



Role of Gamification and Mobile Health Applications in Improving Oral Hygiene Practices: A Narrative Review

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Abstract: - Over 80% of school-age children worldwide and 60–90% of children with primary dentition suffer from dental caries, which continues to be a major global health concern. Poor dental hygiene in early childhood can cause discomfort, stunted growth, and a lower standard of living. Effective educational strategies are vital because parents have a significant influence on children's oral health behaviors, particularly during the early developmental years. However, the long-term efficacy of conventional oral health education techniques like lectures and printed materials is frequently found to be limited. The use of game design elements in non-gaming contexts is known as gamification, and it has become a cutting-edge strategy to boost engagement and encourage healthy habits. With an emphasis on its use through mobile health (mHealth) platforms, this review examines the function of gamification in oral health education. A thorough search for studies published between 2010 and 2023 was done using the PubMed, Scopus, Web of Science, and ERIC databases. The review focuses on important gamification components that increase motivation and adherence to oral hygiene practices, such as goals, rewards, feedback, and social interaction. A number of gamified apps, such as Brush DJ, Pokémon Smile, and Colgate Magik, are designed mainly for kids and use interactive and entertaining features to help them brush their teeth more effectively. To assess long-term efficacy and broaden the application of gamification in comprehensive oral health education and behavioral modification, more excellent research is required.

Keywords: Dental caries, gamification, health promotion, mobile apps, mobile health, oral health, oral health education.



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INTRODUCTION

According to the Global Burden of Disease, 60-90% of children have caries in their primary teeth, and oral hygiene being a serious concern worldwide, affects more than 80% of schoolchildren. [1-2] Children with poor oral health can have substantial effects, such as tooth caries, periodontal disorders, discomfort, decreased growth and development, and compromised quality of life. [3] Parents are responsible for their children's oral health hygiene and behaviour, particularly during preschool, and should monitor them timely. [4] However, maintaining adequate oral hygiene in young children can be challenging because proper tooth-brushing techniques are often difficult for them to understand and practice independently. Therefore, interactive and game-based approaches can help

simplify oral hygiene instructions, improve motivation, and encourage better brushing habits in children. [5] Since the early years of life are critical for developing lifelong oral health practices and behaviors, introducing engaging and age-appropriate oral health education at this stage is highly important. Traditionally, oral health education relied on traditional methods such as lectures, demonstrations, and printed materials, which have been demonstrated to have a negligible or short-term effect on children. [6] With the increasing use of smartphones and digital technologies, mobile health (mHealth) applications have emerged as promising tools for interactive oral health education. One such approach is gamification, which uses game-like elements to improve engagement, motivation, and healthy behaviors. By making oral hygiene routines more enjoyable, gamified

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applications may help children develop and maintain effective brushing practices. [7]

GAMIFICATION

Gamification is defined as the use of game design elements to non-gaming circumstances. [8] This technique improves products, services, and information systems by incorporating game-like aspects with the goal of increasing user motivation, productivity, and behaviour. [9] It is an innovative educational strategy that engages and inspires youngsters while also improving their learning providing engaging and immersive experiences by capitalising on the popularity of games and technology. It also gives rapid feedback, helping students learn practical skills and complex concepts in oral health education. [10-11]

However, just a few studies have used gamification in the health promotion field of dentistry; where they discovered that gamification increased oral hygiene knowledge and attitudes among Indian youth. The first was a quasi-experiment using the Snakes and Ladders board game, which revealed that participants' knowledge improved significantly after seven days of play. The second was a randomised controlled trial (RCT) that used the dot game and concluded that the study group performed better at a three-month follow-up than the control group who only received standard educational approaches. [12] Despite the favourable findings of board games, word games, and video games in transferring knowledge and developing abilities among learners, it is critical to note that the existing body of research on serious games in oral health education is still limited, and further research is required. [3]

SEARCH STRATEGY

To identify relevant literature for gamification in oral health education, we conducted a comprehensive search across four major databases: PubMed, Scopus, Web of Science, and ERIC, covering studies from 2010 to 2023. This multi-database search aimed to minimize sampling bias. The inclusion criteria specified peer-reviewed articles published in English-language journals. Studies were required to focus on gamification as a pedagogical tool in the context of oral health education. We employed a title-keyword search strategy, ensuring that all articles contained variants of our primary search terms: "gamification" and "oral health education." Various combinations of keywords related to gamification were used (e.g., game-based learning, serious games, digital learning, interactive games), along with terms associated with oral health (e.g., dental health, oral hygiene, cavity prevention, tooth brushing).

