

ORIGINAL ARTICLE

A quasi-experimental study on the use of pop-up books to improve dental caries knowledge among elementary school students

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ABSTRACT

Introduction: Dental caries are caused by multiple factors, including both internal and external influences on individuals. The Kedungmundu Health Center area ranks first in the prevalence of dental caries among elementary school students, with 3.739 affected children. If left untreated, caries can lead to infection, spread to other teeth, and negatively affect overall oral health. This study aims to analyze the effectiveness of pop-up books in improving dental caries knowledge among elementary school students. **Methods:** This study employed a quasi-experimental design using a pre-post control group approach. The sample consisted of 66 students aged 10-11 years from SDN Sendangmulyo 01 Semarang, selected through simple random sampling. The participants were divided into two groups 33 in the experimental group and 33 in the control group. Statistical analysis was performed using a paired t-test. **Results:** Prior to the intervention, a majority of control participants (81.8%) and experimental participants (57.6%) displayed good understanding of dental caries. Following the counseling session, the experimental group exhibited significant improvement, with 81.8% attaining good knowledge compared to 60.6% in the control group. Statistical analysis revealed significant knowledge gains in the experimental group ($p=0.006$), confirming pop-up book media as an effective educational tool. **Conclusion:** Educational counseling using pop-up book media is effective in increasing dental caries knowledge among elementary school students.

KEYWORDS

School age children, dental health education, *pop-up books*

INTRODUCTION

Oral health plays a vital role in maintaining overall quality of life. According to the *Survei Kesehatan Indonesia* (2023), the prevalence of dental caries reached 43.6%.¹ The survey also indicated that 57.6% of Indonesians experienced dental and oral problems, yet only 10.2% received medical treatment. In Semarang City specifically, 37.2% of residents were reported to have cavities, but only 6.46% received treatment in the form of dental fillings.¹ Providing education about dental caries should begin at an early age, as early childhood is crucial period when children start to develop awareness of oral hygiene and adopt habits that can either support or negatively impact their teeth.^{2,3}

Knowledge about dental and oral health should be introduced to elementary school-age children, as this is ideal for addressing oral health problems. During this period, children are still in a crucial phase of growth and development.^{4,5} A person's awareness of the importance of oral health is often reflected in their level of knowledge. The more comprehensive one's knowledge, the more likely they are to

prioritize oral hygiene.^{6,7} Compared to adults, children tend to have poorer oral hygiene due to their higher consumption of sugary foods and beverages, which increases their risk of developing cavities.⁸

Dental health education is one of the directed efforts aimed at changing individuals' or groups' behaviors- from poor habits to healthier practices, particularly in preventing dental caries. Elementary school students are considered strategic targets for health program implementation. In addition to their large number, they are easily accessible and well organized, making it easier to deliver education and practical skills. Children at the elementary school age generally face difficulties in understanding abstract learning materials. Learning media can help bridge this gap and extend beyond conventional promotional methods.

Educational media include posters, game cards, pamphlets, pocket books, pop-up books, lectures, and others. Pop-up books are unique and engaging educational tools that can help students better understand health-related content.^{9,10} Studies have shown that pop-up book media are more effective than leaflets in increasing dental caries knowledge among elementary school students.¹¹

Pop-up books are a type of educational material that, when opened, display three-dimensional images, offering a more immersive and engaging learning experience¹². It is hoped that the pop-up books can be integrated into students' daily learning activities to enhance their oral health knowledge and ultimately help prevent cavities.^{6,13} Pop up books provide a new learning experience, encourage active student participation, and improve the effectiveness of the teaching and learning process through visualized enriched materials.^{5,14}

Pop-up book media creates an engaging and interactive educational environment. These books contain entertaining illustrations that can be shaped or moved, revealing vibrant, embossed images on each page.^{14,15} Enhancing knowledge, attitudes, and behaviours related to dental and oral health requires effective educational strategies, including comprehensive oral health programs. Factors that influence oral health education include the learning environment, student characteristics, educator approaches, teaching methods, and the choice of instructional media.¹⁶

According to data from the Semarang City Health Service (2022), the Kedungmundu Community Health Center ranked first in dental caries prevalence among 37 community health centers, with a total of 3,739 elementary/MI students affected by dental caries or cavities. This high prevalence highlights the urgent need for increased oral health education to raise awareness and improve students' health literacy, thereby helping them prevent caries.^{6,17}

Despite this concerning prevalence, there has never been an educational program on dental and oral health-particularly dental caries-that utilizes communication-based learning media. Survey results further indicate that limited knowledge about dental caries stems from the lack of targeted dental health education. The novelty of this study lies in applying pop-up book media as a communication-based learning tool for dental caries education, which has not been previously explored in oral health programs. Therefore, this study aims to analyze the effectiveness of pop-up books in improving dental caries knowledge among elementary school students.

