ORIGINAL ARTICLE

Changes of oral health motivation and knowledge following the implementation of the android-based quitee educational application among children aged 8–11 years: a pre-experimental study

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ABSTRACT

Introduction: Motivation and oral health knowledge among elementary school children remain suboptimal. Interactive digital educational applications, such as the Android-Based Quitee Educational Application, have been developed as engaging learning tools for oral health through visuals, animations, and game-based elements that are appropriate for children's characteristics. This study aimed to evaluate changes in oral health motivation and knowledge following the implementation of the Android-Based Quitee Educational Application among children aged 8–11 years. **Methods:** This study employed a pre-experimental one-group pretest-posttest time-series design. The sample size was calculated using the Slovin formula, resulting in 126 participants selected through proportionate stratified random sampling from SD Negeri Tamamaung 1 Makassar. Oral health motivation and knowledge were measured before the intervention and at three post-intervention time points following the implementation of the Android-Based Quitee Educational Application. Data were analyzed using the Friedman test, followed by post hoc Wilcoxon signed-rank tests. **Results:** Oral health motivation and knowledge scores increased across all post-intervention assessments compared with baseline measurements. The median motivation score increased from 14.0 at pretest to 19.0 at the third posttest, whereas the median knowledge score increased from 9.0 to 12.0. All pairwise comparisons were statistically significant ($p<0.001$), with Wilcoxon effect sizes indicating large effects for motivation ($r=0.63–0.87$) and moderate-to-large effects for knowledge ($r=0.33–0.84$), demonstrating the magnitude of the observed improvements. **Conclusion:** The implementation of the Android-Based Quitee Educational Application was associated with significant improvements in oral health motivation and knowledge among elementary school children. However, the findings should be interpreted cautiously due to the absence of a control group.

KEYWORDS

Education, quitee, motivation, knowledge, oral health, children.

INTRODUCTION

Oral health is an essential component of general health and well-being, playing a vital role in children's growth, development, and overall quality of life. Oral diseases remain among the most prevalent non-communicable diseases worldwide, with dental caries being one of the most common chronic conditions affecting children. Untreated oral diseases may result in pain, discomfort, difficulty eating, sleep disturbances, impaired school performance, and reduced quality of life, thereby affecting children's overall development.[3–5]

In Indonesia, oral health problems among children remain a major public health concern. According to the Indonesian Health Survey (SKI) 2023, the prevalence of dental caries was 49.9% among children aged 5–9 years and 37.2%

among those aged 10–14 years. Local epidemiological data further indicate that dental caries remains highly prevalent in South Sulawesi and Makassar, with reported prevalence of 55.54% and 52.09%, respectively. Furthermore, the prevalence of dental caries among children aged 5–9 years reached 65.51%, highlighting that school-aged children continue to experience a substantial burden of oral diseases. These findings emphasize the need for effective preventive and promotive oral health interventions targeting elementary school children.[13]

Children aged 8–11 years were selected for this study because this age range represents a critical period for establishing lifelong oral health behaviors. According to Piaget's theory of cognitive development, children in this age group are in the concrete operational stage, during which they develop logical thinking, improved attention, and the ability to process concrete information systematically. These developmental characteristics enable children to understand health-related concepts more effectively and actively participate in interactive learning activities. Consequently, educational interventions delivered through digital applications that combine visual, auditory, and game-based learning components are considered appropriate for this age group.[14–16]

Knowledge and motivation are important determinants of oral health behavior. Adequate knowledge enables children to understand the importance of maintaining oral hygiene, whereas motivation encourages the consistent implementation of healthy oral hygiene practices. Previous studies have reported that many school-aged children continue to demonstrate inadequate oral health knowledge, low motivation to maintain oral hygiene, and inconsistent tooth-brushing practices, contributing to the persistence of preventable oral diseases. Therefore, educational interventions that improve both knowledge and motivation are essential for promoting sustainable oral health behaviors among children.[9–12]

Advances in digital technology have created new opportunities for health education. Android-based educational applications provide interactive learning experiences through visual content, animations, quizzes, and game-based activities that are attractive to children. Previous studies have demonstrated that digital educational applications can improve health knowledge, increase learning engagement, and enhance motivation when educational content is age-appropriate, interactive, and visually appealing.[17–20]

