

EFFECTIVENESS OF DIGITAL POP-UP BOOKS IN IMPROVING ELEMENTARY STUDENTS' KNOWLEDGE OF EYE HEALTH

*Efektivitas Media Pop-Up Book Digital dalam Meningkatkan Pengetahuan
Kesehatan Mata Siswa Sekolah Dasar*

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ABSTRAK

Anak usia sekolah di Indonesia banyak mengalami kelainan penglihatan dan membutuhkan kacamata, salah satunya akibat rendahnya kesadaran kesehatan mata. Penelitian ini bertujuan mengevaluasi efektivitas buku pop-up digital sebagai media edukasi untuk meningkatkan pengetahuan siswa sekolah dasar tentang kesehatan mata. Desain penelitian kuasi-eksperimental one-group pretest-posttest melibatkan 56 siswa kelas lima di sebuah SD Islam di Tasikmalaya, Indonesia, yang dipilih dengan purposive sampling. Siswa diberikan buku pop-up digital kesehatan mata yang telah divalidasi dan disajikan secara interaktif di kelas. Intervensi dilakukan dalam satu sesi pada hari yang sama. Data dikumpulkan melalui tes pengetahuan 10 item sebelum dan sesudah intervensi, kemudian dianalisis menggunakan Wilcoxon Signed Rank Test. Hasil analisis menunjukkan peningkatan signifikan pada skor pengetahuan (rata-rata pretest $34,6 \pm 14,1$; posttest $86,6 \pm 11,4$; $p < 0,001$). Temuan ini menegaskan bahwa buku pop-up digital interaktif dan menarik secara visual efektif meningkatkan pemahaman serta retensi siswa mengenai kesehatan mata. Umpan balik siswa dan guru juga menunjukkan media ini mampu menumbuhkan motivasi dan minat belajar, serta berpotensi diadopsi lebih luas dalam edukasi kesehatan. Sebagai kesimpulan, buku pop-up digital merupakan inovasi yang berdampak positif dalam meningkatkan pengetahuan kesehatan mata anak. Integrasinya ke dalam program pendidikan seperti UKS atau pembelajaran reguler dapat berkontribusi pada peningkatan kesadaran dan praktik pencegahan kesehatan mata, sekaligus mendukung kesejahteraan generasi muda.

Kata kunci: kesehatan mata, pop-up book digital, siswa

ABSTRACT

School-age children in Indonesia are reported to experience visual impairments requiring corrective glasses. One contributing factor is the low public awareness of eye health, highlighting the need for educational interventions. This study aimed to evaluate the effectiveness of a digital pop-up book as an educational medium to improve elementary school students' knowledge of eye health. A quasi-experimental one-group pretest-posttest design was applied, involving 56 fifth-grade students from an Islamic elementary school in Tasikmalaya, Indonesia, selected through purposive sampling. Students were provided with a validated digital pop-up book on eye health, presented interactively in the classroom. The intervention was delivered in a single session, and knowledge was measured using a 10-item self-developed test administered before and after the session. Data were analyzed using the Wilcoxon Signed Rank Test. Results showed a significant increase in students' knowledge scores (pretest mean 34.6 ± 14.1 ; posttest mean 86.6 ± 11.4 ; $p < 0.001$). The findings indicate that interactive digital pop-up books effectively enhance students' understanding and retention of eye health concepts. Feedback from

students and three teachers emphasized the medium's ability to foster motivation and interest, with potential for broader application in health education. In conclusion, digital pop-up books are innovative and impactful tools for improving children's eye health knowledge. Their integration into educational initiatives, such as the School Health Program (UKS) or classroom learning, can significantly contribute to raising awareness and preventive practices, thereby supporting the overall well-being of younger generations.

Keywords: *eye health, pop-up book digital, students*

INTRODUCTION

Visual impairment has emerged as a critical global health issue, with prevalence rates increasing due to lifestyle changes and exposure to risk factors. According to the World Health Organization (WHO) 2021 report, approximately 2.2 billion people worldwide experience visual impairment, with at least one billion of these cases being preventable or unaddressed [1]. This issue is particularly pronounced in developing countries, where access to eye care services is often limited. Moreover, the WHO projects this figure will double if appropriate interventions are not implemented.

In Indonesia, the issue of visual impairment represents a significant challenge. As reported by the 2018 Basic Health Research (Riskesdas), approximately 20% of the 66 million school-age children in elementary school in Indonesia experience eye disorders at an early age, with as many as 80% of these children ultimately requiring the use of glasses [2], [3]. Insufficient awareness of eye health exacerbates this issue, leading to untreated vision disorders that can negatively impact children's cognitive development, social interactions, and academic performance.

One of the primary risk factors contributing to visual impairment in children is excessive screen time. In recent years, Indonesia has been identified as one of the countries with the highest rates of internet usage in the world, ranking fourth globally with an average screen time of approximately five hours per day among both children and adults [4], [5], [6]. Prolonged screen exposure has been linked to digital eye strain, dry eyes, and an increased prevalence of myopia [7], [8], [9]. Furthermore, excessive screen time can affect children's cognitive functions, emotional regulation, and overall well-being [10].

