The Use of Pop-Up Books Successfully Improved Oral and Dental Health Knowledge Among Preschool Children

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ABSTRACT
Dental and oral health play a crucial role in supporting children's growth, nutrition, and overall well-being. Preschool children are particularly vulnerable to dental problems due to limited independence in maintaining oral hygiene and frequent consumption of sugary foods. Innovative educational media are needed to improve oral health knowledge at an early age. This study aimed to determine the effect of Pop-Up Book media on dental and oral health knowledge among preschool children at RA Al-Ikhlas Tuban. A pre-experimental one-group pretest–posttest design was employed involving 43 preschool children selected through total sampling. Respondents completed a pretest, received oral health education using Pop-Up Book media, and completed a posttest seven days later. Knowledge was measured using an ordinal scale and categorized as good, fair, or poor. Data were analyzed using the Wilcoxon Signed-Rank Test with a significance level of $p < 0.05$. Before the intervention, most respondents had poor knowledge (79%), with none achieving a good category. After the Pop-Up Book education, 81% of respondents reached the good category, while only 5% remained in the poor category. The median knowledge score increased from 40.6 (7.6–74.6) to 100 (53.8–100). The Wilcoxon test showed a significant difference between pretest and posttest scores ($p = 0.000$). In conclusion, pop-up book media significantly improved dental and oral health knowledge among preschool children. interactive visual media are effective tools for early childhood oral health education.
Keywords: pop-up book; oral health education; preschool children' dental knowledge; pre-experimental design

INTRODUCTION
Dental and oral health constitute an integral part of overall well-being and are closely linked to children's physical growth, cognitive development, and psychosocial functioning. The oral cavity plays a central role in mastication, swallowing, speech, and facial aesthetics; therefore, disturbances in dental structures can have far-reaching consequences. In early childhood, when nutritional intake is critical for optimal growth, any impairment in chewing ability may reduce the efficiency of nutrient absorption, potentially affecting immune competence, metabolic processes, and developmental milestones [1]. Thus, maintaining healthy teeth and oral tissues is essential not only for preventing disease but also for supporting broader aspects of child development.

Globally, dental health problems; particularly dental caries remain among the most prevalent chronic conditions in childhood. The World Health Organization reports that 60–90% of children worldwide experience dental caries, making it one of the most widespread non-communicable diseases in the pediatric population [2]. In Indonesia, the situation mirrors global trends, with national data from the Basic Health Research (Riskesdas) indicating a prevalence of 57.6% among children [3]. Alarmingly, early childhood caries (ECC) is highly prevalent, with rates reaching 93% among children aged 5–6 years and an average def-t score of 8.43, reflecting severe caries activity and extensive destruction of primary teeth [4]. These epidemiological patterns highlight the urgent need for effective preventive strategies and early interventions.

The burden of dental caries is also evident at the provincial level. In East Java, dental and oral health problems among children remain substantial, with Tuban Regency reporting a prevalence of 45.79% [5]. Such high rates indicate persistent gaps in oral health literacy, preventive behaviors, and access to dental services. If left untreated, dental caries can progress to pulpitis, abscess formation, and systemic infection. Beyond physical symptoms, caries can cause chronic pain, difficulty chewing, sleep disturbances, reduced concentration, and impaired school performance. These consequences collectively diminish children's quality of life and may hinder their social participation and emotional well-being [6].

Preschool age represents a critical developmental window in which children transition from primary to permanent dentition. During this period, children typically lack the cognitive maturity and motor skills required to maintain proper oral hygiene independently. They are also more likely to consume sugary snacks and beverages, often without adequate parental supervision. Limited knowledge among parents and caregivers further exacerbates the risk of caries, as early preventive practices; such as tooth-brushing supervision, dietary control, and routine dental check-ups are frequently overlooked [7]. Consequently, oral health education during early childhood becomes essential for shaping foundational knowledge, attitudes, and behaviors that can persist throughout life.

Traditional oral health education methods for children often rely on didactic lectures, which may not be developmentally appropriate for young learners. Preschool children typically have short attention spans, high curiosity, and a preference for visual and tactile stimuli. Lecture-based approaches may fail to engage them effectively, resulting in poor comprehension and limited retention of information. In contrast, visual learning tools have been shown to enhance attention, motivation, and cognitive processing in early childhood education [8]. Among these tools, the Pop-Up Book stands out as an interactive, three-dimensional medium that stimulates sensory engagement and facilitates conceptual understanding. Pop-Up Books present images that rise or unfold when pages are opened, creating a dynamic learning experience that captures children's interest and encourages active participation [9].