Conventional oral health education in elementary schools is generally delivered through lectures, printed leaflets, posters, or demonstrations. Although these methods can effectively convey health information, they often provide limited opportunities for active participation and may not maintain children's motivation throughout the learning process. In contrast, digital educational applications integrate multimedia content, interactive activities, immediate feedback, and gamification features that encourage children to participate actively and repeatedly in learning. These characteristics are expected to facilitate better knowledge retention and strengthen motivation.[21–23]

Although digital educational applications have increasingly been used in oral health promotion, previous studies have primarily evaluated improvements in oral health knowledge using conventional pretest-posttest designs. Evidence regarding their effects on both oral health motivation and knowledge assessed through repeated measurements over time remains limited. Furthermore, no published study has specifically evaluated the implementation of the Android-based Quitee Educational Application using a pre-experimental one-group pretest-posttest time-series design among elementary school children. Therefore, this study aimed to evaluate changes in oral health motivation and knowledge following the implementation of the Android-based Quitee Educational Application among children aged 8–11 years.[28–30]

METHODS

This study employed a pre-experimental one-group pretest-posttest time-series design to evaluate changes in oral health motivation and knowledge following the implementation of the Android-Based Quitee Educational Application. The study was conducted among students aged 8–11 years at SD Negeri Tamamaung 1 Makassar, Indonesia. This age group was selected because it represents a developmental stage characterized by increasing cognitive ability, curiosity, and receptiveness to interactive learning. Furthermore, children in this age range remain at relatively high risk of dental caries, making them an important target population for oral health promotion and preventive education.[29]

The study population consisted of 183 eligible students. The minimum sample size was determined using the Slovin formula because the population was finite and well-defined, and no previous studies evaluating the Quitee educational application were available to provide an effect size estimate for a formal power-based sample size calculation. As this was an exploratory pre-experimental study, the Slovin formula was considered an appropriate approach for estimating the minimum required sample size. Based on this calculation, a minimum sample of 126 participants was obtained. Participants were selected using proportionate stratified random sampling to ensure proportional representation of children aged 8, 9, 10, and 11 years. Stratification by age was performed because cognitive development, learning ability, and comprehension of health education differ across these age groups and may influence children's understanding of the educational content and their responses to the intervention. Although age-specific comparisons were not the primary objective of this study, proportional representation of each age group improved the representativeness of the study sample. No participants withdrew during the study; therefore all 126 participants completed the intervention and all scheduled assessments.

The study employed two research instruments: an oral health knowledge questionnaire and an oral health motivation questionnaire. Both questionnaires underwent validity and reliability testing using data from 35 respondents before the main study. In addition, the oral health motivation questionnaire underwent content validation through expert judgment by four experts, consisting of two thesis supervisors and two thesis examiners with expertise in Dental Public Health and Health Education. The experts evaluated the relevance, clarity, and appropriateness of each questionnaire item for children aged 8–11 years. The oral health motivation questionnaire demonstrated good internal consistency, with a Cronbach's alpha coefficient of 0.75, while the oral health knowledge questionnaire demonstrated a Cronbach's alpha coefficient of 0.80.

The Android-Based Quitee Educational Application was developed by the researcher in collaboration with an information technology (IT) development team as an interactive educational medium for elementary school children. The application includes three educational features, namely mini-games, puzzles, and quizzes, which provide educational content on dental plaque, dental caries, dentin hypersensitivity, halitosis, proper tooth-brushing techniques, the appropriate use of toothpaste, and dental floss. However, in the present study, only the mini-game feature was used as the intervention. Prior to implementation, the application underwent functional testing by the IT development team to verify that all application functions, navigation systems, and interactive features operated properly. In addition, usability testing was conducted among 15 children from the target age group to evaluate the application's ease of use, clarity of instructions, navigation, visual attractiveness, and overall user experience. The usability testing demonstrated that the application was easy for children to use and suitable for implementation in the main study.

Baseline measurements of oral health motivation and knowledge were obtained before the intervention using the respective questionnaires (pretest). Participants subsequently received oral health education using the mini-game

feature of the Android-Based Quitee Educational Application over three consecutive weeks, with three learning sessions per week, resulting in a total of nine sessions. Each session lasted approximately 15–30 minutes. Oral health motivation and knowledge were reassessed after the first week (Posttest 1), the second week (Posttest 2), and the third week (Posttest 3).

