

Adult facilitators creating a space for children to co-design a toothbrushing game for improved oral health

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Abstract

Introduction: The Pacific region has a serious problem of child dental caries, with negative health consequences. Urgent action is needed, including effective prevention in the form of toothbrushing. Efforts to encourage children to brush their teeth have focused on the idea that they have inadequate knowledge and motivation about oral health. However, contemporary health promotion theories indicate that ‘nudging’ or persuasion, and health promotion as ‘edutainment’ are also important strategies. In the case of oral health promotion for children this could include fun activities, such as use of games.

The internet provides many tools and a platform for digital games to be created and accessed. This offers opportunities for children to be involved in co-designing and using digital games creating personalised approaches to oral health promotion. Adults are likely to play an important role in facilitating the process. This research project aimed to explore ideas about the role of adults as educational facilitators creating a space for children to be involved in the co-design of a digital toothbrushing game.

Methods: Participatory Action Research (PAR) methods were employed in this research emphasising partnership, creativity, and empowerment between researched and researcher offering a good fit with the project.

Seven young adults, aged 21 – 30, were invited to undertake two PAR workshops to develop ideas for facilitating toothbrushing game co-design with children.

Results: The views and perspectives of the adult facilitators centred around five themes: What is a game? Introducing children to games; creating a space for children; children-centred membership; making learning fun and gainful for children. The themes emphasize creating a child-centred space where children’s voices and views in co-designing games are heard and respected.

Conclusion: The study proposed that collaborating with children in a partnership setting provides opportunities for adult facilitators to address power imbalances and foster a child-centred approach to oral health promotion activities. Child-centred approaches, including co-design and use of digital tools and games, where children participate in partnership and express their views and voices in oral health programmes, should be further explored.

Keywords: Participatory action research, child co-design, toothbrushing game, oral health promotion, school oral health, child digital prosumers, serious games

First author: This research was undertaken as part fulfilment of a Master of Public Health.

Introduction

Dental caries in the Pacific Islands

Dental caries is a chronic disease affecting children and adults worldwide including in the Pacific Islands (Peres et al., 2019; Petersen, 2003; Reddy, 2018). The increased availability and consumption of sugary and highly processed foods due to globalisation are major contributing factors (Pili et al., 2021). As a result of globalisation there has been a shift from local agricultural practices of hunting and fishing, and local diets based on such foods, to eating imported foods (Hughes & Marks, 2009; The Pacific Island Times, 2021; WHO, 2010). Processed foods are popular as they are easy to access, cheaper, and tasty (Aldwell et al., 2018; Connell, 2014). As a result, Pacific Island communities are now grappling with deteriorating oral health and an increase in diet-related health issues such as obesity, diabetes, and cardiovascular diseases (Conn et al., 2020; The Pacific Island Times, 2021; WHO, 2010). These changes have significantly contributed to the rise in dental caries, with a high sugar content; such foods require less chewing compared to whole foods. Saliva plays an important role in protecting teeth from acid erosion and bacteria growth. Diminished saliva production exacerbates the risk of dental caries formation.

Despite the prevalence of dental caries in the Pacific Islands, research on different country experiences is limited (Oral Health Pacific Islands Alliance (OPIA), 2023; Pili et al., 2021). In recent studies, high rates of mean DMFT (decayed, missing, and filled teeth) have been reported in countries such as the Republic of Marshall Islands, Guam, Palau, New Caledonia, Fiji, Cook Islands, Tokelau, Samoa, American Samoa, Tonga, and Tuvalu. In New Caledonia for example, nearly 50% of 6-year-old children have at least one decayed or missing tooth. Rural communities in Fiji also face disproportionately high rates of dental caries. This figure rises dramatically to nearly 100% among 15-year-olds in Rarotonga (Pili et al., 2021). In New Zealand, the prevalence of dental caries among 5-year-olds has remained static since 2008. The proportion of 5-year-old children experiencing no dental decay, past or present, increased from 52.1% to 60.6% between 2002 and 2017. Nevertheless, this trend appears to have reversed, with a subsequent decline to 56% by 2022 (Environmental Health Intelligence, 2024).

Existing studies consistently point to a strong link between inadequate access to oral healthcare and high rates of dental caries. Oral health services in the Pacific Islands are scarce due to a combination of factors such as poor geographical access, and low economic, and infrastructural levels (Aldenhoven, 2015; Maimanuku et al., 2024; Pili et al., 2021; Tatui et al., 2018; WHO, 2024). Geographical isolation is one of the contributing factors that limit access to oral health services. Many Pacific Islands are remote, making it difficult to deliver oral health services to communities (Maimanuku et al., 2024; Oral Health Pacific Islands

Alliance (OPIA), 2023). Cost and transportation of dental equipment are major barriers, adding to inaccessibility for a significant portion of the community, particularly for those in lower socio-economic groups (Pili et al., 2021).