The use of Pop-Up Books aligns with contemporary health promotion strategies that emphasize child-centered learning, multisensory engagement, and culturally appropriate educational materials. Moreover, integrating Pop-Up Books into oral health education supports national initiatives such as *Indonesia Bebas Karies 2030*, which prioritize early prevention, community-based education, and innovative health communication approaches [10]. By presenting oral health concepts in an appealing and interactive format, Pop-Up Books can help children understand the importance of tooth-brushing, healthy eating, and regular dental visits, thereby fostering positive health behaviors from an early age.

A preliminary assessment conducted at RA Al-Ikhlas Tuban revealed an average def-t score of 14.3 among 10 preschool students, indicating a very high level of caries severity. Interviews with school personnel further showed that the School Dental Health Program (UKGS) had not been implemented effectively due to limited information, insufficient resources, and the absence of dental health personnel responsible for program delivery. Additionally, oral health education using Pop-Up Book media had never been introduced at the school, suggesting a significant gap in educational strategies and health promotion efforts.

These findings underscore the need for innovative and engaging educational interventions tailored to the developmental characteristics of preschool children. Pop-Up Books offer a promising solution by combining visual appeal, interactive features, and educational content in a single medium. Based on these conditions, this study was conducted to examine the effect of Pop-Up Book media on improving dental and oral health knowledge among preschool children at RA Al-Ikhlas Tuban. The intervention is expected to enhance children's understanding, promote healthier oral hygiene behaviors, and contribute to long-term prevention of dental caries.

METHODS

Research design

This study employed a pre-experimental design using the one-group pretest–posttest approach, in which a single group of respondents was assessed before and after the intervention without the inclusion of a comparison or control group [11]. This design was selected because it allows researchers to evaluate changes in the dependent variable following the administration of an intervention within the same population, thereby enabling the measurement of direct effects attributable to the treatment while maintaining feasibility in educational settings involving young children. Although this design does not control for external influences, it is widely used in early childhood health education research due to its practicality, ethical suitability, and ability to capture short-term learning outcomes.

Prior to data collection, the study obtained ethical clearance from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya, ensuring that all procedures adhered to ethical standards for research involving children. Permission to conduct the study was also granted by the school administration. Parents or guardians were informed about the study's objectives, procedures, and benefits, and verbal assent was obtained from the children in accordance with ethical guidelines for research involving minors. Confidentiality of participant data was strictly maintained, and all activities were designed to be safe, non-invasive, and educationally beneficial for the children.

Location and time of study

The research was conducted at RA Al-Ikhlas Tuban, located in Tuban Regency, East Java, Indonesia. The study was implemented across several phases to ensure systematic data collection and intervention delivery. The initial data collection (pretest) took place in August 2025, followed by the intervention phase in February 2026, and the final data processing and manuscript preparation occurred between March and April 2026. This timeline allowed adequate intervals for planning, intervention repetition, consolidation of knowledge among respondents, and rigorous analysis of the collected data.

Study subjects and recruitment

The study population consisted of all preschool children enrolled at RA Al-Ikhlas Tuban, totaling 43 children. Because the population size was fewer than 100 individuals, the sampling technique used was non-probability total sampling, meaning that the entire population was included as research participants [12,13]. This approach ensured comprehensive coverage of all eligible children, minimized sampling bias, and enhanced the representativeness of findings for the school's preschool population. All children who met the inclusion criteria; namely, being enrolled as active students and present during the data collection period were included in the study.

Independent variable: Pop-up book intervention

The independent variable in this study was the use of Pop-Up Book media as an educational tool for dental and oral health promotion. The Pop-Up Book is a three-dimensional interactive learning medium designed to visually and physically engage children through images that rise or unfold when pages are opened. The intervention aimed to enhance children's understanding of oral health concepts by presenting information in an attractive, age-appropriate, and interactive format.

The Pop-Up Book used in this study contained a series of structured educational themes designed to introduce preschool children to essential concepts of dental and oral health. Through its interactive three-dimensional pages, the book guided children to understand the fundamental causes of poor oral hygiene, helping them recognize how inadequate brushing habits, improper cleaning techniques, and unhealthy dietary choices can lead to dental problems. It also explained the basic requirements for proper tooth-brushing, including the need for clean and appropriate tools, the correct amount of toothpaste, and the importance of adult supervision during brushing. The narrative further emphasized the recommended frequency and timing of brushing; particularly after breakfast and before bedtime as well as demonstrated correct brushing techniques in a simple, visually engaging manner that children could easily imitate. In addition, the Pop-Up Book introduced examples of foods that support dental health, such as fruits and vegetables, and contrasted them with sugary snacks and drinks that may harm teeth. Finally, it highlighted the importance of routine dental check-ups every six months, encouraging children to view dental visits as a normal and positive part of maintaining their overall health.

