had improved their learning experience because the game-based approach in ToothPoly appeared more appealing for learning about oral health. During the playtesting session, it was observed that the players were excited when they could answer the questions correctly from the game cards and engaged in discussions about what they learned.

*“I just learned that sugar is a carbohydrate from this game. I did not know about it before. It was a discovery for me!”* (Participant 12)

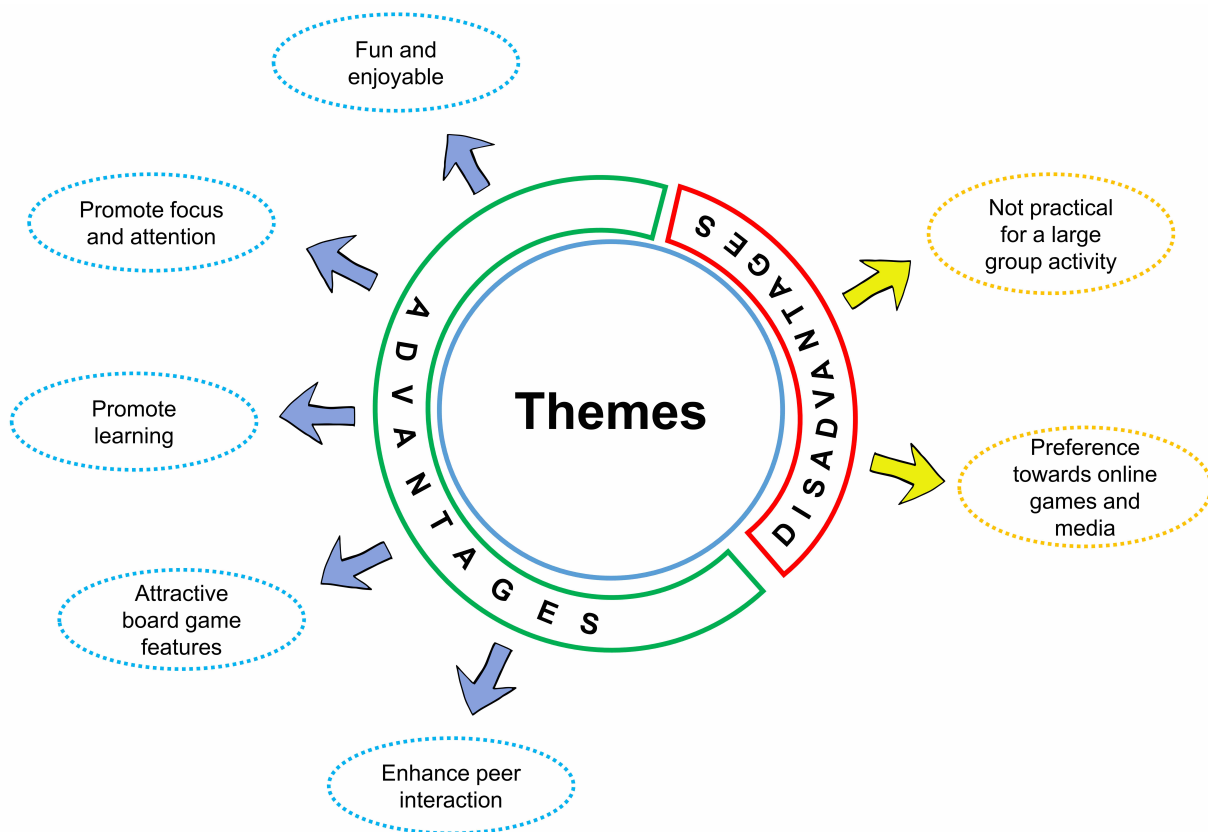


FIGURE 2. Summary of the emerged themes for the advantages and disadvantages of playing the ToothPoly board game.

*“I thought it was normal to bleed when I brush my teeth. I did not know it could be due to something else, such as swollen gums.”* (Participant 16)

### 3.1.4 Attractive board game features

Nearly all the schoolchildren expressed their attraction towards the overall board game features. Most of them described the illustrations, the design, the pictures, and the colours as very attractive and captured their attention to explore and play the game. It was observed that the children were excited to flip through all the game components. They reported that the game features increased their curiosity towards the game. Hence, they were motivated to play and learn by taking part in the game session.

*“I like the game because it is colourful. We like bright colours like this. I like the drawing on the game board too. The doctor in the game booklet looked handsome. I feel attracted to this game. I would like to know more about it.”* (Participant 3)

*“The teeth set are colourful. There are nice pictures of fruits and vegetables. The illustrations are nice. Some pictures represent the cards at every Jom card. The features make me want to explore what it is all about.”* (Participant 18)

The custom-made teeth and the *Jom* cards, which were part of the reward items had generated high interest among the children. These items motivated the children to compete with each other to win the game. After completing the game, the children expressed mixed emotions. Some children admitted the impact of feeling challenged in completing the game mission and this certainly helped them become more engaged in the game. Some children showed temporary frustration when their opponents won the game, and they tended to challenge each other for a rematch.