Public funding for oral health care is limited as many Pacific Islands are small (WHO, 2024). Oral health services receive a lower priority compared to other health services. Limited opportunities for dental training within local communities result in a substantial shortage of trained dental professionals willing to practice in remote islands (Livtunvanu, 2011; Maimanuku et al., 2024). As a result of these limitations, individuals with less or no formal education in health care often provide oral health services to address the lack of qualified professionals (Maimanuku et al., 2024; Oral Health Pacific Islands Alliance (OPIA), 2023; Steel, 2013). Having said that, oral health is an area of health that lends itself well to low-cost and easy prevention. Prevention is the key. Simple, affordable measures can significantly reduce the risk of serious and complex dental conditions.

Governments of the Pacific region's response

In recent years, Pacific governments, have implemented campaigns to increase community awareness of the importance of oral health care. In New Zealand, the National Oral Health Day, organised by the New Zealand Dental Association, is celebrated annually in November. In 2023, the event introduced the “Switch to Water Challenge” which encourages the community to eliminate sugary drinks for the entire month of November (NZDA, 2023). Some Pacific Islands have introduced school-based toothbrushing programmes to educate children about good oral health.

Pacific Islands have used various strategies, such as cultural festivals and events championing traditional cuisine and local foods, as well as education and awareness campaigns. Pacific governments are increasingly concerned about the impact on dental caries and general health of the high consumption of imported products (WHO, 2019). Initiatives aim to discourage people from purchasing imported processed products (Conn et al., 2020). Farmers are strongly encouraged to produce sufficient local and traditional healthy food that can remain as part of the staple diet (WHO, 2019).

In Vanuatu for example, a trend was noted whereby mothers opted to buy imported food rich in sugar for their children as it was cheap and attractive (WHO, 2007). Consequently, the government made efforts to encourage mothers to choose local foods such as potatoes, bananas, and snacks (e.g., manioc chips) that have more nutritional value than imported foods (WHO, 2007).

Pacific communities have limited knowledge and understanding about the cause of dental caries, its consequences, and how it can be prevented

(Alrmaly & Assery, 2018). Furthermore, Pacific communities do not have access to preventive measures such as fluoride intake, dental sealants, or regular examinations to prevent dental caries, as well as oral health promotion campaigns (Willie, 2017). The prevalence of dental caries has, to some extent, decreased in richer countries due to the introduction of community fluoride initiatives (Broadbent et al., 2015; Petersen et al., 2005; WHO, 2022). However, even with the added resources for dental public health interventions and oral health promotion, rich countries continue experiencing a high incidence of dental caries, particularly among underprivileged communities (Cruz, 2014; Petersen, 2003).

New Zealand is a rich country located in the South Pacific with multicultural and diverse, ethnic communities (Stats NZ, n.d), including a significant proportion and diversity of Pacific Island communities. Despite the country's overall wealth, some communities in New Zealand face significant levels of inequity and poverty (Nelson, 2016). Even with government-funded dental care for children in New Zealand, substantial inequalities persist based on ethnic background, geographic location, and socioeconomic disparities (Shackleton et al., 2018).

Inequalities in oral health in children based on ethnicity were reported in the 1980s (Ministry of Health NZ, 2010; Moffat et al., 2017), with subsequent studies highlighting higher rates of dental caries and oral health inequities among Māori and Pacific children (Public Health Advisory Committee, 2003); Thornley et al. (2021). The 2022 data from the Community Oral Health Service in New Zealand show that 44% of 5-year-old children and 31% of 12-year-old children had dental caries: with Māori and Pacific children being the most affected. 5-year data show that 61% of Māori children and 67% of Pacific children had dental caries. Comparatively, the 12-year-old data show that 41% of Māori children and 33% of Pacific children had dental caries (Ministry of Health NZ, 2021).

New trends in oral health promotion in a digital society

Traditionally, oral health promotion initiatives have relied on analogue communication methods to educate communities. Methods have included printed brochures, television advertisements and health service campaigns. However, the advent of the digital revolution has significantly changed communication pathways offering interactive and dynamic opportunities for oral health promotion. Bansal et al. (2023) and Sharma et al. (2022) highlight the potential of digital interactive platforms such as mobile applications and social media to disseminate and share oral health messages. Furthermore, there has been an important conceptual shift in that now the digital user has become less passive as the internet offers opportunities for the user to be a producer, creator, and communicator alongside the traditional creator of content (Conn et al., 2017).

Children as avid users of digital technology have emerged as such 'prosumers;' that is, going beyond consumption (as consumers) to becoming producers (Toffler, 1981). There is now scope for children to actively participate in the co-creation of oral health promotion activities. In this rapidly evolving digital landscape, co-designing oral health promotion activities presents a unique opportunity. Some argue that children have become digitally comfortable, and capable of co-designing interactive and personalised oral health promotion experiences that can be shared through the internet learning themselves and also shared with other children (Herrero-Diz et al., 2016; Jenkins et al., 2009).