The intervention was delivered in small groups of five children per group to facilitate interaction, ensure focused attention, and allow individualized guidance. The Pop-Up Book was used twice during the first meeting to reinforce comprehension, accompanied by a question-and-answer session to encourage active participation. A second educational session was conducted during the next meeting to strengthen retention and provide repeated exposure to key concepts.

Dependent variable: Knowledge of dental and oral health

The dependent variable was the level of dental and oral health knowledge among preschool children. Knowledge was measured using a structured questionnaire administered during the pretest and posttest phases. The questionnaire assessed multiple domains of oral health knowledge, including understanding of dental hygiene practices, brushing techniques, dietary influences, and preventive behaviors.

The responses obtained from the knowledge questionnaire were evaluated using an ordinal scoring system, allowing each child's level of understanding to be classified according to the proportion of correct answers. Based on this scoring approach, children who achieved between 76% and 100% correct responses were categorized as having *good* knowledge, those who scored between 56% and 75% were classified as having *fair* knowledge, and those whose correct responses fell below 56% were placed in the *poor* knowledge category. This categorization provided a clear framework for interpreting changes in knowledge before and after the intervention and enabled the researchers to assess the effectiveness of the educational media in enhancing oral health understanding among preschool children. This scoring system allowed for clear classification of knowledge improvement following the intervention.

Data collection procedures

Data collection was conducted by four trained enumerators who had received detailed briefings on the study materials, intervention procedures, and standardized communication techniques to ensure consistency across all sessions. During the first meeting, children completed the pretest individually under supervision. Immediately afterward, the Pop-Up Book educational intervention was delivered in small groups. The same educational content was repeated during the next meeting to reinforce learning.

The posttest was administered seven days after the second intervention session. This interval was intentionally selected to allow children sufficient time to internalize, recall, and apply the newly acquired knowledge in daily routines, thereby providing a more accurate measure of learning retention rather than short-term memorization.

Data processing and statistical analysis

The data underwent a series of systematic processing steps to ensure accuracy and reliability before analysis. The first stage involved editing, during which all completed questionnaires were carefully reviewed to check the completeness of responses and to verify that each item had been answered clearly and consistently. Following this, the coding process was carried out by assigning numerical codes to categorical responses, allowing the qualitative information provided by the children to be transformed into structured numerical data suitable for statistical analysis. Once coding was completed, the data were entered into the Statistical Package for the Social Sciences (SPSS), ensuring that all variables were accurately transferred into the software for further examination. The final stage consisted of data cleaning, where the dataset was scrutinized to identify and correct any inconsistencies, entry errors, or anomalies that might compromise the validity of the analysis. Through these sequential steps, the dataset was refined and prepared for both descriptive and inferential statistical testing.

Given that the dependent variable was measured on an ordinal scale, the data were analyzed using the Wilcoxon Signed-Rank Test, a non-parametric statistical test appropriate for comparing paired samples in pretest–posttest designs. This test evaluates whether the median difference between pre-intervention and post-intervention scores is statistically significant. A p-value < 0.05 was considered indicative of a significant effect of the Pop-Up Book intervention on children's oral health knowledge [14,15].

RESULTS

The study was carried out at RA Al-Ikhlas Tuban and involved a total of 43 preschool children as research participants. All respondents took part in a complete sequence of research activities designed to measure changes in their dental and oral health knowledge following the educational intervention. The process began with an initial assessment of knowledge, during which each child completed a pretest to evaluate their baseline understanding of oral hygiene practices, healthy and unhealthy dietary choices, and the importance of routine dental care. This pretest served as a crucial reference point for determining the effectiveness of the intervention.

After the pretest, the children participated in an educational session that utilized the Pop-Up Book as a visual and interactive learning medium. The Pop-Up Book was specifically selected because of its ability to engage young learners through three-dimensional illustrations, dynamic page movements, and age-appropriate explanations. During the intervention, children were guided through the content in small groups, allowing them to interact with the material, ask questions, and receive clarification from the facilitators. The educational session was structured to ensure that children not only observed the visual elements of the Pop-Up Book but also understood the underlying concepts related to maintaining dental and oral health.

Following the intervention, the children were given time to internalize and apply the information they had learned. After this consolidation period, a posttest was administered to reassess their level of knowledge. The posttest mirrored the structure of the pretest, enabling a direct comparison of scores before and after the educational activity. This comparison allowed the researchers to determine whether the Pop-Up Book intervention had successfully improved the children's understanding of dental and oral health.