*“I feel proud that I won this game. After winning, I feel more confident to help my other friends finish playing this game by giving them tips on the correct answer.”* (Participant 28)

*“I want to play this game again. Next time, I want to beat my friends and will be the winner.”* (Participant 34)

### 3.1.5 Enhance peer interaction

The children pointed out that the ToothPoly game allowed players to interact actively with each other. They felt that during peer interactions, they could build self-confidence by reading the cards aloud and asking their friends questions from the game cards. The children acknowledged that this board game could be one of the mediums for peer interaction and use it to play with their friends at school, either in class or as part of extracurricular activities.

*“This board game allows me to spend my time with my friends. I can play and learn something with my friends.”* (Participant 21)

*“I can play this game, especially at the end of the year after the formal syllabus has ended, or use it as part of the club activities such as the Doktor Muda (Little Doctor) program. If this was available in school, I could use this with my friends to play and learn simultaneously.”* (Participant 29)

## 3.2 Disadvantages of playing the toothpoly board game as an oral health education tool

### 3.2.1 Preference towards online games and media

Some children mentioned the availability and their preference towards online game applications as the main disadvantage against physical board games. In today's modern era and with the advancement of technologies, children are increasingly exposed to digital games more than non-digital games which influenced their preferences.

*“I am not familiar with the board game. This is the first time I have played with it. I prefer playing games on my hand-phones. I have to download the game, charge my handphone and play with it. It was easy.”* (Participant 11)

*“I prefer to spend my time watching television than playing this game. I can also learn from all the videos on YouTube.”* (Participant 32)

Although mobile phones or gadgets are not allowed in primary schools in Malaysia, highly-promoted digital games and their popularity on social media platforms resulted in children being more exposed to online games than physical board games. Unlike online games, physical board games are considered outdated by some children.

*“I would play this game at school with my friends because I do not have my handphone. But, I will choose a handphone over this board game at home. I am sure my friends will be the same.”* (Participant 38)

### 3.2.2 Not practical for a large group activity

Several participants mentioned that the suitability of the ToothPoly board game for large group activities was questionable when the number of players exceeds a specific threshold. The collective feedback emphasized the potential negative impact on the overall experience and active participation in such settings. It is essential to carefully consider the balance between participant numbers, aiming to foster interaction and engagement while avoiding excessive group sizes that can impede focus and prolong waiting times.

*“...if the game session involved more than four people, there will be too many people talking and playing. I cannot focus on the game content. It will be too crowded”* (Participant 41)

*“It will be boring if there were too many players. It will take some time to get to my turn to play,”* (Participant 15)

Some children also mentioned that the ToothPoly game might not be practical when a large number of people were involved. While they enjoyed the small group activity that enhanced their learning experience, they expressed the need for multiple sets of the board game to allow more players to play. If a limited number of the board games is available, only a small number of children can play the game at a time. Additional costs may incur if more sets of Toothpoly are needed to accommodate large number of players.

*“Another problem with this type of game was that it could only be played for small group activities with a maximum of four players. If we were to play in a class of 30 children, we would need at least eight sets of this board game.”* (Participant 28)

“We need a lot of board games to cater to more students.”  
(Participant 12)

#### 4. Discussion

The present study explored the advantages and disadvantages of ToothPoly board game for delivering OHE to schoolchildren in Malaysia. Majority of the schoolchildren agreed that the ToothPoly board game enabled them to learn about OH in a fun and enjoyable way, and improved their focus and attention in the learning process. In addition, the board game elements, such as its attractive design, challenges element, rewards and gameplay features, motivated the schoolchildren to keep on playing. The game also enhanced their social and learning skills. On the other hand, the schoolchildren provided insights on the disadvantages of the ToothPoly board game citing their preference towards online games and the game’s perceived lack of practicality when a large group of children was invited to play the game.

In this study, the game dynamics was found to intensify the children’s learning experience. The schoolchildren reported that playing the board game helped them to learn about OH in an exciting way, which they preferred over the conventional OH talks by the school dental nurses or dentists. This confirmed the existing findings that highlighted the motivation of individuals to choose gamification as a learning method over traditional approaches [2, 4]. The gamification approach in the board game has gained popularity for educational purposes, as it has been shown to increase students’ enthusiasm and knowledge when used effectively [21].

