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Engaging Pedagogy: Evaluating an interactive oral health education for preschoolers in Indonesia

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Abstract

Introduction: Dental caries remains a major public health problem among preschool children in Indonesia, with prevalence exceeding 76% according to national data. The low level of treatment and limited early oral health education exacerbate the negative impact of caries on children's growth and development. Community service project aimed to improve toothbrushing knowledge and skills among children aged 2–5 years through an edutainment-based approach using multimedia storytelling and an interactive board game**.**

Method: The educational program was conducted in a private preschool in Surabaya, involving 106 children. The intervention consisted of two sessions: multimedia storytelling featuring tooth characters and healthy versus unhealthy food, and an interactive board activity where children categorized food items as tooth-friendly or harmful. Evaluation was carried out by observing children's toothbrushing performance on a typodont model using a standardized checklist.

Results: Showed progressive improvement in brushing proficiency with age, ranging from 71% in 2-year-olds to 90% in 5-year-olds. Gender differences were also observed, with girls performing better (85%) than boys (81%). The findings demonstrate that non-didactic, play-based learning methods such as storytelling and interactive games are more effective than traditional approaches in promoting oral health behaviors among young children.

Conclusion: This program may serve as a model for enhancing the Indonesian School Dental Health Program (UKGS) with age-appropriate and engaging educational strategies.

Keywords: Community Service; Dental Caries; Storytelling; Interactive Board; Preschool Children

1. Introduction

Dental Caries stands as a chronic infectious disease that emerges as one of the most widespread serious public health problems affecting young children throughout the world [1]. The Basic Health Research (Riskesdas) from 2018 demonstrated that dental caries reached a disturbing 90.2% prevalence in five-year-old children. A systematic review and meta-analysis conducted confirmed these findings by reporting a 76% dental caries prevalence in Indonesian children [2].

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The severe impact of the disease in Indonesia matches the high prevalence rates. The def-t index establishes a vital measurement system to assess decayed teeth and teeth extracted because of caries and filled primary teeth. The def-t scores from West Java regions exceeded 10.03 and 10.74 according to research conducted in these areas while the World Health Organization classifies such scores as "very high" when the index exceeds 6.6 [3]. The treatment gap for 5-year-old children with oral health problems becomes evident through Riskesdas 2018 data which reveals that despite oral health issues affecting over half of this age group only 9.5% receive professional care [4]. The untreated dental caries creates extensive consequences which reach beyond the oral health area. Dental caries causes extensive dental pain that results in eating disruptions and sleep disturbances and poor nutrition along with detrimental effects on body development [1]. Long-term infection and inflammation pose dangers to children's overall health status [4]. Dental pain causes significant functional and psychosocial effects on children which results in decreased focus leading to lower school grades and more absences and a degraded life quality [1, 4].

During this developmental stage children form dietary patterns and hygiene practices that will persist through their teenage years and into their adult lives. The main objective of early oral health education exceeds basic information sharing because it targets the development of long-lasting positive health practices [5]. The educational approach for this age group must consider the major developmental transformations which occur between two and five years old [5, 6]. The stage of development restricts children from executing health understanding and complex tasks like brushing teeth because they lack the capacity to follow multi-step instructions [1, 5]. The developmentally suitable approach in pedagogy requires educational materials and teaching strategies that match the natural learning abilities of the target student group.

Young children show poor response to traditional health education methods that include lectures and pamphlet distribution according to research [7]. Young children learn best through active participation in playful activities and exploration while engaging with their environment instead of receiving information passively [6]. Educational methods must transition toward child-centered and innovative teaching methods. Storytelling stands as a very effective instrument as children at an emotional and cognitive level understand health messages through this culturally universal teaching method which makes them more memorable and relatable and persuasive [8, 9]. Studies demonstrate that interactive educational content which includes digital presentations and games and puzzles delivers exceptional results for teaching dental hygiene to children [10, 11]. The educational method of game-based learning transforms learning into an enjoyable activity which encourages students to actively participate while delivering instant feedback to improve their knowledge retention rates [10]. Through gameplay children can physically handle objects and make decisions which converts abstract ideas into tangible concepts that reinforce learning objectives through an effective body-centered experience.