The data obtained from both the pretest and posttest were then analyzed to identify changes in knowledge levels. Through this analytical process, the study aimed to determine the extent to which the Pop-Up Book contributed to enhancing oral health literacy among preschool children. The overall research procedure; from initial assessment to intervention and final evaluation provided a comprehensive framework for examining the effectiveness of interactive educational media in promoting better oral health knowledge in early childhood.

Demographic characteristics of preschool children

Based on Table 1, the study involved a total of 43 preschool children, whose demographic characteristics provide an important contextual foundation for interpreting the results of the intervention. In terms of sex distribution, 15 children (35%) were male, while 28 children (65%) were female. This indicates that the respondent group was predominantly composed of girls, a pattern that may reflect enrollment trends at RA Al-Ikhlas Tuban or broader demographic characteristics of the local preschool population. The predominance of female respondents is relevant for understanding potential differences in learning engagement, communication styles, or responsiveness to educational media, although the study did not specifically analyze sex-based variations.

Table 1. Distribution of preschool children based on demographic characteristics at RA Al-Ikhlas Tuban, 2026

Demographic characteristic	Category	Frequency	Percentage
Sex	Male Female	15 28	35 65
Age (years)	5 6 7	9 14 20	20 33 47

Age distribution also shows a clear pattern. Children aged 7 years constituted the largest proportion of respondents, totaling 20 children (47%). This was followed by children aged 6 years, with 14 respondents (33%), and children aged 5 years, with 9 respondents (20%). Thus, the majority of participants were in the upper range of preschool age, specifically 7 years old. This age composition is particularly significant because children at this developmental stage generally possess more advanced cognitive abilities, better attention span, and greater capacity to understand structured educational content compared to younger preschoolers. Their developmental readiness may influence how effectively they receive, process, and retain information presented through interactive media such as the Pop-Up Book.

The dominance of 7-year-old respondents also suggests that many children were approaching the transition from early childhood to early primary school, a period marked by increasing independence in daily routines, including oral hygiene practices. At this age, children typically begin

to develop more consistent brushing habits, greater curiosity about health-related topics, and improved ability to follow instructions. Consequently, the educational intervention delivered in this study may have been particularly well-timed to support the formation of healthy oral hygiene behaviors before children enter formal schooling.

Furthermore, the demographic profile of respondents provides insight into the social and educational environment of RA Al-Ikhlas Tuban. The relatively balanced distribution across age groups, combined with the predominance of female students, reflects a typical preschool setting in which children are grouped by developmental readiness rather than strict chronological age. This diversity in age may also contribute to variations in baseline knowledge, learning pace, and interaction during the intervention sessions.

Overall, the characteristics of respondents presented in Table 1 offer essential context for interpreting the outcomes of the Pop-Up Book intervention. Understanding the demographic composition; particularly the predominance of female students and the concentration of children aged 7 years helps clarify how the educational media may have influenced learning effectiveness and knowledge acquisition among preschool children at RA Al-Ikhlas Tuban.

Knowledge of dental and oral health before and after the use of pop-up book media

The results presented in Table 2 illustrate the baseline level of dental and oral health knowledge among the 43 preschool children prior to the implementation of the Pop-Up Book educational intervention. The initial assessment revealed that the majority of respondents demonstrated a low level of understanding regarding essential oral health concepts. Specifically, 34 children (79%) fell into the *poor* knowledge category, indicating limited awareness of proper tooth-brushing practices, dietary influences on dental health, and the importance of routine dental check-ups. Meanwhile, 9 children (21%) were categorized as having *fair* knowledge, suggesting partial but incomplete comprehension of oral hygiene principles. Notably, none of the respondents achieved a *good* knowledge score during the pretest phase. This distribution underscores the substantial need for targeted oral health education within this population, as the baseline knowledge level was insufficient to support effective oral hygiene behaviors.

Table 3 presents the results of the posttest administered after the children received oral health education using the Pop-Up Book. The distribution of knowledge categories shows a marked improvement compared to the pretest results. A substantial proportion of respondents; 35 children (81%) achieved a *good* knowledge score, reflecting a strong grasp of the oral health concepts introduced during the intervention. This dramatic increase from 0% in the pretest to 81% in the posttest demonstrates the effectiveness of the Pop-Up Book as an engaging and developmentally appropriate educational medium. Additionally, 6 children (14%) were categorized as having *fair* knowledge, indicating moderate improvement and partial mastery of the material. Only 2 children (5%) remained in the *poor* knowledge category, a significant reduction from the initial 79%. This shift suggests that the majority of children were able to absorb, retain, and understand the information presented through the Pop-Up Book, even within a relatively short intervention period.