CHARACTERISTICS OF GAMIFIED ORAL HEALTH APPLICATIONS

Gamified oral health applications incorporate game design elements into non-gaming contexts to improve user engagement, motivation, and behavioral outcomes. Common gamification features include rewards, points, badges, levels, timers, feedback systems, avatars, storytelling, and progress tracking. Personalized profiles, visual animations, music, and augmented reality (AR)-based interactions are also frequently integrated to enhance user participation and sustain interest in toothbrushing activities. Such gameful elements help transform routine oral hygiene practices into engaging and motivating experiences for children. [13]

Several gamified oral health applications have been developed using these interactive features to promote effective brushing habits and improve children's oral health education.

OVERVIEW OF GAMIFIED ORAL HEALTH APPLICATIONS

AQUAFRESH BRUSH TIME APP

Haleon developed the Aquafresh Brush Time app, a free Android app that makes oral hygiene interesting for children by promoting brushing for the two minutes, and by incorporating dance routines and music with interactive characters like Captain Aquafresh and the Nurdles. It has a vibrant, easy-to-use interface and allows for up to four user profiles, each of which can be customized with different backgrounds, costumes, dance themes, and music. The app teaches how to brush the teeth properly and maintain good oral hygiene while letting them listen to their favorite music. [14]

BRUSH DJ

The Brush DJ app, developed by Ben Underwood, is a free mobile application designed to enhance toothbrushing duration and effectiveness. The app plays two minutes of music from the user's device, encouraging adherence to the dentist-recommended brushing time. In addition to its timer function, the app supports comprehensive oral hygiene by providing reminders for brushing, flossing, mouthwash use, and dental appointments. It is aligned with the guidelines outlined in *Delivering Better Oral Health* by the National Health Service. The app has been widely adopted across more than 185 countries, with user feedback indicating that 89% of users feel motivated to brush for longer durations, and 92% would recommend the app to others. [15]

BRUSHING HERO

The Brush Hero app is an interactive, game-based tool that combines learning and entertainment to encourage children to learn about oral health. This app creates an immersive and captivating brushing experience by putting kids in the role of heroic characters who use their toothbrushes to defeat animated creatures. In-game performance is directly impacted by brushing effectiveness, with improved brushing methods boosting the player's strength and advancement. Additionally, users can enhance their skills by gathering "hero cards," and further engagement opens up new challenges and levels. [16]

BRUSHMASTER

BrushMaster is a promising digital application that combines instruction with entertaining, interactive features to address the pervasive problem of poor brushing habits. Through gamified features, the app teaches users efficient brushing techniques, making oral hygiene both educational and entertaining.

Key Features:

- **Brushing Simulations:** Enable for hands-on learning and progress.
- **Feedback and Scoring:** The app provides real-time feedback on brushing pressure, motion, and coverage, helping users get high scores and improve their technique.

- **Unlockable Levels:** This increases as level progresses to improve users' skill providing a dynamic experience. [17]

BRUSH MONSTER

One of the first electric toothbrush systems based on augmented reality (AR), Brush Monster is a cutting-edge oral health technology that makes brushing fun and interactive for kids.