This paper details a community service project that emerged as a solution to the critical need for suitable oral health solutions for Indonesian preschool children. The project goals to create and evaluate an educational counselling program using multimedia stories and an interactive board for enhancing oral health understanding and competencies of 2–5-year-old preschool children in Surabaya Indonesia.

2. Material and Methods

This research adopted a one-group post-test only design because it serves as a typical approach for initial program assessments in quasi-experimental studies. The project operated from a private preschool in Surabaya which stands as Indonesia's second-largest urban center. The project did not document the educational environment's characteristics including curriculum structure together with student-teacher ratio and health policies within the school framework.

2.1. Participant Characteristics

The research involved 106 preschool children (N=106) from a private educational institution. The research participants spanned the complete preschool age range from 2 to 5 years old, consisting of 48 girls and 52 boys. The project did not identify any exclusion criteria that would prevent students with developmental delays or physical disabilities from joining the activities.

2.2. The Educational Intervention

The intervention followed "edutainment" and active learning principles which aim to teach through enjoyable activities [12]. The educational program included two essential components which project facilitators delivered to students during a classroom session.

2.3. Component 1: Multimedia Stories

The Educational program started with the delivery of multimedia stories (figure 1.) that were suitable for the children's age group. The designed stories used simple oral health principles to deliver the information in an interactive way. The animated characters in the stories used tooth characters and food personas to present two opposing food categories which included healthy food items like fruits and vegetables and milk alongside unhealthy food items such as candies and cookies and sugary sodas. The storyline taught children about how the toothbrush as a protector removes the food debris. In this storyline, how to brush your teeth were explicitly taught. The educational content included multimedia elements such as animated graphics and character sounds and background noises to engage young children while improving their understanding and memory of essential information[13].

Figure 1 Multimedia stories with animated Characters

2.4. Component 2: Interactive Board

The second element consisted of a hands-on interactive board that served as a gaming platform. The board featured two distinct parts showing both a contented healthy tooth and an unhappy carious tooth (figure 2.). A selection of food images along with three-dimensional food models was provided to children during the activity. Each food item was assigned to either the "healthy for teeth" or "unhealthy for teeth" section by children in their groups or alone when they approached the board. Through this activity children could enhance their understanding of the concepts which were presented in the multimedia stories by performing physical movements. Through this activity facilitators could offer prompt corrective guidance within a playful setting as children participated actively while interacting with their peers and solved problems.

Figure 2 The board featured two distinct parts showing both a contented healthy tooth and an unhappy carious tooth

2.5. Outcome Measurement: Assessment of Tooth Brushing Proficiency

The main goal of this intervention was for the child to show proper tooth brushing skills. The assessment took place right after the educational session ended. A trained assessor watched each child separately as they brushed a large dental model (typodont) during the task.

A procedural checklist (table 1.) served to standardize the assessment process of "correct technique." Although a validated specific instrument was not used the assessment criteria were built from essential principles of proper tooth brushing. A child demonstrated proficiency through the execution of a specific set of predetermined essential steps which included using the correct amount of toothpaste on the brush, brush position, cleaning all three tooth surfaces, and employing gentle circular or back-and-forth motions instead of forceful scrubbing (figure 3.).

Table 1 Procedural Checklist of Proficiency

N	Skill Step	Expected Behavior Description	Score (0 = not performed, 1 = performed)
1	Applying toothpaste	Uses a pea-sized amount of toothpaste	0 / 1
2	Correct brush position	Places the toothbrush at an angle of approximately 45° toward the gumline	0 / 1
3	Brushing motion	Uses circular/gentle back-and-forth movements (not hard scrubbing)	0 / 1
4	Outer tooth surfaces	Brushes all outer surfaces of the teeth	0 / 1
5	Inner tooth surfaces	Brushes all inner surfaces of the teeth	0 / 1
6	Chewing surfaces	Brushes all chewing surfaces of the teeth	0 / 1
7	Brushing duration	Brushes for at least ±1 minute (observed using a simple timer)	0 / 1

Maximum Score = 7; Proficient: score ≥ 5 (e.g., ≥70% of steps performed correctly); Not proficient: score < 5.