In traditional oral health promotion approaches, the focus has been on the expertise of health professionals or health teachers. In the digital era, there is growing recognition of children's potential as co-designers of educational games using the internet. Yet, given the speed of change and the newness of these possibilities, the potential for exploring the place of children's curiosity and creativity as prosumers and users in digital oral health promotion has yet to be realised. This study aims to explore strategies for facilitating children's participation in co-designing oral health promotion digital games.

Methods

PAR emphasises collaboration, creativity, problem-solving, and empowerment by working closely with participants and inviting them to engage with notions of voice (Lawson et al., 2015; Schubotz, 2020). These characteristics of PAR, foster active participation that aligns well with the aim of this study which was to develop ways of engaging children as co-designers of a digital toothbrushing game. Seven adults, aged 21-30 years, recruited from the student body at Auckland University of Technology (AUT) and representing various disciplines with a shared interest in collaborating with children, took part in the research. These participants engaged in two participatory workshops aimed at generating ideas for establishing a conducive environment for children to co-design a toothbrushing game. The recruitment of adult facilitators occurred through announcements posted on the AUT Learning Management System and by dissemination of invitations across different disciplines and through colleagues, utilising word-of-mouth communication and email invitations.

The adult facilitators encompassed a diverse range of backgrounds including a student from the University of Auckland School of Science and Mathematics pursuing a teaching qualification for secondary schools, two graduates from the AUT School of Arts and Design specialising in Digital Design with a minor in Motion Capture, and four students from the AUT School of Clinical Sciences studying oral health, and with an interest in future teaching roles in oral health. One oral

health student possessed prior experience as a primary school teacher overseas.

The workshops were designed to foster a creative and enjoyable environment encouraging adult facilitators to discuss, exchange, and co-create knowledge in the domains of oral health, children as co-designers, and toothbrushing games (Horgan, 2017). To achieve this, activity-based methods were used (Groundwater-Smith et al., 2015) including word-writing exercises, drawing activities, and mind-mapping techniques, with digital devices. Before the workshops, the researcher provided an overview of the research objectives and methodology, contextualised the activities and approaches in oral health, and introduced the co-design process. These topics were explained:

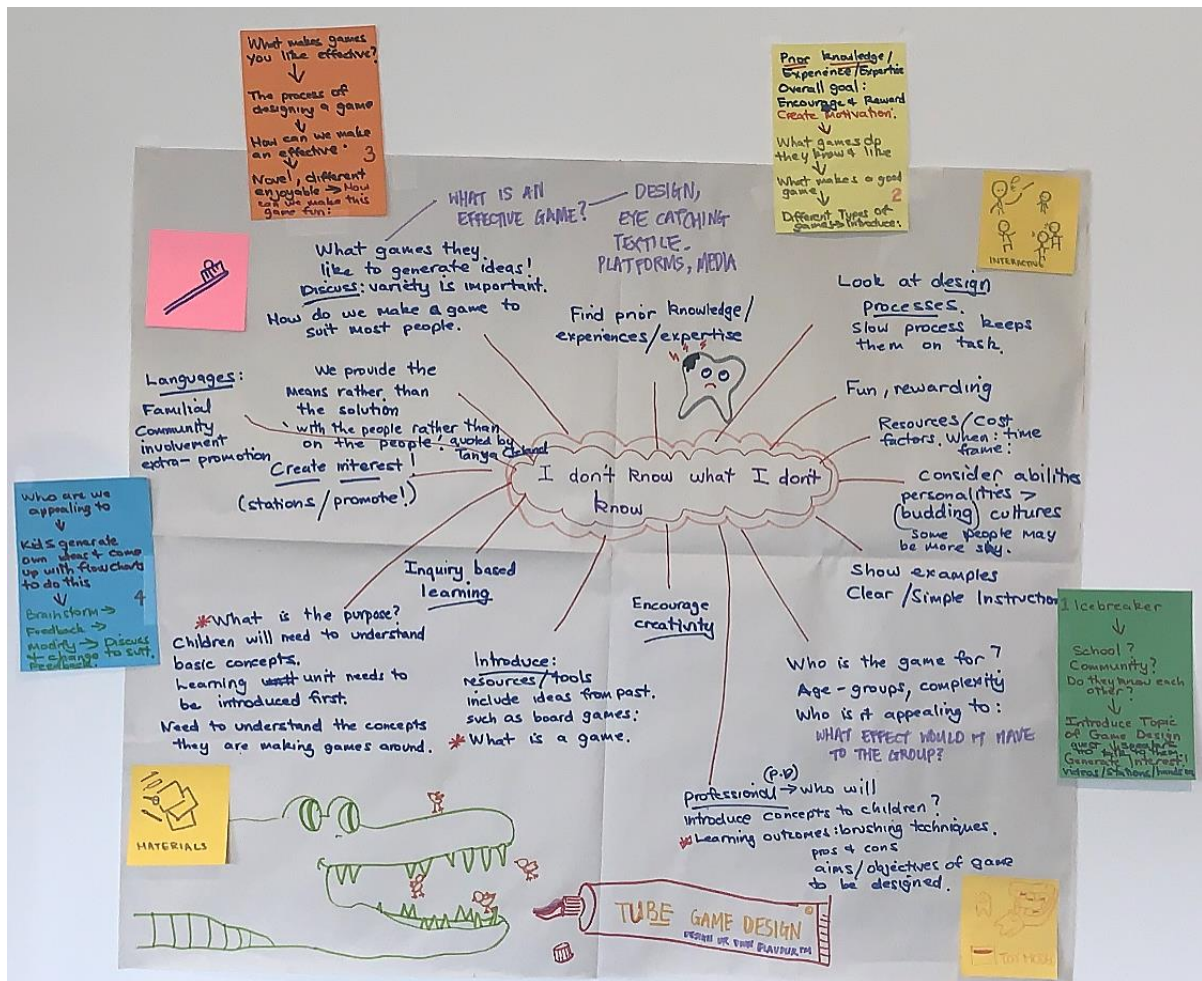
- PAR focus.
- Dental decay and its consequences in children.
- Dental decay in the Pacific region.
- The digital era and children's role as co-designers and prosumers.
- The concept of prosumers.
- The concept of serious games.