The finding that playing board games promote active learning through discussion during the gameplay is well supported by existing literature [9, 10]. The active participation among players helped students to engage and stay focused during the game. These interactions improved children’s memory, enabling them to retain information for longer periods [2]. This finding is consistent with findings from previous studies that reported positive outcomes when employing a game-based approach as a learning tool in capturing children’s attention and interest [12]. This can help to increase children’s learning productivity since they absorb the learning information more easily than other teaching techniques [2]. However, long-term evaluation is needed to confirm whether the perceived benefits will translate into positive oral health behaviour changes. Some studies have cautioned about the possibility of children playing games solely for entertainment without actively engaging in the learning process incorporated in the game [12]. Therefore, it is recommended that adult or teacher supervision is present during gameplay sessions to facilitate children’s learning and maximize the benefits of the gaming experience.

Many children expressed their interest in the ToothPoly board game due to its features such as attractive graphics, game cards, and a reward system. This finding is similar with findings from the literature that suggests incorporating appealing features can encourage the use of board games [2, 9]. A systematic review by Suleiman-Martos *et al.* [22] (2021) further supports this point, indicating that a reward system in game-based learning can increase players’ retention, motivate players to continue playing and enhance their overall experi-

ence [4]. However, studies have also shown that relying too heavily on rewards can have potential downsides. Users may lose interest once they have earned all the available rewards, creating a sense of competition that can be counterproductive to teamwork and collaboration during gameplay. Therefore, a balanced approach in incorporating rewards in game-based learning should be considered to maximize their benefits while minimizing potential drawbacks.

The healthy competition vibe between players in their efforts to win the game was highlighted by the schoolchildren. Previous studies have shown that challenges element, competition between players, and collaborative activities can positively affect motivation and enhance the learning experience [4, 23]. This study incorporated a competition element through the game final objective, *i.e.*, collecting teeth (game items) and game cards, which encouraged the players to keep playing and motivated them to become more familiar with the game content [24]. It is known in the literature that incorporating interactive and competitive elements into the gameplay can improve learning performance for the intended users. Nevertheless, it is essential to remember that the competition aspect should be adequately planned, as highly competitive games could discourage schoolchildren if they were asked to achieve more than their prior knowledge and skills would allow. Thus, proper planning in the game development stage is crucial to ensure that the challenge element in the game that is posed as competition does not act as a double-edged sword [25].

The educational value of a board game goes beyond providing opportunities for OHE. The design of the board game which necessitates multiple players encourages peer interaction among the children, leading to the development of their self-confidence and communication skills. The formation of peer support among schoolchildren encouraged their teamwork and positive collaboration. Similar findings were reported by earlier studies that reported the positive effects of board games in fostering soft skills among children [12, 22]. These positive effects are critical for positive behavioural development, especially in children. In contrast, a study has suggested that children may only benefit from interactions if they are playing with familiar faces and surrounded by people with similar interests [23]. Otherwise, interactions with unfamiliar individuals may be limited and adversely impact the quality of the gameplay session. This is relevant to the present study as the children played the board game among their classmates, facilitating comfortable interaction and discussion among them.

Although the use of a board game as an OHE tool has several advantages, it also faces several limitations as expressed by the children. The availability of online game applications and children’s preference for digital education media was perceived as the main disadvantage to physical board game activity. Digital technology has become increasingly prevalent, making digital games more accessible and popular among young and primary schoolchildren [26]. Despite mobile phones or gadgets being generally prohibited in primary schools in Malaysia, children still have access to gadgets at home. According to a national survey, most (98.7%) of Malaysian adults own a smartphone, and almost half of children (47%) in Malaysia use the Internet daily. Of the children who access the Internet, more than half (56.3%) own a device themselves [27]. It can be stipulated that

parents permit their children to play online games using their smartphones or purchase smartphones for their children to use at home, particularly during the recent COVID-19 pandemic.

Several studies in Brazil and the United Kingdom have reported the benefit of mobile games in improving children's OH knowledge [28, 29]. However, it is imperative to ensure balance in technology use when engaging in such activities with children. Excessive screen time and smartphone use may negatively affect children's development and social skills [30]. Early exposure to smartphones and gadgets has led children to become more familiar with mobile games than physical board games. Therefore, a combination of digital and non-digital game activities may be a way forward to improve OHE delivery, and future research should explore how this hybrid approach influences children's acceptance and their OH behaviours.