Figure 3 Child demonstrating correct toothbrushing steps: appropriate toothpaste amount, proper brush positioning, cleaning of all tooth surfaces, and gentle motions

2.6. Data Analysis

The post-intervention assessment data underwent analysis using descriptive statistics. The main analysis involved determining which percentage of children from each specific age group (2, 3, 4, and 5 years) demonstrated proficiency in the correct tooth brushing technique. The study results present descriptive data about participant achievement after the educational

3. Results and Discussion

3.1. Demographic data by Age and Gender Group

The demographic data involved 106 children from four age and gender groups. The data describes the number of participants divided by age and gender. The data is presented in Table 2, which provides a clear visualization of the participants' demographics.

Table 2 Demographic data by Age and Gender Group (N=106)

Age Group (Years)	Number of Female (Fn) (Fn/n*100%)	Number of Male (Mn) (Mn/n*100%)	Number of Participants (n)
2	14 (67%)	7 (33%)	21 (100%)
3	9 (39%)	14 (61%)	23 (100%)
4	13 (42%)	18 (58%)	31 (100%)
5	12 (39%)	19 (61%)	31 (100%)
Total	48 (45%)	58 (55%)	106 (100%)

3.2. Post-Intervention Proficiency in Tooth Brushing Technique by Age and Gender Group

The assessment of tooth brushing proficiency after the educational intervention involved 106 children from four age and gender groups. According to the results, children's age and gender showed a clear correlation with their ability to correctly perform the demonstrated teeth brushing technique.

The main study result shows how proficiency rises progressively as children grow older and females are more consistent and develop faster than males in the 2–5-year age group. The results are summarized in table 3 and 4, which provides a clear visualization of this age-dependent gradient and gender differences in skill acquisition.

Table 3 Post-Intervention Tooth Brushing Proficiency by Age Group (N=106)

Age Group (Years)	Number of Participants (n)	Proficient (P) (P/n*100%)
2	21	15 (71%)
3	23	18 (78%)
4	31	27 (87%)
5	31	28 (90%)
Total	106	N/A

Table 4 Post-Intervention Tooth Brushing Proficiency by Gender Group (N=106)

Age Group (Years)	Number of Female (Fn)	Proficient of Female (PFn) (PFn/Fn*100%)	Number of Male (Mn)	Proficient of Male (PMn)(PMn/Mn*100%)
2	14	10 (71%)	7	5 (71%)
3	9	8 (89%)	14	10 (71%)
4	13	12 (92%)	18	15 (83%)
5	12	11 (92%)	19	17 (89%)
Total	48	41 (85%)	58	47 (81%)

Table 2 shows that of the total data from 106 participants, there were more males than females, with males accounting for 55% and females accounting for 45%. The most important discovery from this research reveals that chronological age directly correlates with children's ability to execute tooth brushing correctly in table 3. The recorded proficiency rates from 71% at age two to 90% at age five show a direct relationship with the established developmental patterns of early childhood. The educational intervention achieved its objectives but its success depended significantly on each child's developmental level for performing complex tasks.

The cognitive development of essential abilities follows a specific pattern according to observed results. Children aged two primarily learn by imitating directly and their ability to follow basic one-step commands is well established [5]. Their 71% success rate is commendable but likely reflects a capacity for mimicry of the gross movements of brushing rather than a conceptual understanding of the sequence or its purpose. Their short attention span makes it impossible for them to understand abstract concepts about hygiene or future consequences such as developing cavities. The cognitive development of children at three years old allows them to follow two-step instructions and understand symbolic thinking which enables them to connect brushing away "sugar bugs" to a concrete action [14, 15]. The improvement in performance to 78% indicates that children are better able to understand and execute slightly more advanced information sets. The significant improvement in performance among four- and five-year-olds (87% and 90% respectively) matches the development of advanced cognitive abilities. Older children demonstrate better understanding of sequential steps and cause-effect relationships ("eating candy without brushing makes teeth sick") along with better attention span and developing literacy abilities that help them maximize story-based learning [15]. Their high success rate demonstrates that their cognitive system has developed a strong structure for understanding and remembering the multiple steps required for proper tooth brushing.