Key Features:

- **Augmented Reality Integration:** uses the device camera to apply a playful filter to child's face and guides them with a virtual toothbrush that hovers over the sections of their mouth that need attention, ensuring they brush every area effectively.
- **Real-Time Motion Sensor:** tracks brushing time and technique for each of the 16 areas of the mouth, providing detailed reports on performance and pinpointing areas that need improvement.
- **Brushing Technique:** incorporates the Fones Method, which emphasizes brushing in circular motions.
- **Interactive Gameplay:** Children save the world from gross bacteria (the green monsters!) and earn virtual stickers for each successful brushing session.
- **Selfies and Progress Reports:** With the app's face recognition feature, kids can take selfies and view color-coded dental reports that track their brushing progress. Each area is timed with a 10-second interval, encouraging thorough brushing despite the slightly longer duration compared to typical recommendations. [18]

BRUSHEEZ LITTLE MONSTERS APP

The interactive, kid-focused BrushEez Little Monsters app creates and customizes virtual "monster" characters to brush their teeth, increasing motivation and engagement during oral hygiene routines. In order to provide a fun user experience, the app also includes interactive features, music, and vibrant animations. [14]

BRUSH UP

The Morehouse School of Medicine and the National Institutes of Health have approved the Brush Up app, an interactive oral health tool that uses entertaining elements like animated characters, music, and selfie-based feedback to teach kids how to brush their teeth properly.

In order to provide real-time feedback on user performance, the app uses motion-tracking technology to track brushing duration and coverage. Children initially brushed for brief periods of time (roughly 7.5 seconds) and concentrated mostly on visible tooth surfaces, according to early prototype evaluations. However, users showed notable improvements in brushing behavior with consistent use and weekly gameplay, without further parental or researcher guidance. After two weeks of regular nightly use, a study by health scientists found that brushing performance improved by about 78%. These results imply that the Brush Up app's interactive and self-directed learning features can successfully improve brushing habits. [19]

CHOMPER CHUMS

For children ages 4 to 11, United Concordia Dental developed this app that makes brushing and flossing interactive with healthy eating habits. The app features colorful animal guides, such as a lion, horse, and alligator. In addition to earning points by brushing various mouth areas, chasing "sugar bugs," and learning about healthy eating, kids can design and name their own animal friend. Regular brushing adds excitement to their routine by earning coins that can be spent on their pet's food and earning the "Super Smile Award" for brushing twice a day. [20]

COLGATE MAGIK

Colgate Magik is an augmented reality (AR)-based oral health app created by Colgate-Palmolive that aims to make brushing fun for kids between the ages of five and ten. The application, which works with both Colgate Magik smart toothbrushes and regular manual toothbrushes, lets kids engage with a virtual world where they can effectively brush out "cavity monsters." In-game currency, such as diamonds, is awarded to users and can be used to unlock AR face masks, extra features, and higher levels.

Interactive features and practical tools-

The Colgate Magik kit contains a 7-inch toothbrush, a Magik connector for integrating technology, and a phone stand. The software, which is available on both Android and iOS, works flawlessly with the toothbrush to assist children through a two-minute brushing routine. As they brush, they see their face next to a graphic of teeth infested with Cavity Monsters. To combat these creatures, kids must brush the appropriate areas of their mouth. [21]

DISNEY MAGIC TIMER BY ORAL-B

Disney Magic Timer by Oral-B is a gamified oral health app created by Procter & Gamble with the goal of motivating kids to brush their teeth effectively including well-known characters from Disney, Marvel, and Star Wars franchises.

It includes a two-minute timer that is in line with the recommended brushing time, along with visual and auditory cues that help kids along the way. Children's continued engagement is reinforced as they brush and unlock images and rewards that feature well-known characters from movies like Toy Story, The Lion King, and Frozen. Although data reported by the developer indicates that up to 90% of kids brush for longer periods of time when using the app, there isn't much solid independent clinical evidence to back up this assertion. [22]

GRINQUEST

A gamified digital platform called GrinQuest was created to improve patient compliance and engagement with orthodontic treatment. By enabling users to design and customize avatars that change as their treatment progresses, the app promotes a sense of accomplishment and ongoing engagement. The platform includes daily challenges that promote important orthodontic behaviors, such as wearing aligners consistently, maintaining good oral hygiene, and avoiding foods that are restricted. Positive feedback mechanisms reinforce adherence by rewarding users with virtual incentives and customizable avatars. [17]

MIMIZOUR CLEAN TEETH

A child-focused oral health app called Mimizaur Clean Teeth was created to encourage good brushing practices in kids between the ages of three and six. The purpose of these interactive visual components is to sustain interest over time and promote thorough brushing.