The adult facilitators organised themselves into two groups (Group A and Group B). Each group was provided with materials to express their ideas, including coloured paper, markers, and sticky note pads to exhibit as hard copies. Additionally, participants had access to their electronic devices (iPads, smartphones, and laptops) to access and share information relevant to the co-design exercise.

To capture the dynamics of the workshops and inform future research, the researcher employed field notetaking. These notes documented observations focusing on; information-gathering processes with each group, social interactions and communication patterns between group members, the content of conversations, including topics discussed, and motivation and enthusiasm displayed by participants towards the co-design activity. Ethical approval was granted by the AUT Ethics Committee; reference number 19/285.

Following the workshop activities, both adult facilitator groups presented their findings through visual presentations in the form of posters, capturing the creative ideas generated, and reflecting the diverse perspectives within each group. The posters included a combination of brainstorming, drawings, and writing text to communicate their proposed approaches. Group A meticulously articulated and disseminated creative concepts in a methodical and all-encompassing manner, employing a combination of coloured sticky notes, vivid hues, text annotations, and illustrative renderings to represent their proposed approach for creating a space for children to co-design a toothbrushing game (Figure 1).

Figure 1. Poster from Group A.



In contrast, Group B created a straightforward presentation format, using paper and markers to visually represent creative suggestions. Their presentation consisted of two posters. Poster 1 (Figure 2) represents the initial brainstorm captured. It offers valuable insights into the group's initial thought process and the direction of their ideation. Group B's Poster 2 (Figure 3) focuses on ideas that represent concepts a co-design process. The analysis of this poster reveals the group's consideration for child co-design activities.

Figure 2. Poster 1 from Group B.