Another disadvantage highlighted by the children was the practical issue of using board games for large group activities. While these children acknowledged the benefits of board games in small group activities, they commented on the need for multiple physical game sets to accommodate more players simultaneously. These findings have implications for the implementation of ToothPoly at the school level, often involving many students. A possible solution to this issue could be to rotate the children with different activities, including the board game station, to ensure everyone can participate. Alternatively, embed the board game activity into an existing school club activity, namely the "Little Doctor" programme for the continuity of OH activities led by students and teachers [31]. Additionally, students can borrow and use the board game as part of the after-class or indoor co-curriculum activity. The findings suggest that board games are a valuable adjunct tool for promoting OH enjoyably and engagingly. However, other resources, such as educational videos or OH talks, could be incorporated alongside the board game to support further learning in large group settings. As a stand-alone OHE activity may not be suitable in certain settings, the delivery of OHE can be diversified to cater to different learning needs among children. OH messages can be reiterated in different contexts and formats, helping to reinforce the importance of oral hygiene habits to them. Similar studies have also reported that combining both methods could intensify the process leading to a more effective and enjoyable learning experience [3, 5]. The present findings suggest the need to consider children's preferences and practical considerations when designing OHE interventions to enhance their acceptability as well as effectiveness.

This study has several limitations. Initially, the study intended to include participants from multiple schools, however, the data collection was interrupted by the COVID-19 pandemic where most schools were closed for a long duration. This resulted in a limited number of children from different schools being able to participate due to varying school re-opening times. Another limitation is the use of a homogenous age group, specifically 12-year-old schoolchildren from a single school may limit the transferability of the findings to other contexts. However, efforts were made to include children from diverse socio-demographic backgrounds within the same school to capture a broader range of perspectives despite the

homogeneity in age. The findings may provide valuable insights for future studies sharing similar educational practices, curriculum, and student demographics, or studies involving children of similar ages in different cultural or geographic contexts. It is acknowledged that that the researcher (FS) having a dental background and being part of the game developer team could have potentially introduced bias, however no other interviewer-related biases identified. Nevertheless, despite these limitations, the findings of this study provide valuable insights to shape future research in the development and evaluation of game-based activities related to OH. The findings also have the potential to provide insights into the design of more engaging, sustainable, and effective interventions to improve OH outcomes among schoolchildren in Malaysia. Future studies should consider including students from both public and private schools to increase the representativeness of the findings and gain different perspectives on the potential use of the ToothPoly board game to promote children's OH related-learning. Further evaluation, including comparison with other OHE tools, is recommended to explore the long-term impacts of different OHE approaches on children's OH knowledge and behaviours.

## 5. Conclusions

The ToothPoly board game was perceived to be beneficial as an OHE tool to promote children's OH related-learning. The schoolchildren felt the board game was enjoyable, fun and encouraged peer interactions. The game also helped to foster peer support, promote learning, and improved understanding of OH. However, the presence of online games and the practicality of playing the ToothPoly with a large group of students were reported as the disadvantages of the board game. Further research is warranted to optimize its use and assess its impact in different settings and populations.

## ABBREVIATIONS

OH, oral health; OHE, oral health education; WHO, World Health Organization; SDS, school dental service; DMFT, decayed missing filled permanent teeth; FGD, focus group discussion; MYR, Malaysian Ringgit.

## AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

## AUTHOR CONTRIBUTIONS

NAMN, NFSR and ZYMY—designed the research study. NFSR—performed data collection and analysis. NAMN and ZYMY—provided assistance and advice during data analysis. NFSR and NAMN—wrote the first draft of the manuscript. ZYMY—gave critical comments on the intellectual content of the manuscript. FDY, UHO and AK—provided constructive feedback to improve the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and



approved the final manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in accordance with the Declaration of Helsinki guidelines. Ethical approval for this study was obtained from the Medical Ethics Committee, Faculty of Dentistry, University Malaya ((DF CO2010/0055 (L); (DF CO2103/0080 (P))). Permission to conduct the study was obtained from the Oral Health Programme, Ministry of Health Malaysia, Ministry of Education Malaysia and Negeri Sembilan State Education Department. Parents' informed consent was obtained before data collection and assent from participating schoolchildren.

## ACKNOWLEDGMENT

The authors would like to thank the Oral Health Programme, Ministry of Health, the Ministry of Education, Negeri Sembilan State Education Department for their approval to conduct this study. Special thanks to our funder, teachers and schoolchildren who involved in this study for their kind cooperation.

## FUNDING

This study was funded by the Ministry of Higher Education Malaysia, Prototype Research Grant Scheme (No: PRGS/2/2019/SKK14/UM/02/1) and Postgraduate Grant, Faculty of Dentistry, University Malaya (No: DPRG/11/21).

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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**How to cite this article:** Nor Fatimah Syahraz Abdul Razakek, Zamros Yuzadi Mohd Yusof, Farrah Dina Yusop, Unaizah Hanum Obaidellah, Amirrudin Kamsin, Nor Azlida Mohd Nor. Exploring Malaysian schoolchildren's perception of the advantages and disadvantages of the toothpoly board game: a qualitative study. *Journal of Clinical Pediatric Dentistry*. 2024; 48(1): 101-110. doi: 10.22514/jocpd.2023.096.