Table 2. Distribution of dental and oral health knowledge before the use of Pop-Up Book media among preschool children at RA Al-Ikhlas Tuban

Knowledge category	Frequency	Percentage
Good	0	0
Fair	9	21
Poor	34	79

Table 3. Distribution of dental and oral health knowledge after the use of Pop-Up Book media among preschool children at RA Al-Ikhlas Tuban

Knowledge category	Frequency	Percentage
Good	35	81
Fair	6	14
Poor	2	5

The comparison between Tables 2 and 3 clearly demonstrates the positive impact of the Pop-Up Book intervention on children's dental and oral health knowledge. Prior to the intervention, knowledge levels were predominantly low, with nearly four-fifths of the respondents lacking essential understanding of oral hygiene practices. This initial condition reflects common challenges in early childhood oral health education, where traditional lecture-based methods often fail to capture children's attention or facilitate meaningful learning.

Following the intervention, however, the distribution of knowledge categories shifted dramatically. The Pop-Up Book, with its interactive three-dimensional illustrations and child-friendly narrative, appears to have effectively enhanced comprehension and engagement. The substantial increase in the proportion of children achieving *good* knowledge scores suggests that the medium successfully translated abstract oral health concepts into concrete, visually accessible forms that preschool children could easily understand and remember.

The reduction in the *poor* knowledge category; from 34 children to only 2 further highlights the intervention's effectiveness. This improvement indicates that even children with initially limited understanding were able to benefit from the Pop-Up Book's structured and repetitive learning approach. The presence of a small number of children who remained in the *poor* category may be attributed to individual differences in learning pace, attention span, or developmental readiness, which are common variations in early childhood education.

Overall, the findings confirm that the Pop-Up Book serves as a powerful educational tool capable of significantly improving oral health knowledge among preschool children. Its interactive nature, visual appeal, and age-appropriate content make it particularly suitable for early childhood learning environments, supporting both cognitive engagement and long-term retention of health information.

Statistical analysis

The statistical analysis presented in Table 4 provides a comprehensive overview of the changes in dental and oral health knowledge among preschool children following the Pop-Up Book educational intervention. The pretest results show that prior to receiving any instructional material, the respondents exhibited relatively low levels of oral health knowledge. The median pretest score was 40.6, with a wide range of 7.6 to 74.6, indicating substantial variability in baseline understanding. This broad distribution suggests that while a few children possessed moderate knowledge, the majority had limited familiarity with essential oral hygiene concepts such as correct brushing techniques, appropriate brushing frequency, dietary influences on dental health, and the importance of routine dental check-ups.

Table 4. Results of the Wilcoxon Signed-Rank Test for dental and oral health knowledge before and after the use of Pop-Up Book media among preschool children at RA Al-Ikhlas Tuban

Knowledge score	Median (minimum–maximum)	p-value
Before education	40.6 (7.6–74.6)	0.000
After education	100 (53.8–100)	—

After the educational intervention, the posttest results revealed a dramatic and consistent improvement in knowledge scores. The median posttest score increased to 100, with a narrower and significantly higher range of 53.8 to 100. This upward shift indicates that nearly all respondents

demonstrated substantial gains in comprehension and retention of the material presented through the Pop-Up Book. The compression of the score range toward higher values also suggests that the intervention not only elevated overall knowledge but also reduced disparities between children, leading to a more uniform level of understanding across the sample.

To determine whether the observed improvements were statistically significant, the Wilcoxon Signed-Rank Test was employed. This non-parametric test is appropriate for paired ordinal data and is commonly used to evaluate pretest–posttest differences when normality assumptions are not met. The analysis yielded a p-value of 0.000 ($p < 0.05$), providing strong evidence that the increase in knowledge scores was not due to random variation. In statistical terms, the null hypothesis (H0), which states that there is no difference in knowledge before and after the intervention, was rejected, while the alternative hypothesis (H1), indicating a significant difference, was accepted.

The combination of descriptive and inferential findings reinforces the effectiveness of the Pop-Up Book intervention. The substantial rise in median scores, the upward shift in minimum and maximum values, and the statistically significant p-value collectively demonstrate that the Pop-Up Book successfully facilitated learning in a population that typically requires highly visual and interactive educational approaches. These results align with existing literature emphasizing the importance of developmentally appropriate, visually engaging, and interactive educational tools for young children, particularly in health-related learning contexts.

Overall, the statistical analysis clearly indicates that the Pop-Up Book-based oral health education had a positive and measurable impact on respondents' knowledge. The intervention not only improved individual scores but also transformed the overall distribution of knowledge categories, shifting the majority of children from poor or moderate levels to the good category. This outcome underscores the value of visually oriented educational strategies in promoting health literacy and supporting equitable learning outcomes among preschool children.