METHODS

The study employed a quasi-experimental design.¹⁸ A total of 196 students from SDN Sendangmulyo 01 Semarang participated in this study. They were randomly selected using a simple random sampling technique, ensuring each student had an equal chance of being included.¹⁹ The sample size was determined using the Slovin formula, resulting in 66 students from grades 4 and 5, aged 10-11 years, who met the inclusion criteria: willingness to participate, proficient reading ability, and high curiosity. Children aged 10-11 years are considered capable of logical thinking and can categorize certain objects or situations.

The students' knowledge levels were assessed using a questionnaire, which was validated ($p < 0.05$) and reliable (Cronbach's alpha value > 0.07). The scores were categorized as Good ($\geq 75\%$), Sufficient (56-74%), and Poor ($< 55\%$).²⁰ The knowledge indicators included: the definition of dental caries, causes, formation process, signs and symptoms, types, prevention methods, proper tooth brushing techniques, and treatment of dental caries.

Data normality was tested using Kolmogorov-Smirnov test (p -value > 0.05). To compare differences between and within groups, the independent t-test and paired t-tests were employed respectively. This study was conducted in strict adherence to ethical research principles.^{21,22}

RESULTS

The frequency distribution of participants in the control and experimental groups is presented in Table 1. In terms of gender, both groups had a comparable proportion of male and female participants. Regarding age, most participants in the control group were 11 years old, whereas the majority in the experimental group were 10 years old.

Table 1. Respondent characteristic

Characteristics	Group			
	Control		Experiment	
	n= 33	%	n= 33	%
Gender				
Male	15	45.5	16	48.5
Female	18	54.5	17	51.5
Total	33	100	33	100
Age				
10 years	13	39.4	19	57.6
11 years	20	60.6	14	42.4
Total	33	100	33	100
Level of Knowledge				
Good	27	81.8	19	57.6
Moderate	3	9.1	9	27.3
Poor	3	9.1	5	15.2
Total	33	100	33	100

Table 2. Frequency distribution based on level of knowledge of dental caries before and after being given counseling

Level of knowledge of dental caries	Group			
	Control		Experiment	
	n= 33	%	n= 33	%
<i>Pre Test</i>				
Good	27	81.8	19	57.6
Moderate	3	9.1	9	27.3
Poor	3	9.1	5	15.2
<i>Post test</i>				
Good	20	60.6	27	81.8
Moderate	8	24.2	6	18.2
Poor	5	15.2	0	0

Table 2 presents the frequency distribution of dental caries knowledge levels in the control and experimental groups, before and after receiving counseling using pop-up books. In the control group, prior to the intervention, the majority of participants demonstrated a good level of knowledge ($n=27$; 81.8%). However, after counseling, the proportion of participants with good knowledge decreased to ($n=20$; 60.6%).

In contrast, the experimental group showed a positive change. Before the intervention, 19 participants (57.6%) demonstrated a good level of knowledge.

Following the pop-up book counseling, this number increased to 27 participants (81.8%). These findings indicate a notable improvement in knowledge following the intervention, primarily among female participants aged 11 years

Table 3. Results of student knowledge questionnaire answer about dental caries

No.	Question	Mean			
		Pre	%	Post	%
1.	Definition of dental caries	26	79	31	93.9
2.	Foods that cause dental caries	30	91	32	97
3.	Impacts of consuming sweet and sticky foods	32	97	32	97
4.	On the surface of the teeth there is a buildup of food debris that has not been cleaned	28	85	29	87.9
5.	Early signs of dental caries	30	91	32	97
6.	A person feels when dental caries begins to appear	28	85	32	97
7.	There are sweet and sticky food residues in the mouth that are fermented by germs	31	94	32	97
8.	Types of dental caries	25	76	30	90.9
9.	Habits that speed up the process of dental caries	25	76	27	81.8
10.	The sequence of formation of dental caries	25	76	28	84.8
11.	If the infection from a cavity has spread causes brittle teeth	29	88	30	90.9
12.	Dental caries is found on only one tooth surface	29	88	27	81.8
13.	The contents of toothpaste are good for teeth	12	36	25	75.8
14.	Foods that can prevent dental caries	20	61	28	84.8
15.	Time for a dental and oral health check	26	79	27	81.8
16.	The right time to brush your teeth	28	85	31	93.9
17.	Parts of the teeth that must be brushed when brushing your teeth	26	79	31	93.9
18.	Dental caries treatment	19	58	27	81.8
19.	Dental caries cleaning	15	45	26	78.7
20.	Treatment of dental caries	22	67	31	93.9

There was a notable increase in knowledge about dental caries following an intervention using pop-up books. The most significant improvement was observed in knowledge related to the content of toothpaste that is beneficial for dental health, where correct responses increased from 36% before the intervention to 75.8% after the intervention (Table 3).