This study revealed two noteworthy findings. First, girls outperform boys in all age groups. Second, age is not the only factor influencing proficiency. The topic of gender equality in life has always been of international importance. Many researchers have focused on differences in investment and development between boys and girls in terms of health and education. Previous studies have suggested that girls from only-child families may outperform boys in cognitive development. Without sibling competition and with undivided parental attention, girls may exhibit stronger cognitive development outcomes than boys. The results of this study are based on the theory that girls may have an advantage in early cognitive performance in supportive and low-competition environments, particularly when they are the sole recipients of household attention and stimulation [16].

The results demonstrate that developmental readiness acted as a barrier to the intervention's success. The Educational program demonstrates general success yet its standardized delivery to different developmental stages may have been less than optimal. The program objectives seemed too advanced for the youngest participants yet too simple for the oldest participants. The study indicates that the population requires different oral health education programs rather than a single standardized approach. Such a program should operate through developmental stages in its curriculum. Two-year-olds should experience sensory exploration and parental guidance during familiarization processes and simple imitation activities. The educational focus for three- and four-year-olds should move toward learning basic brushing sequences and brush purpose. Instruction for five-year-olds should include teaching advanced techniques as well as independent brushing skills and comprehensive understanding of diet-hygiene connections to oral health.

3.3. The Power of Play: Efficacy of Multimedia Storytelling and Interactive Engagement

The successful skill achievement demonstrates the effectiveness of project pedagogy which uses active methods to teach children who face the most developmental challenges. The project establishes its intervention through multimedia storytelling and interactive play according to modern understanding of early childhood learning.

The success of multimedia stories as an educational tool results from three main factors. Children naturally respond to narratives because these stories engage their minds and form emotional bonds with health information [13]. The use of personified teeth characters with hero and villain roles between toothbrush and sugar bugs transforms complex oral hygiene into a concrete and memorable story. The addition of education “how to brush correctly” was also added into the multimedia elements which included animation and sound improved understanding because students received information through both visual and auditory channels. The combination of visual and auditory learning methods (dual-coding approach) reduces memory load in children's developing working memory so they can better process and remember new information [14].

The interactive board function converted passive learning into hands-on engagement that supported the storytelling narrative. The established body of evidence shows how game-based learning increases children's motivation along with their participation and knowledge retention when teaching health education content[10]. The physical process of

placing food into health and unhealthy categories helps children effectively remember the dietary lessons they learn. Active learning which requires students to perform tasks instead of listening produces better and more enduring knowledge retention[17]. Educational experiences for preschoolers should remain directly linked to playful activities according to this project's successful results.

3.4. Implications for Community Oral Health Education and Policy in Indonesia

This study acts as an important example of a successful concept even though it has certain restrictions. The study shows that affordable educational tools based on multimedia and interactive methods can effectively teach basic oral health skills in Indonesian preschools. This research holds essential value for the development of national public health programs.

The Indonesian School Oral Health Program (UKGS) serves as the fundamental framework for children's public oral health initiatives [18]. The current methods of the program depend on health talks and demonstrations which might not achieve optimal results with young children. The project's positive outcomes indicate that UKGS would gain advantages from using contemporary evidence-based educational tools such as animated stories and interactive games in its preschool programs. Such an educational strategy would most likely improve student involvement together with better achievement results in its programs.

The main discovery about developmental readiness must guide both policy-making and program development. The development of public health programs should create multiple educational materials and activities that adapt to various developmental levels of preschool children. The educational materials must be designed with specific developmental needs of children in mind to match their cognitive and motor abilities at the 2, 3, 4, and 5-year marks so that learning goals remain suitable for each age group

4. Conclusion

The oral health education program run by this community service project, aimed at preschool children, achieved several important results. The multimedia storytelling intervention combined with interactive board games significantly improved toothbrushing skills in 106 children aged 2-5 years after the program was completed. The main findings show that the success rate of children increased gradually with age, with 2-year-olds achieving 71% toothbrushing skills, while 5-year-olds achieved 90%. In addition, in terms of gender differences, girls achieved an 85% success rate, while boys achieved 81% in the average category for all ages.

Children's ability to learn and perform tasks is highly dependent on their cognitive and fine motor development stages appropriate for their age and gender, based on the strong relationship observed. This study strongly supports non-didactic interactive health promotion methods for this age group as it shows that storytelling and game-based learning are effective pedagogical tools.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors declare no conflicts of interest related to the publication of this manuscript.

Statement of ethical approval

Ethical Approval was obtained from the individual participant included in this study.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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