Key Features:

- **Personalized Accounts:** Mimizaur lets you to create several accounts for your children, allowing them to earn and track their own achievements.
- **Flexible Timer Settings:** Brushing timer of 1 or 2 minutes, ensuring enough brushing time while preserving flexibility and parental control.
- **Interactive Elements:** Engaging features such as hilarious music, including the popular "Zyumba-Kakazyumba," makes brushing teeth more enjoyable.
- **Rewards and Achievements:** Each finished brushing session gets super-achievements, which encourages children to continue brushing. [23]

POKEMON SMILE

By combining dental care with the Pokémon universe, the app turns brushing your teeth into an enjoyable experience. The app uses augmented reality to turn brushing into an interactive game in an effort to motivate kids to brush thoroughly and regularly. Children can "rescue" the Pokémon characters they see on their screens while brushing by getting rid of imaginary germs. With almost 100 Pokémon available for free, the app encourages children to brush frequently in order to finish their Pokédex. Additionally, the app offers special incentives that make brushing more enjoyable, like Pokémon Caps that show up on their in-game avatar. By taking and sharing pictures of themselves wearing these virtual Pokémon caps, kids can improve their experience and give their brushing routine a whimsical, unique touch. [24]

TOOTHFAIRY

A startup-based digital app called ToothFairy was created for kids between the ages of 4 and 12 with the intention of encouraging regular oral hygiene habits through entertaining and interactive features. The app turns everyday tasks like brushing and flossing into gamified experiences because it understands how difficult it is to keep young users motivated.

Key Features:

- **Virtual Pet Companion:** Each child adopts a virtual tooth fairy pet upon registration. This companion grows and flourishes based on the child's oral care efforts.
- **Quests and Challenges:** The app offers daily quests, such as defeating sugar bugs, and challenges, like brushing for the full two minutes, rewarding children for their efforts and progress.
- **Leaderboards and Badges:** Children can compete with friends, track their achievements, and earn badges for milestones such as consecutive days of brushing or maintaining cavity-free checkups. [17]

TOOTHSAVERS BRUSHING GAME

This educational app as part of the Kids' Healthy Mouths campaign by the Partnership for Healthy Mouths, Healthy Lives. In this interactive game, players join Toothy and the Toothsavers to combat the effects of an evil sorceress's spell, which has caused decay and cavities in the kingdom.

Gameplay:

Players have two minutes to brush away the spell's damage from whimsical characters like the Dragon, Little Red Riding Hood, and the Pirate. Effective brushing helps these characters achieve better oral health.

Personal Brushing:

Players are encouraged to brush alongside each Toothsaver for two minutes, twice a day. Consistent brushing unlocks new Toothsavers and, after 30 days of dedication, provides the chance to confront the evil sorceress. [25]

TOOTHY: TOOTHBRUSH TIMER

It is a complete oral health application made to track and enhance each person's brushing and flossing habits. To encourage adherence to suggested oral hygiene practices, the app includes tracking and timing features. Its compatibility with both electric and manual toothbrushes increases its usability and accessibility for a variety of users.

Key Features:

- **Brushing and Flossing Tracking:** It tracks the length of your brushing and flossing sessions, allowing you to monitor and improve your dental hygiene regimen.
- **Audio Integration:** For individuals who prefer listening to music while brushing their teeth, the app can also track how much time they spend listening to their audio library.
- **Built-in Calendar:** The app includes a calendar to help you keep track of your brushing and flossing routine, making it simpler to stay consistent.
- **Customizable Settings:** You can adjust settings according to your preferences, including voice-over instructions and integration with your music collection to make brushing more enjoyable.
- **Reminders and Alerts:** Toothy sends reminders to:
 - Change your toothbrush or brush head every three months.
 - Brush at least twice a day.
 - Floss or clean interdentally daily.
 - Use mouthwash separately from brushing. [26]

WIGGLES BRUSH

Developed by Australian Unity, The Wiggles app turns tooth brushing into a fun and engaging activity for young children. Designed primarily for younger kids, the app features a catchy two-minute music video that makes the brushing routine more enjoyable.