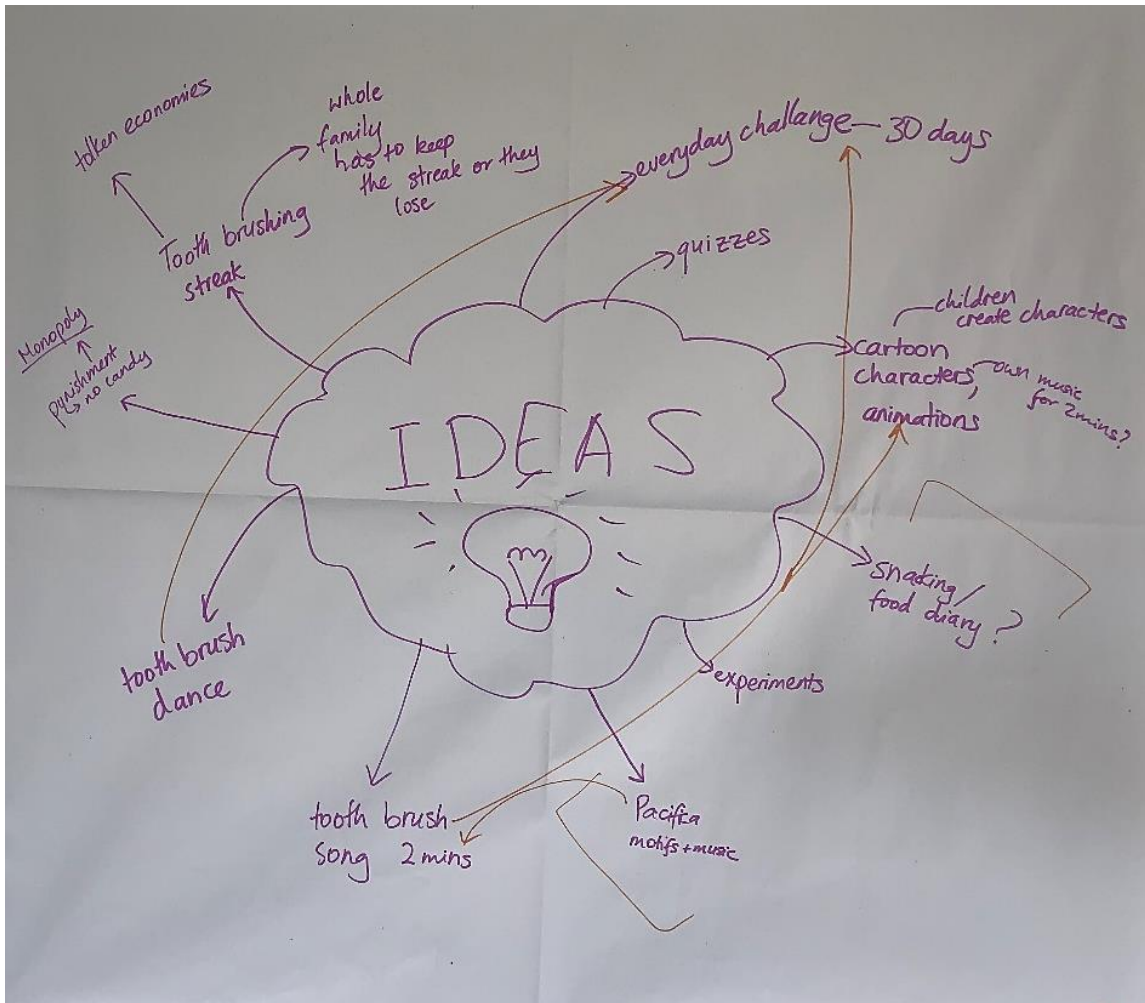
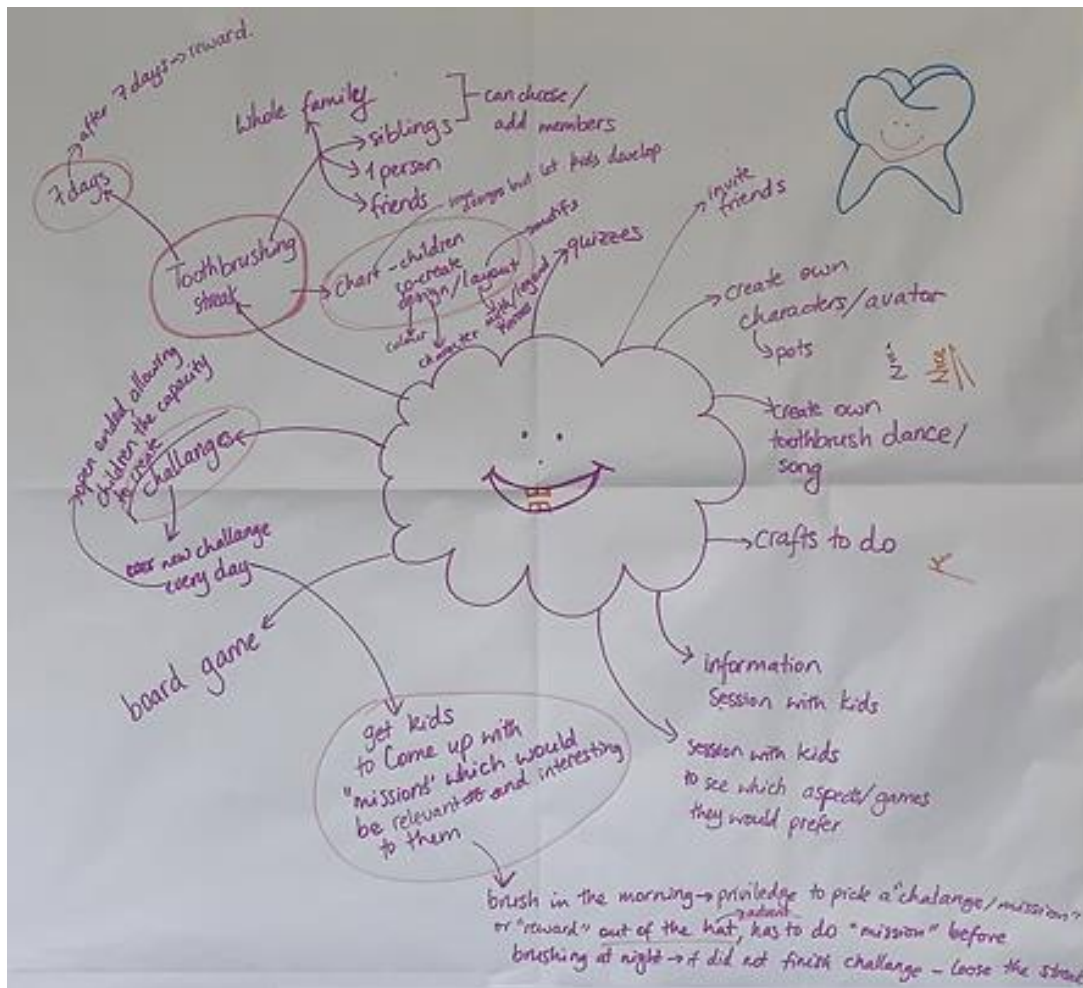


Figure 3. Poster 2 from Group B.