These repeated assessments were performed to monitor changes over time and evaluate the consistency of participants' responses following repeated exposure to the intervention, thereby strengthening the time-series design. To minimize the influence of extraneous factors, all participants received the same educational intervention using the same version of the Android-Based Quitee Educational Application in the same school environment. The intervention was delivered under the supervision of the same research team using standardized procedures, instructions, educational materials, and session duration throughout the study. In addition, all participants completed the same questionnaires under similar classroom conditions at each assessment point to ensure consistency in data collection.

Data were analyzed using IBM SPSS Statistics version 30. Descriptive statistics were used to summarize participant characteristics and questionnaire scores. Data normality was assessed using the Kolmogorov–Smirnov test. Because the data were not normally distributed ($p < 0.05$), non-parametric statistical analyses were performed. Changes in oral health motivation and knowledge across the four assessment time points were analyzed using the Friedman test, followed by pairwise comparisons using the Wilcoxon signed-rank test with Bonferroni correction. Effect sizes (r) were calculated to determine the magnitude of the observed changes. Statistical significance was established at $p < 0.05$.

RESULTS

The demographic characteristics of the study participants based on gender and age are presented in Table 1.

Table 1 Respondent characteristics based on gender and age

Variable	Category	n(%)	Mean ± SD
Gender	Male	62 (49.2)	9.59 ± 1.11
	Female	64 (50.8)	
Age	8 years	28 (22.2)	
	9 years	29 (23.0)	
	10 years	36 (28.6)	
	11 years	33 (26.2)	

The study included 126 children aged 8–11 years. Female participants accounted for 50.8% of the sample, while male participants accounted for 49.2%. The mean age of the participants was 9.59 ± 1.11 years. The distribution of participants across age groups was relatively balanced, indicating adequate representation of each age category included in the study.

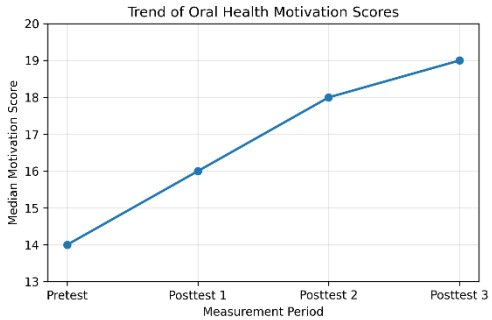

Figure 1. Changes in oral health motivation scores across the four assessment time points.

Figure 1 illustrates the trend in oral health motivation scores across the four assessment time points. A progressive increase in the median motivation score was observed from 14 at pretest to 16 at posttest 1, 18 at posttest 2, and 19 at posttest 3, indicating a consistent improvement in children's oral health motivation throughout the intervention period.

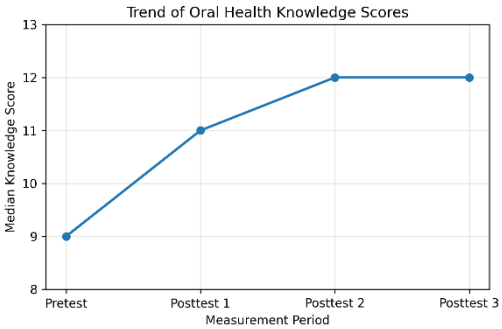

Figure 2. Changes in oral health knowledge scores across the four assessment time points.

Figure 2 shows the trend in oral health knowledge scores across the four assessment time points. The median knowledge score increased from 9 at pretest to 11 at posttest 1 and reached 12 at posttest 2, remaining stable at posttest 3. This finding suggests that oral health knowledge improved following the intervention and was maintained until the end of the study.

Table 2. Friedman test for dental health motivation

Variable	Pretest Median (IQR)	Posttest 1 Median (IQR)	Posttest 2 Median (IQR)	Posttest 3 Median (IQR)	χ^2	P-value
Motivation	14.0 (4.0)	16.0 (2.25)	18.0 (2.0)	19.0 (0.0)	343.3	<0.001

*Friedman Test ($p < 0.05$).

The Friedman test revealed a statistically significant difference in motivation scores across the four measurement periods ($\chi^2 = 343.3$; $p<0.001$). The median motivation score increased from 14 at pretest to 16 at posttest 1, 18 at posttest 2, and 19 at posttest 3, indicating a progressive improvement in children's oral health motivation throughout the intervention period. Changes in oral health knowledge scores across the four measurement periods were analyzed using the Friedman test. The results are presented in Table 3.