Key Features:

- **Catchy Song and Video:** The app plays a lively song with lyrics that describe the brushing process, accompanied by a vibrant video showcasing a diverse group of children brushing their teeth.
- **Motivational Stickers:** Children can earn virtual stickers each time they complete a brushing session, adding an element of motivation and achievement.
- **Brushing Guidance:** While the app does not specifically guide where to brush, it encourages parents to ensure

their children brush all areas, top and bottom, inside and outside, left and right.

Development and Appeal

The app promotes healthy brushing habits for young children. Leveraging the charm of The Wiggles, Emma Watkins (The Yellow Wiggle), Lachy Gillespie (The Purple Wiggle), Simon Pryce (The Red Wiggle), and Anthony Field (The Blue Wiggle), encourages the preschoolers with their developmentally appropriate content and charismatic performances. [27-28]

Table 1: Frequency of Key Gamification Features in Reviewed Apps

Gamification Element	No. of Apps (n=17)	Interpretation
Timer (2-min brushing)	13	Core behavioral reinforcement
Rewards (points, badges, coins)	13	Strong motivator for children
Feedback (real-time/progress)	10	Moderately used; improves technique
Personalization (avatars/profiles)	11	Enhances engagement and ownership
Story/Narrative	12	Widely used for immersion
AR / Advanced Interaction	5	Emerging but not widely adopted
Social/Competition features	4	Least utilized element

Table 2: Technological Platform and Gamification Approach of Included Oral Health Applications

App Name	Platform (iOS/Android/Other)	Technology Type	Primary Target Group
Aquafresh Brush Time	Android	Mobile app (2D interactive media)	Children
Brush DJ	iOS & Android	Mobile health (mHealth) app	Children, adolescents
Brushing Hero	iOS & Android	Game-based learning app	Children
BrushMaster	Android/iOS (app-based)	Educational simulation app	Children
Brush Monster	Android & iOS	AR + smart toothbrush integration	Children
BrushEez Little Monsters	Mobile app (Android/iOS)	Animated interactive app	Children
Brush Up	Mobile platform	Sensor-based mobile app	Children
Chomper Chums	Android & iOS	Mobile game app	Children
Colgate Magik	Android & iOS	AR + smart toothbrush system	Children
Disney Magic Timer (Oral-B)	Android & iOS	Mobile gamified timer app	Children
GrinQuest	Mobile platform	Behavioral orthodontic app	Adolescents/orthodontic patients
Mimizaur Clean Teeth	Android/iOS	Animated educational app	Preschool children
Pokémon Smile	Android & iOS	AR-based mobile app	Children
ToothFairy	Mobile app	Gamified habit-tracking app	Children
Toothsavers Brushing Game	Android/iOS	Story-based educational game	Children
Toothy Toothbrush Timer	Android & iOS	Utility + tracking app	General users
Wiggles Brush	Mobile app	Video-based engagement app	Preschool children

DISCUSSION

The current review emphasizes the growing use of gamified mobile applications as cutting-edge supplements in oral health education, especially for enhancing children's motivation, engagement, and brushing habits. Gamification techniques like rewards, real-time feedback, narrative storytelling, augmented reality (AR), and personalization were widely used in all of the applications that were included to encourage brushing habits. These results are in line with well-established behavioral science theories, especially those pertaining to self-determination theory and reinforcement learning, which hold that behavior adoption is influenced by both intrinsic enjoyment and external rewards.