DISCUSSION

Dental and oral health knowledge before the use of pop-up book media

Before the educational intervention was administered, the majority of preschool children demonstrated a low level of dental and oral health knowledge, indicating that their initial understanding of essential oral hygiene concepts was far from optimal. Most respondents fell into the *poor* knowledge category, reflecting limited awareness of fundamental practices such as proper brushing techniques, appropriate brushing frequency, healthy dietary choices, and the importance of routine dental check-ups. This condition is consistent with the developmental characteristics of preschool-aged children, who are still in the early stages of cognitive growth and typically operate within the *knowing* stage of learning, where information is recognized but not yet fully understood or applied meaningfully.

The low baseline knowledge observed among respondents can be attributed to a combination of internal and external factors. Internally, age and cognitive maturity play a crucial role; preschool children possess limited abstract reasoning abilities and rely heavily on concrete, visual, and experiential learning. Their educational exposure is also shaped by early childhood curricula, which may not consistently emphasize oral health topics. Externally, environmental influences such as parental guidance, school practices, and prior exposure to health information significantly affect children's understanding. Limited access to structured oral health education, insufficient reinforcement at home, and minimal interaction with dental professionals contribute to the low level of knowledge observed in this study [16].

Interestingly, the children showed relatively better understanding in areas related to healthy food choices for dental health. This pattern may be explained by the fact that information about food; particularly fruits, vegetables, and sugary snacks is frequently encountered in daily life and often reinforced by parents and teachers. Children are more likely to recognize foods that are "good" or "bad" for their teeth because these concepts are concrete, familiar, and directly connected to their everyday experiences. In contrast, more technical aspects of oral hygiene, such as the correct brushing technique, direction of brushing strokes, and optimal brushing duration, received lower scores. These skills require procedural knowledge and motor coordination, which preschool children may not yet fully possess. Many children brush their teeth merely as a routine activity without understanding the underlying purpose or the correct method, resulting in ineffective cleaning despite regular brushing.

These findings align with previous research reporting that preschool children generally have low levels of dental and oral health knowledge because they have not yet developed an understanding of the importance of maintaining oral hygiene from an early age [6]. Within the framework of health behavior theory, limited access to accurate and age-appropriate information serves as a dominant predisposing factor contributing to low oral health knowledge among young children [16]. Without adequate exposure to structured educational materials, children rely primarily on observation and imitation, which may not always lead to correct practices.

The conditions observed in this study underscore the urgent need for educational interventions that are tailored to the developmental characteristics of preschool children. Visual-based educational media, such as Pop-Up Books, offer a promising solution by presenting information through engaging images, vibrant colors, and three-dimensional forms that capture children's attention and facilitate comprehension. Pop-Up Books transform abstract concepts into concrete visual experiences, making it easier for children to understand and remember oral health information. Their interactive nature encourages active participation, enhances motivation, and supports deeper cognitive processing, thereby addressing the limitations associated with traditional lecture-based approaches.

In summary, the low level of dental and oral health knowledge observed before the intervention highlights the importance of implementing innovative, visually oriented educational strategies. The Pop-Up Book, with its child-friendly design and interactive features, is well-suited to bridge the gap between children's developmental needs and the complexity of oral health concepts, ultimately contributing to improved health literacy in early childhood.

Dental and oral health knowledge after the use of pop-up book media

Following the delivery of oral health education using the Pop-Up Book, a substantial improvement in the respondents' knowledge was observed, with the majority of preschool children advancing into the *good* knowledge category. This marked shift indicates that the intervention was highly effective in enhancing children's understanding of essential oral hygiene concepts. After the educational sessions, children demonstrated noticeably stronger abilities in identifying and explaining correct tooth-brushing techniques, including the appropriate movements, directions, and duration required for effective cleaning. They also showed improved comprehension of the recommended timing for brushing; particularly after breakfast and before bedtime reflecting a deeper grasp of daily oral hygiene routines.

In addition to brushing practices, children exhibited enhanced awareness of dietary influences on dental health. They were better able to distinguish between foods that support oral health, such as fruits and vegetables, and those that may contribute to dental caries, such as sugary snacks and beverages. Furthermore, the children displayed a clearer understanding of the importance of routine dental check-ups every six

months, recognizing dental visits as a preventive measure rather than merely a response to pain or discomfort. This shift in perception is significant, as it reflects a transition from passive to proactive attitudes toward oral health maintenance.