Thematic analysis as outlined by Braun and Clark (2006), was employed to analyse the data collected from the group discussions and poster presentations. This process involved a multi-step approach. First, a comparative analysis of the poster content across all groups was conducted. Field notes were used concurrently to enrich and corroborate the analysis from the posters. This initial comparison aimed to identify similarities and differences in the ideas presented by the adult facilitators. Following the initial comparison, a more focused analysis was undertaken for each poster. The researcher engaged in a close reading process, meticulously reviewing the content of each poster on multiple occasions. This in-depth examination of the posters aimed to extract key concepts relevant to the research question.

Thematic coding techniques, as recommended by Braun and Clarke (2006), were then used to compile separate lists of these key concepts. An in-depth comparison of the key concepts helped to create a thematic map as suggested by (Braun & Clarke, 2006). The comparative process of the key concepts and the thematic map aided in refining the themes

and elucidating the essence and relevance of each theme in addressing the research question, in line with the methodological framework as suggested by (Gibbs, 2018). As a result of the comparative process, five child-centred themes emerged from the data analysis.

Theme 1: What is a game?

Theme 2: Introducing children to games.

Theme 3: Creating a space for children.

Theme 4: Children-centred membership.

Theme 5: Fun and gainful for children.

Table 1 presents a thematic map outlining the core themes from the thematic analysis process. To understand the transcription from each group, a coloured-coded transcript was used (see Figure 4).

Figure 4. Summary of the main themes. Transcripts written in blue font correspond to Group A, while those in green font represent Group B

The Five Themes Associated with Creating a Space for Co-Designing Digital Toothbrushing Games with Children.

Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
What is a game?	Introducing children to games	Creating a space for children	Children-centred membership	Fun and gainful for children
<ul style="list-style-type: none"> ▪ 'I don't know what I don't know' concept relating to children's knowledge about oral health and serious games concepts. ▪ Smiley face concept. ▪ What is a game? ▪ Introducing oral health concepts to children ▪ Prior knowledge and experiences. ▪ Use ideas from past games - board games, physical games, digital games. ▪ Games they like to generate further ideas. ▪ Game variety is important. ▪ Timeframe (fits everywhere). 	<ul style="list-style-type: none"> ▪ Oral health concepts need to be introduced to use in their games. ▪ What is an effective game? ▪ Purpose, aims, and objectives of the game. ▪ Learning outcomes: More toothbrushing and techniques. ▪ Introducing resources, tools, and cost factors. ▪ Provide the means of co-design rather than the solution. ▪ Work with people rather than on the people. 	<ul style="list-style-type: none"> ▪ Look at design processes by inviting game specialists. ▪ Design eye-catching, colours, heroes, and characters. ▪ Session with kids to see which aspects of games they would prefer or like the most. ▪ Create your own toothbrushing dance or song. ▪ Co-create design colour and characters, myths, legends, and heroes. ▪ Provide clear and simple information relating to oral health and developing games. 	<ul style="list-style-type: none"> ▪ Who is the game for? ▪ To whom is the game appealing? ▪ How do we make a game to suit a diverse group of children? ▪ Considered children's voices, languages, age groups, complexity, abilities, personalities, and cultures. ▪ Children's ideas are respected. ▪ Children will have individual design preferences – some may prefer to work alone at times. ▪ Community, friends, and family involvement. ▪ What effect would the game have on the group if participants were of different ages? 	<ul style="list-style-type: none"> ▪ Children creating challenges, missions, quizzes, and rewards. ▪ Create a space where children have fun co-designing a game. ▪ Promote interests, motivation, and interaction. ▪ Allow children to have fun with games to promote interest. ▪ Experimenting with games they know to produce new ideas. ▪ Children creating rewards to promote advanced game levels.

Following the completion of the thematic analysis process and identification of themes, the subsequent phase involved documenting the findings following the guidelines proposed by Braun and Clarke (2006). The process encompassed six iterative stages: familiarisation with the data, generation of initial key codes, searching for themes, reviewing the themes, naming the themes, and finally, reporting these to the adult facilitators for their opinion and validation.

A collaborative approach with the adult facilitators guided decisions about the themes including consulting them. Consulting with the adult facilitators for theme verification aligns with the core principles of PAR emphasising collaboration and consultation between the primary researcher and the adult facilitators (Schubotz, 2020). This collaborative process strengthens the research by ensuring the themes accurately represent the facilitators' experiences and perspectives (Kindon et al., 2007).