Table 4. Increase in average pretest and posttest scores in the experimental group and control group

Group	Pretest	Posttest	Mean (SD)	p value
Experiment	76.96	83.63	6.67	0.006
Control	79.67	77.63	-2.04	0.085

The increase in the average pretest and posttest scores in the control and experimental groups was analyzed to determine whether a significant difference in knowledge improvement existed between the experimental group, which received pop-up book counseling, and the control group, which received leaflet-based counseling (Table 4).

The results of the analysis in Table 4 show that the control group had a p-value of 0.085 in the independent t-test, which is greater than 0.05 ($p > 0.05$). This indicates that there was no significant difference in the pretest scores between the control group and experimental group regarding their level of knowledge about dental caries. However, after the intervention, the post-test results revealed a significant difference between the two groups, with a p-value of 0.006 ($p < 0.05$), indicating that the intervention using pop-up books was effective in increasing students' knowledge of dental caries.

Table 5. Analysis of the effectiveness of dental caries knowledge levels before and after giving pop-up books media education

Knowledge	n	Mean	p value
Experiment	33	83.63	0.001
Control	33	77.63	

The p-value obtained from the paired t-test in both groups was $p=0.001$, which is less than 0.005 ($p<0.05$). Therefore, it can be shown that there were significant differences between the control group and the experimental group. The level of knowledge about dental caries significantly differed between students who received counseling using pop-up book media and those who received leaflet media.

DISCUSSION

The frequency distribution of knowledge levels about dental caries (Table 1 and Table 2) before the intervention in the control group showed that most participants had a good level of knowledge, with 27 people (81.8%). After receiving counseling, the number of students with good knowledge in the control group decreased to 20 people (60.6%). In the experimental group, before receiving counseling treatment, 19 students (57.6%) demonstrated a good level of knowledge. Following the counseling with pop-up book media, this number increased to 27 people (81.8%). These results indicate an improvement in knowledge before and after the intervention, particularly in the experimental group. The increase in knowledge was most notable among female participants aged 11, who showed a higher proportion of good knowledge after receiving the pop-up book intervention.

Educational interventions using pop-up books are more engaging for children because they provide clearer visual representations. Unlike traditional books, pop-up books promote interaction with the learning material, enabling children to actively engage with the content. These books use three-dimensional designs created through techniques such as folding, rolling, and rotating. A key advantage of this medium is its tactile and interactive features, allowing readers to touch, open, and fold components of the book. This will help readers remember the material being studied.²³

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The results of this study are in line with previous studies demonstrating that pop-up books focusing on dental health are effective in enhancing elementary school students' knowledge.²⁴ This finding is supported by the increase in the knowledge scores observed among students who received educational guidance using pop-up books compared to those who did not. Pop-up books serve as an educational medium that positively influences students' learning outcomes.

The results of the difference test in Table 4 indicate a significant difference in post-test knowledge scores between the control and the experimental groups, as shown by the independent t-test result ($p=0.006$). This difference is also observed from the post-test scores presented in the table, with the experimental group showing higher knowledge scores than the control group. These findings suggest that the intervention using pop-up book media had a positive impact on improving students' knowledge of dental caries. This result is supported by other studies, which have shown that pop-up books, as an engaging three-dimensional (3D) learning medium, effectively captured children's attention. When opened, these books display illustrations in a dynamic and unique format, which can stimulate children's imagination and enhance comprehension.²³

Pop-up books are a form of three-dimensional visual media that can serve as an alternative educational tool. They are defined as animated books specifically designed to form a three-dimensional structure when the book is opened. The unique and engaging Visualization presented in pop-up books can stimulate children's interest in learning, enhance memory retention, and help develop their cognitive abilities. In addition, pop-up books can also function as a bridge between real-world situations and the symbols that represent them. The media images

presented in pop-up books are concrete so that it can overcome the limitations of one's observation and clarify complex topic.²⁵