The effectiveness of the Pop-Up Book can be attributed to its engaging and developmentally appropriate design. The medium presents information through three-dimensional illustrations, vibrant colors, and interactive elements that naturally attract children's attention and sustain their focus throughout the learning process. Preschool children, who are in the *golden age* of cognitive and behavioral development, are particularly receptive to visual stimulation and experiential learning. At this stage, children process information more effectively when it is presented in concrete, visually rich formats rather than abstract verbal explanations. The Pop-Up Book leverages these developmental characteristics by transforming oral health concepts into tangible, visually accessible experiences that children can easily interpret and remember [17].

The improvement in knowledge observed after the intervention suggests that children progressed beyond the basic *knowing* level and reached higher cognitive stages, including *understanding* and even *application*. According to established classifications of knowledge, children in the *good* category demonstrate not only the ability to recall information but also the capacity to interpret and apply it in relevant contexts, such as daily brushing routines or food choices [18]. This progression indicates that the Pop-Up Book did more than simply introduce new information; it facilitated meaningful learning that children could integrate into their everyday lives.

These findings are consistent with previous studies reporting that Pop-Up Book media can significantly enhance learning outcomes by increasing children's interest, motivation, and engagement. The interactive nature of the medium encourages active participation, prompting children to explore, ask questions, and interact with the material rather than passively receiving information. Such engagement supports deeper cognitive processing and improves retention of educational content, making Pop-Up Books particularly effective for health education in early childhood settings [9].

Moreover, the results reinforce the broader evidence base demonstrating that early oral health education, when delivered through appropriate and engaging methods, can substantially improve children's knowledge and contribute to the formation of healthy behaviors. Introducing oral health concepts during early childhood lays the foundation for lifelong habits, helping children internalize the importance of maintaining clean teeth, choosing healthy foods, and seeking regular dental care. When these messages are conveyed through enjoyable and visually stimulating media, children are more likely to adopt and sustain positive behaviors, ultimately supporting long-term oral health outcomes [2].

In summary, the significant increase in dental and oral health knowledge following the Pop-Up Book intervention highlights the value of interactive visual media in early childhood education. The Pop-Up Book effectively bridged the gap between children's developmental needs and the complexity of oral health concepts, enabling preschool children to achieve higher levels of understanding and application. These results underscore the importance of incorporating innovative, child-centered educational tools into oral health promotion programs to foster meaningful learning and support healthy behavior formation from an early age.

Effect of pop-up book media on dental and oral health knowledge

The statistical and descriptive findings of this study collectively demonstrate a meaningful and substantial improvement in dental and oral health knowledge among preschool children following the use of Pop-Up Book media. Prior to the intervention, most respondents were categorized as having *poor* knowledge, reflecting limited understanding of essential oral hygiene concepts. After the intervention, however, the majority shifted into the *good* knowledge category, indicating a marked enhancement in comprehension and retention of the educational material. This transition from low to high knowledge levels underscores the effectiveness of the Pop-Up Book as an instructional tool tailored to the developmental characteristics of early childhood learners.

From the perspective of health promotion theory, knowledge serves as a fundamental predisposing factor that shapes an individual's readiness to adopt healthy behaviors. According to established models of health education, improvements in knowledge often precede and facilitate subsequent changes in attitudes and behaviors. Effective health education interventions aim to strengthen this cognitive foundation, enabling individuals; particularly children to make informed decisions about their health. In this study, the Pop-Up Book functioned as a structured educational stimulus that successfully elevated children's cognitive awareness of oral hygiene practices, thereby fulfilling the theoretical expectation that knowledge enhancement is the first step toward behavior change [16].

The observed increase in knowledge can be further explained through the Stimulus–Organism–Response (S-O-R) framework, which provides a behavioral lens for understanding how individuals process and react to external stimuli. In this context, the stimulus was the Pop-Up Book-based educational session, designed to deliver oral health information through visually engaging and interactive content. The organism refers to the preschool children, whose cognitive processing is strongly influenced by visual stimuli, concrete representations, and experiential learning. The response was the significant improvement in knowledge scores following the intervention. This pattern suggests that the visual stimulus provided by the Pop-Up Book was effectively received, processed, and internalized by the children, resulting in measurable cognitive change [16]. The S-O-R model thus offers a theoretical explanation for why visually rich educational media are particularly effective for young learners.