Results

Theme 1. What is a game?

Both groups emphasised the importance of introducing basic oral health and game concepts to children in a teaching situation. Group A explored their ideas by assuming that '*children do not know what they do not know*'. The assumption was that children have little knowledge about oral health or co-design of games. Group A suggested introducing images with teeth to encourage children to brainstorm and talk freely about what they know or do not know about oral health. They also suggested creating an environment where children can collaboratively practice designing a game based on previous experiences with playing games. This opportunity would also allow children to look at the design process and compare their new game's effectiveness, features, and enjoyability with other games.

Group B on the other hand, had the assumption that children like to play physical games as they might not have access to technology to play digital games. However, this group suggested that since children know about physical games, they could use this knowledge to generate game ideas. They suggested that like an outdoor game where the activity has been ticked off as completed, this similar concept could be used in the co-design of a toothbrushing game. The rationale for this initial step was to create a space for children so they could co-design an oral health game.

Theme 2. Introducing children to games

Group A proposed a collaborative approach to game introduction, emphasising child-centred empowerment. They suggested that facilitators should encourage children to discuss their existing game knowledge and compare their effectiveness. This would foster a sense of ownership and agency in the learning process. The group stressed the importance of providing children with the tools and resources

to make their own decisions rather than simply giving them solutions. They highlighted that facilitators should work with children, creating an environment where they can actively explore and learn.

Group B focused on the potential of co-designing in game creation. They suggested that by providing children with tools and information about oral health, they could actively participate in designing toothbrushing games. This approach would not only encourage toothbrushing but also create a sense of ownership in the learning process.

Both Group A and Group B believed in children-centred approaches to game introduction and learning. Group A emphasised empowerment and providing children with the means to make their own decisions, while Group B focussed on co-designing games to encourage creativity and ownership.

Theme 3. Game co-design – creating a space for children

Group A proposed a collaborative approach to game co-design, involving teachers and game designers. They suggested that by introducing game concepts and providing hands-on experiences, children would be motivated to participate in the design process. The group emphasised the importance of enabling creative freedom with children's own design space to encourage enjoyment and motivation. They also proposed the idea of voting on the best co-designs to encourage engagement and recognition.

Group B highlighted the significance of respecting children's individual preferences in game design. They emphasised the importance of incorporating elements that appeal to children, such as eye-catching visuals, favourite colours of beloved characters. This would allow children to express their creativity and make the games more personal and meaningful. They also suggested incorporating personal elements like creating avatar characters or adding customised songs to further personalise their gaming experience.

While Themes 2 and 3 may have some overlap in terms of child-centred approaches and the importance of creating engaging learning environments, they focus on distinct aspects. Theme 2 primarily addresses the initial introduction of games to children, while Theme 3 focuses deeply on the collaborative process of game co-design, emphasising creativity, personalisation, and child-centred approach.

Theme 4. Child centred membership

Both groups indicated that it is essential to know the children and learn from them. Knowing children's backgrounds could influence the children's interests and motivation to participate in a project. Children from different groups or communities may have different personalities, interests, and abilities to participate. The creation of a space should allow children to express themselves based on their individual experiences and preferences.

Group A recognised that it is essential to respect children's voices and abilities to participate. Children are different, and they bring exciting ideas. This concept of respect aligns with PAR and Article 12 of the United Nations Convention on the

Rights of the Child (UNCRC) 1989 about respecting children’s right to express their views about all matters affecting them. Horgan (2017) emphasised that it is important to empower children and listen to their voices as they have the potential to be great contributors to new knowledge.