Table 3. Friedman test for oral health knowledge

Variable	Pretest Median (IQR)	Posttest 1 Median (IQR)	Posttest 2 Median (IQR)	Posttest 3 Median (IQR)	χ^2	P-Value
Knowledge	9.0 (2.0)	11.0 (1.0)	12.0 (1.0)	12.0 (0.0)	266.2	<0.001

*Friedman Test ($p < 0.05$).

The Friedman test showed a statistically significant difference in knowledge scores across the four measurement periods ($\chi^2 = 266.2$; $p < 0.001$). The median knowledge score increased from 9 at pretest to 11 at posttest 1 and 12 at both posttest 2 and posttest 3, indicating an improvement in children's oral health knowledge following exposure to the Quitee educational application. Post hoc pairwise comparisons were conducted using the Wilcoxon Signed Rank Test with Bonferroni correction to identify differences between measurement periods. The results are presented in Table 4.

Table 4. Post hoc pairwise comparisons for motivation scores

Comparison	Z	P-value	Effect Size (r)	Interpretation
Pretest vs Posttest 1	-9.623	<0.001	0.86	Large
Pretest vs Posttest 2	-9.616	<0.001	0.86	Large
Pretest vs Posttest 3	-9.761	<0.001	0.87	Large
Posttest 1 vs Posttest 2	-9.487	<0.001	0.76	Large
Posttest 1 vs Posttest 3	-9.232	<0.001	0.82	Large
Posttest 2 vs Posttest 3	-7.104	<0.001	0.63	Large

*Wilcoxon Signed Rank Test with Bonferroni correction (α = 0.0083)

Post hoc pairwise comparisons demonstrated statistically significant differences between all measurement periods for motivation scores ($p < 0.001$). The effect sizes ranged from 0.63 to 0.87, indicating large effects across all comparisons. The largest effect was observed between pretest and posttest 3 ($r = 0.87$), suggesting substantial improvements in motivation following repeated exposure to the Quitee educational application. Post hoc pairwise comparisons for oral health knowledge scores are presented in Table 5.

Table 5. Post hoc pairwise comparisons for knowledge scores

Comparison	Z	P-value	Effect Size (r)	Interpretation
Pretest vs Posttest 1	-8.185	<0.001	0.73	Large
Pretest vs Posttest 2	-9.389	<0.001	0.84	Large
Pretest vs Posttest 3	-9.389	<0.001	0.84	Large
Posttest 1 vs Posttest 2	-6.852	<0.001	0.61	Large
Posttest 1 vs Posttest 3	-7.567	<0.001	0.67	Large
Posttest 2 vs Posttest 3	-3.718	<0.001	0.33	Medium

*Wilcoxon Signed Rank Test with Bonferroni correction (α = 0.0083)

Post hoc pairwise comparisons also demonstrated statistically significant differences between all measurement periods for knowledge scores ($p < 0.001$). Effect sizes ranged from 0.33 to 0.84. Large effects were observed for most comparisons, while the comparison between posttest 2 and posttest 3 showed a moderate effect size ($r = 0.33$), indicating that improvements in knowledge tended to stabilize during the later stages of the intervention.

DISCUSSION

This study evaluated changes in oral health motivation and knowledge among children aged 8–11 years following the implementation of the Android-based Quitee educational application. As presented in Table 4, oral health motivation scores increased progressively across all measurement periods. The median motivation score increased from 14.0 at pretest to 16.0 at posttest 1, 18.0 at posttest 2, and 19.0 at posttest 3. The Friedman test demonstrated a statistically significant difference across the four measurement periods ($\chi^2 = 343.258$; $p < 0.001$), indicating that motivation scores changed significantly over time following exposure to the Quitee educational application.

The post hoc analyses shown in Table 4 further demonstrated statistically significant differences between all measurement periods ($p<0.001$). Effect sizes ranged from 0.63 to 0.87, indicating large effects across all pairwise comparisons. The largest effect size was observed between pretest and posttest 3 ($r = 0.87$),

suggesting that the greatest change in motivation occurred after repeated exposure to the intervention throughout the study period.[17-25]

Similarly, oral health knowledge scores improved across all measurement periods. As shown in Table 5, the median knowledge score increased from 9.0 at pretest to 11.0 at posttest 1 and reached 12.0 at both posttest 2 and posttest 3. The Friedman test revealed a statistically significant difference across the four measurement periods ($\chi^2=266.129$; $p<0.001$). Furthermore, post hoc analyses presented in Table 5 demonstrated statistically significant differences between all measurement periods, with effect sizes ranging from 0.33 to 0.84. Large effect sizes were observed for most comparisons, while the comparison between posttest 2 and posttest 3 showed a moderate effect size ($r = 0.33$), suggesting that improvements in knowledge tended to stabilize during the later stages of the intervention.