Previous research supports the findings of this study. The effectiveness test comparing data before and after dental health education using pop-up books showed that the p-value in the intervention group was 0.000 ($p < 0.05$), while the control group had a p-value of 0.182, indicating that pop-up books are effective in improving dental health knowledge. Furthermore, based on the independent t-test, the results of the knowledge difference test between the intervention group and the control group yielded a p-value of 0.000 ($p < 0.05$), showing that the pop-up book medium was significantly more effective in improving oral health knowledge compared to the control group.²⁶

Pop-up books are a type of book that contains three-dimensional (3D) elements, allowing students not only to hear and read but also to be actively involved in the learning process.²⁴ Based on research conducted on respondents aged 10-11 years, some students still lacked knowledge about the importance of fluoride in toothbrushing. This was indicated by the low knowledge score related to the use of fluoride. To overcome this, follow-up activities can be conducted to help children reinforce the material they have learned. The term "fluoride" is not well understood by children, as language acquisition depends heavily on the regular use of words by people around them. The richer the language children are exposed to, the faster their vocabulary develops.²⁷

Children's vocabulary development accelerates with increased language input, which is closely tied to cognitive growth. This cognitive-linguistic connection directly impacts how children process health information. When teaching complex health concepts like fluoride use, educational strategies must account for both linguistic accessibility and evidence-based content. The Cochrane Library confirms the efficacy of fluoride toothpaste in preventing tooth decay compared to non-fluoride toothpaste. Current Guidelines strongly recommend twice-daily brushing for two minutes fluoride toothpaste to prevent dental caries and other oral health complications.²⁴

At the beginning of elementary school, students learn around 2,500 words by age 6-7 expanding to approximately 50,000 words by age 11-12. Several studies show that a 9-year-old child can speak a variety of different languages when consistently exposed to them. Such findings underscore how children's memory and use of vocabulary depends heavily on routine conversational practice.⁴

These cognitive-linguistic developments align with Jean Piaget's psychological theory, where, at the concrete operational stage, children have begun applying logical thinking to physical objects and situations. It is within this psychological framework that pop-up books prove particularly effective for children aged between 10 and 11 years old. The three-dimensional nature of pop-up books can provide a strong visual-tactile stimuli that match children's developing concrete thinking ability, and support their understanding of reversible transformations.²⁸

Based on the statistical test results in Table 5, there was a significant difference in knowledge scores before and after the intervention, as shown by the higher average knowledge score following the pop-up book intervention compared to before. The paired t-test produced a p-value of $0.000 < \alpha$ (0.05), indicating a statistically significant effect of the pop-up book as a learning medium. This result is supported by the increased knowledge scores among students who received instruction using the pop-up book medium, which were higher than those of the group that did not receive the pop-up book intervention. Thus, the pop-up book functions as an effective learning aid with a positive impact on students.

In other research, pop-up book learning media was shown to be effective in supporting students' knowledge, with the percentage of students demonstrating understanding increasing from 30% before the intervention to 92.5% afterward.²⁹ There were notable differences between students who received the pop-up book intervention and those who did not. Pop-up books allow students to interact directly with the content or stories presented, providing a more engaging learning experience. Furthermore, students' activeness can be assessed through

observation and tactile engagement, allowing them not only to read, but are also to actively involved in the learning process.³⁰

Pop-up books introduce elements of surprise, which can foster students' curiosity about the continuation of the material or story being presented. These surprises make students more enthusiastic about reading activities.²⁸ This medium has a special appeal, as it can stimulate children's imagination and increase their knowledge.²⁹ One of the advantages of pop-up books media is that it is made using durable, thick paper, making it less prone to damage such as tearing. Each page of a pop-up book features engaging illustrations that can motivate students to be more active and enthusiastic in participating in teaching and learning activities.^{26,31}

The limitations, observed in this study, based on the researcher's direct experience, include the limited number of respondents and the insufficient quantity of printed pop-up book media. It is therefore recommended that future studies increase the sample size and consider modifying or improving the educational media used. Additionally, this research was limited to short-term outcomes, and the long-term effects remain unknown.

CONCLUSION

Pop-up book media has been shown to improve knowledge about dental caries among elementary school students. This type of media is particularly suitable for children aged 10-11 years, as they are in the concrete operational of cognitive development, specifically the reversible transformation phase, during which they begin to understand the concept of change. By incorporating interactive elements that can be transformed and then returned to their initial form, pop-up books can enhance comprehension and make the learning process more engaging and effective. The implications findings of this study suggest that pop-up book can be used as effective medium for dental health education, helping to improve knowledge, shape attitudes, and encourage positive behavior- particularly regarding the prevention of dental caries.

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Data Availability Statement: Data supporting the findings of this study, including links to publicly archived datasets analyzed or generated, are available upon request.

Conflicts of Interest: The authors declare no conflict of interest

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