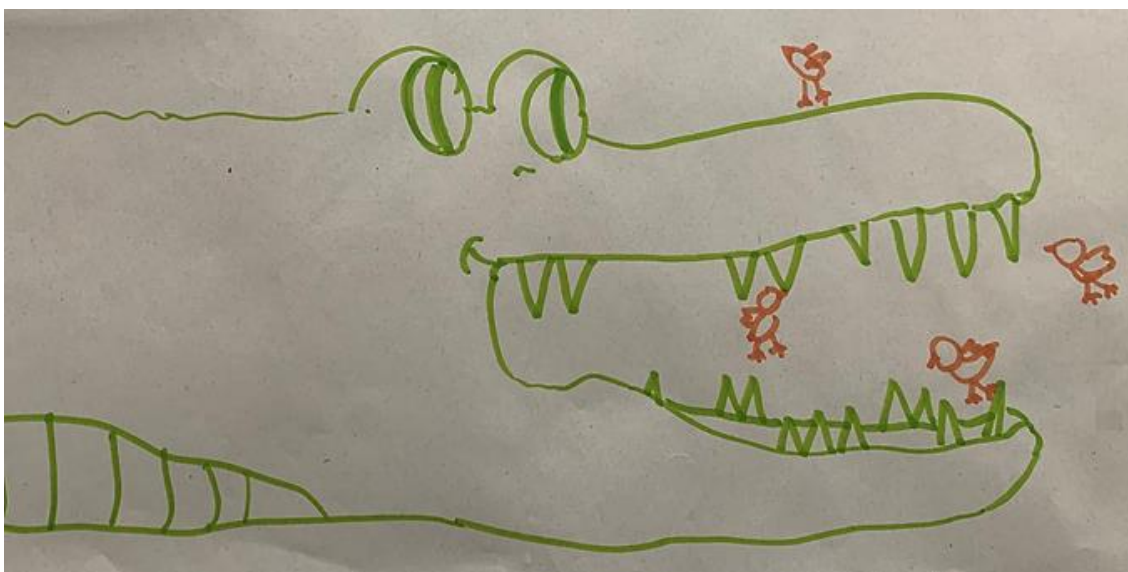
Consideration of children’s ability/preference to participate is important, as some children may be shy and unwilling to participate. Therefore, allowing children to organise themselves was beneficial so they voluntarily can participate and exchange ideas and opinions. Group A recognised the importance of ensuring that children’s ideas are respected, valued, and considered in their co-design of games. Different languages and cultures are essential factors for diversity of ideas, and this promotes co-designing approaches that can suit a diverse group of children. Some children may be too shy to speak, but other members of the group could speak for them, making this a participatory approach to co-design their game.

Group B emphasised the importance of creating an environment where family and friends can be invited to participate in the game co-design process. Friends and family participation would promote sharing ideas to co-design a game that suits most people, and also disseminate health ideas through the family and friend group.

Theme 5. Fun and gainful for children

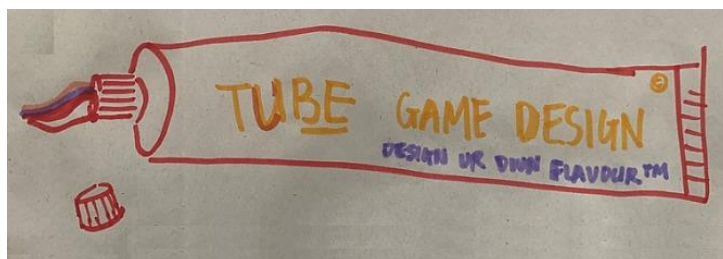
Adult facilitators proposed the creation of a space where children can organise themselves to engage with each other. The space could motivate children to generate ideas and have fun co-designing their games. For example, Group A drew a picture of a crocodile with flying birds. The concept around this picture is that birds clean the crocodile’s teeth in nature. If birds are flying around the crocodile’s teeth, but they are not sitting on the teeth, the birds (Figure 8) will not clean the teeth.

Figure 5. The Crocodile and the Cleaning Birds.



Another idea Group A developed was a picture of toothpaste with the slogan TUBE GAME DESIGN. The concept around this picture is that children may want to develop their toothpaste and flavours. The image highlights the U letter as being YOU (the co-designer) (Figure 6).

Figure 6. TUBE GAME DESIGN Toothpaste.



Group A considered that children may want to experiment with models or objects to develop ideas about their game. Group B considered creating a space where children take full ownership of their game co-design and are in charge of setting their challenges and rewards. Children take control of the co-creation of game missions, quizzes, and rewards. Allowing children to do so will make the game fun, rewarding and motivating. Game challenges co-designed by the children could be more representative and exciting to them. If someone creates the challenges, they may not be what children want. This approach could be seen as something being imposed on them, which goes against the principles of PAR methodology and critical theory approach, challenging the imposition of ideas from adults without representing a child's voice.

Conclusion

The study focused on promoting child oral health through collaborative approaches that empower children as active participants in co-designing health initiatives. It highlighted the importance of involving children not only as recipients of oral health education but also as prosumers or co-designers of oral health, also as ambassadors within their communities. By integrating children's perspectives into research and practice, the study aimed to develop innovative programmes that resonate with their needs and experiences, ensuring that oral health initiatives are genuinely child-centred.

Implications for policy and practice include fostering partnerships between schools, communities, and healthcare providers to create accessible and supportive environments for children's oral health. Policymakers are encouraged to consider children's voices in the development and evaluation of oral health programmes,

which can lead to more effective initiatives. It is also vital for policymakers to consider the role of the digital world not only as a means of providing traditional health education, with its emphasis on information provision, but also as a means of creative exploration by children, facilitated by adults. The emphasis on ongoing evaluation and feedback from children is vital to ensuring programmes meet their needs and adapt over time, transforming how oral health education is approached.

Future research should continue to explore children's roles as co-designers and collaborators in oral health promotion. Areas for investigation could include developing strategies for effective engagement with children and understanding their insights into health-related topics, moving further into the world of serious game development. Establishing more child-centred environments within educational settings for co-design activities is essential, especially with a greater emphasis on the possibilities offered by the digital world.

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