Several intrinsic characteristics of the Pop-Up Book likely contributed to its effectiveness. First, the medium presents information in a concise and practical manner, reducing cognitive load and making complex concepts easier for children to grasp. Second, the use of colorful illustrations and dynamic three-dimensional elements enhances attention, engagement, and memory retention. Visual stimuli are known to activate multiple cognitive pathways, enabling children to form stronger associations between images and concepts. Third, the interactive nature of the Pop-Up Book stimulates curiosity and encourages active participation, which are essential components of meaningful learning in early childhood. These features collectively create a learning environment that is both enjoyable and cognitively enriching, aligning with developmental principles that emphasize the importance of visual and experiential learning during the preschool years [18].

The findings of this study are consistent with previous research demonstrating that illustrated and interactive media; such as Pop-Up Books can significantly improve children's knowledge of dental and oral health. Earlier studies have reported that children exposed to visually oriented educational materials show greater interest, higher motivation, and improved comprehension compared to those receiving traditional lecture-based instruction [8], [14]. The present study reinforces these conclusions by providing empirical evidence that Pop-Up Book media can effectively elevate oral health knowledge among preschool children within a relatively short intervention period.

Furthermore, the results support broader recommendations in pediatric health education, which emphasize the importance of introducing oral health concepts early in life using developmentally appropriate methods. Early childhood represents a critical window for shaping health behaviors, as children are highly receptive to new information and capable of forming lasting habits when guided through engaging and enjoyable learning experiences. When oral health education is delivered using methods that align with children's cognitive and emotional development; such as interactive visual media it not only improves knowledge but also lays the groundwork for healthier behaviors in the future [2].

Despite the positive outcomes, this study acknowledges several limitations. The absence of a control group restricts the ability to compare the intervention's effectiveness against other educational methods or natural learning progression. Additionally, the study focused solely on knowledge outcomes and did not assess changes in attitudes or behaviors, which are equally important components of oral health promotion. These limitations were mitigated through rigorous pretest–posttest procedures and the involvement of trained enumerators who ensured consistent delivery of educational content across all respondents. Nonetheless, future research would benefit from incorporating control groups, longitudinal follow-up, and behavioral assessments to provide a more comprehensive evaluation of the intervention's impact.

In conclusion, the Pop-Up Book proved to be a highly effective medium for improving dental and oral health knowledge among preschool children. Its visual, interactive, and child-centered design aligns closely with the developmental needs of early learners, enabling them to process and retain health information more effectively. The significant increase in knowledge observed in this study highlights the potential of Pop-Up Books as a valuable tool in early childhood oral health education and supports their broader implementation in preschool health promotion programs.

Limitation

The Pop-Up Book leverages these developmental characteristics by transforming oral health concepts into tangible, visually accessible experiences that children can easily interpret and remember. However, this study has several limitations that should be acknowledged. First, the absence of a control group limits the ability to compare the Pop-Up Book intervention with other educational methods or natural learning progression [11]. Second, the study focused solely on knowledge outcomes and did not assess changes in attitudes or actual oral hygiene behaviors, which are essential components of comprehensive health promotion. Third, the short interval between the intervention and posttest may not fully capture long-term retention of knowledge [19-21]. Fourth, the sample was limited to a single preschool, which may restrict generalizability to broader populations with different demographic or socioeconomic characteristics. Fifth, the reliance on self-reported responses from young children may introduce measurement bias due to limited comprehension or inconsistent attention [22-26]. Future research should incorporate control groups, evaluate behavioral outcomes, extend follow-up periods, include more diverse samples, and apply mixed-method approaches to obtain a more holistic understanding of the effectiveness of Pop-Up Book media in early childhood oral health education.

CONCLUSION

Before receiving the Pop-Up Book–based education, most preschool children at RA Al-Ikhlas Tuban demonstrated poor dental and oral health knowledge. After the intervention, the majority of respondents improved to the good knowledge category. The Pop-Up Book proved to have a significant effect on increasing oral health knowledge among preschool children. These findings support the use of Pop-Up Books as an engaging, visually oriented educational medium for early childhood oral health promotion, and suggest that schools and health institutions should consider integrating this media into continuous dental health education programs. Future studies are recommended to include a control group, apply repeated education over a longer period, expand the number and characteristics of respondents, and examine changes in attitudes and behaviors in addition to knowledge.

Ethical consideration, competing interest and source of funding

-This study adhered to established ethical principles for research involving human participants. Prior to data collection, ethical clearance was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya [ethical approval number]. All research procedures; including the delivery of Pop-Up Book–based education, completion of the dental and oral health knowledge questionnaire, and measurement of def-t scores were conducted in accordance with approved research protocols. Parents or legal guardians received clear information regarding the study's objectives, procedures, and the involvement of their children, and provided informed consent before participation. Confidentiality of respondent identity and data was maintained throughout data collection, processing, analysis, and reporting.

-The authors declare that no conflicts of interest were present during the conduct or publication of this study

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