The observed improvements in oral health motivation and knowledge may be explained by established theories of learning and behavior change. According to Self-Determination Theory, motivation is enhanced when learning activities promote engagement, enjoyment, and a sense of competence, particularly when learners experience autonomy, competence, and relatedness.[26,27] The interactive mini-game feature of the Quitee educational application may have supported children's intrinsic motivation by providing immediate feedback, repeated practice, and enjoyable learning experiences. Furthermore, Social Cognitive Theory suggests that repeated exposure and reinforcement facilitate knowledge acquisition and retention.[28] The repeated educational sessions provided by the Quitee application may therefore have strengthened children's understanding of oral health concepts and encouraged sustained motivation throughout the intervention period.

The findings of this study are consistent with previous studies reporting that digital educational interventions may be associated with improvements in children's health knowledge and learning outcomes. Alqahtani et al. reported that mobile health applications may support knowledge acquisition and health-related behavior change through accessible educational content. Similarly, Hapsari et al. found that digital health education interventions were associated with improvements in knowledge and learning outcomes in school-aged children. Previous studies in oral health education have also reported positive changes in oral health knowledge and behavior following the implementation of mobile-based educational interventions.[15–25] The significant improvements observed in Tables 4 and 5 are therefore consistent with the findings of earlier studies investigating digital oral health education.

An interesting finding was the different pattern of change between motivation and knowledge. Motivation scores continued to increase throughout the intervention period, whereas knowledge scores increased rapidly and then tended to stabilize at later measurements. As shown in Table 5, the comparison between posttest 2 and posttest 3 yielded a smaller effect size than earlier comparisons. This finding may indicate that participants had already achieved relatively high knowledge scores by the second posttest, resulting in less opportunity for further improvement during subsequent assessments. This pattern may also reflect a ceiling effect, whereby many participants had already achieved high knowledge scores by the second posttest, limiting the potential for additional score increases despite continued exposure to the educational intervention.

Although improvements were observed following the intervention, the present study employed a one-group pretest-posttest time-series design without a comparison group. Consequently, the findings should be interpreted as an association between exposure to the Quitee educational application and improvements in oral health motivation and knowledge rather than evidence of a direct causal effect.

Several limitations should be considered when interpreting these findings. First, the absence of a control group limits the ability to establish causal

relationships between the intervention and the observed outcomes. Second, repeated measurements may have introduced testing effects because participants became increasingly familiar with the questionnaire items over time. Third, motivation and knowledge were assessed using self-reported questionnaires, which may be subject to response bias. Fourth, the study was conducted in a single elementary school, which may limit the generalizability of the findings to other populations and settings. Finally, the study did not control for external influences, such as oral health information obtained from teachers, parents, social media, or other educational resources during the intervention period, which may have affected participants' motivation and knowledge.

Despite these limitations, the findings suggest that the implementation of the Android-based Quitee educational application was associated with improvements in oral health motivation and knowledge among children aged 8–11 years. Future studies using randomized controlled trials or comparison groups are needed to determine the effectiveness of Quitee relative to other educational approaches and to identify which specific application components contribute most to the observed outcomes.

CONCLUSION

The implementation of the Android-based Quitee educational application was associated with improvements in oral health motivation and knowledge among children aged 8–11 years. Positive changes in both outcomes were observed across the intervention period, indicating that the Quitee application may serve as a useful educational tool for supporting oral health learning among school-aged children.

The implication of this study is that interactive digital educational applications may be incorporated into school-based oral health promotion programs to enhance children's motivation and knowledge regarding oral health. However, because this study employed a pre-experimental design without a control group, further studies using randomized controlled trials or comparison groups are required to confirm these findings and evaluate the effectiveness of Quitee relative to other educational approaches.

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Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Universitas Muslim Indonesia (UMI) with approval number 631/A.1/KEP-UMI/VIII/2025, issued on August 22, 2025.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Consent was also obtained from parents or legal guardians of the participating children prior to data collection.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical considerations involving child participants.

Conflicts of Interest: The authors declare no conflict of interest, either financial or non-financial, that could have influenced the results of this study.

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