The predominance of fundamental behavioral reinforcement techniques like timers, rewards, and feedback systems is a crucial finding from this review. This is consistent with the results of a scoping review conducted by Moreira et al. [9], which found that the majority of oral health apps mainly concentrate on brushing frequency and duration, with little integration of more general oral health behaviors like dietary changes or adherence to dental appointments. The current study's findings are corroborated by Chen et al.'s [29] report that gamification components like progress tracking, rewards, and interactive feedback were the most frequently utilized elements across digital oral health interventions. Brush DJ showed the strongest alignment with evidence-based oral health recommendations among the reviewed applications, especially when it came to its integration of timed brushing, flossing reminders, and dental appointments. Its extensive worldwide usage and high user-reported motivation (88–92%) are in line with research by Underwood et al. [30], which shows that basic mobile health interventions can greatly enhance self-reported oral hygiene behavior. However, such applications frequently rely on user satisfaction metrics rather than clinical outcome validation, as noted in earlier literature, including the review by Kanoute et al. [31].

On the other hand, through AR and sensor-based feedback systems, apps like Pokémon Smile, Colgate Magik, and Brush Monster

show more sophisticated technological integration. By making brushing an immersive experience, these tools increase engagement. Studies assessing AR-based health interventions have reported similar results, indicating that immersive technologies enhance short-term engagement but do not provide strong evidence for long-term behavioral change. One recurrent issue with digital oral health interventions is the disconnect between engagement and long-term efficacy. Narrative-driven learning is further emphasized by game-based apps like Chomper Chums, Toothsavers Brushing Game, and Brushing Hero. In line with Mahmoudi et al. [32], who discovered that gamified interventions increase attention and participation, especially in pediatric populations, these platforms use storytelling and reward systems to boost motivation. Nevertheless, there is still little proof of their long-term clinical efficacy despite their robust motivational design. The fact that these applications primarily target pediatric populations, with few tools aimed at adults and adolescents, is another significant finding. There is a big gap in addressing lifelong oral health behaviors because only a few apps, like GrinQuest, incorporate gamification into orthodontic compliance. Although gamified interventions may be applicable to all age groups, their limited age focus restricts their generalizability.

A critical limitation identified across the reviewed applications is the lack of high-quality clinical validation. While many apps report improved motivation and engagement, very few are supported by randomized controlled trials or longitudinal studies assessing actual reductions in plaque levels, caries incidence, or sustained behavior change. This finding is consistent with Moreira et al. [9], who emphasized that most studies in this field rely on self-reported outcomes and short-term engagement metrics rather than objective clinical endpoints. Furthermore, although advanced technologies such as AR, smart toothbrush integration, and motion tracking are increasingly being incorporated, their adoption remains limited to a small number of applications. This indicates that while innovation in digital oral health tools is growing, their diffusion into mainstream evidence-based dental practice is still in the early stages.

Table 3: Identified Gaps and Limitations in Gamified Oral Health Applications

Domain	Observations from Reviewed Apps
Clinical Evidence	Majority of apps lack randomized controlled trials; rely on user feedback or developer data
Focus of Intervention	Primarily centered on toothbrushing (duration & technique)
Long-Term Effectiveness	Short-term engagement demonstrated; limited long-term follow-up studies
Personalization Depth	Basic customization (avatars, themes) but limited adaptive learning
Integration into Clinical Practice	Rarely integrated into dental clinical workflows
Behavioral Theory Application	Gamification elements used, but not always linked to established behavior change theories
Age Group Coverage	Strong focus on children; minimal tools for adolescents/adults
Social Interaction Features	Few apps include peer competition or social engagement
Technology Utilization	AR used in few apps; AI/adaptive systems largely absent
Standardization	No uniform metrics for evaluating effectiveness

CONCLUSION

Applications for gamified oral health show great promise for improving short-term brushing habits and motivation, especially in young people. Regarding long-term behavioral outcomes and clinical efficacy, there is still a dearth of evidence. With little integration of more comprehensive oral health practices, the majority of applications mainly concentrate on toothbrushing duration and engagement. Furthermore, their adoption in evidence-based dental care is limited by their lack of rigorous clinical validation and theoretical foundation. To maximize their clinical utility, future research should prioritize longitudinal evaluation, broaden their scope beyond pediatric users, and strengthen their integration with behavioral science frameworks.

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