Recognizing the importance of early eye health education, the Indonesian government, through the Ministry of Health, has implemented the Vision Impairment Roadmap 2017–2030 [11]. This initiative focuses on a range of comprehensive measures, including the provision of corrective measures for school-aged children with visual impairments, the development of health services for individuals with diabetic retinopathy, glaucoma, and low vision, and the formulation of a comprehensive and inclusive vision rehabilitation concept. However, integrating structured and engaging eye health education into school learning remains a challenge.

Digital pop-up books offer a promising approach to enhancing eye health education among elementary school students. Pop-up books have been widely recognized for their effectiveness in improving children's comprehension and retention of educational content. Studies have shown that interactive educational materials, such as pop-up books, can significantly enhance knowledge acquisition in various health-related topics. For example, research by Rizkiyah et al. [11] demonstrated the efficacy of pop-up books in increasing students' awareness of COVID-19, while Herwanda et al. [12] found that pop-up books were more effective than traditional posters in promoting dental health knowledge [8].

Despite the proven benefits of pop-up books in health education, research on their application in eye health education remains limited. While studies such as those by Kulsum [13] and Aisah & Setiawan [14] suggest that pop-up books improve students' understanding of eye health concepts, gaps remain in the literature. Specifically, there is

a lack of research on the use of digital pop-up books and their integration into formal eye health education programs in Indonesia. Furthermore, studies employing robust experimental methodologies to evaluate their effectiveness are scarce.

Given these gaps, this study aims to develop and assess the effectiveness of a digital pop-up book intervention in improving elementary students' eye health knowledge in Indonesia. This study addresses a crucial question: How effective are digital pop-up books in enhancing students' comprehension and awareness of eye health? The research will provide insights into the role of digital pop-up books as an innovative educational tool, potentially informing future strategies for integrating eye health awareness into school learning while also fostering greater awareness of the significance of maintaining eye health among children and educators.

METHODS

This research employed a quasi-experimental one-group pretest-posttest design to measure changes in students' knowledge levels before and after the intervention. This design was chosen to facilitate within-group comparisons and provide insight into the impact of the intervention on the same group of subjects. While the absence of a control group presents limitations in establishing causality, this approach was deemed appropriate due to ethical and operational constraints, such as the limited availability of health practitioners and the need to provide equal educational opportunities to all students in the selected class.

The study was conducted in May 2023 with fifth-grade students from an Islamic elementary school in Tasikmalaya, Indonesia. The school was selected due to its established collaboration with the research team. Although it is a faith-based Islamic elementary school, it represents a typical educational setting in Tasikmalaya, particularly those serving lower to middle socioeconomic backgrounds. This makes the school relevant for broader generalization within similar contexts. Furthermore, preliminary discussions with the school indicated that students had limited prior exposure to structured health education programs, particularly regarding eye health. The school also demonstrated openness to integrating educational innovations, making it an appropriate setting to implement and evaluate the digital pop-up book intervention effectively.

A total of 56 students from a designated class participated, selected using purposive sampling. This technique was employed to ensure that participants met the inclusion criteria, specifically that they were becoming cognizant of their health and capable of comprehending information conveyed through visual-audio media. The primary variable investigated in this study was the students' knowledge of eye health, assessed both before and after the intervention employing a researcher-developed test. While this sampling method ensured a homogeneous sample for evaluating the intervention, it also limited the generalizability of the findings to other student populations.

The intervention in this study was a digital pop-up book designed to educate elementary students on eye health and proper eye care practices. The intervention was conducted in the same session on the same day. The research team developed this media using a research and development methodology to ensure educational quality and relevance for young learners. The digital pop-up book was designed to be interactive and visually engaging, incorporating multimedia elements such as animations, narrated text, and interactive content to enhance retention and engagement.

Before implementation, the digital pop-up book underwent content and design validation by a panel of experts comprising a media expert specializing in information technology, a subject matter expert in eye health and learning media, and an experienced elementary school teacher. The experts evaluated the content for accuracy, age appropriateness, and visual clarity, ensuring that the material was pedagogically sound and engaging. The validation process confirmed that all components met the required standards. Additionally, a preliminary pilot test was conducted with students

from a different school but within the same grade level. The feedback from the pilot study was used to refine the media for improved usability and comprehension. The final validated version of the digital pop-up book was then published on YouTube, making it easily accessible to students during the study.



Figure 1. Example of the developed pop-up book digital media

A self-administered knowledge test consisting of ten items was employed to assess students' comprehension of eye health before and after the intervention. The test was designed to evaluate key concepts covered in the digital pop-up book, including eye fatigue and its causes, eye examination, nutritious food for eye health, 20-20-20 rules, and various types of refractive error. The test's validity and reliability have been previously validated. The content validity was assessed through expert judgment, ensuring alignment with the educational objectives. The reliability analysis was conducted using Cronbach's Alpha, yielding a coefficient of 0.688, indicating acceptable internal consistency. Each test item underwent a thorough review process to ensure clarity and suitability for elementary school students.

Before the intervention, students were administered the pretest to establish a baseline understanding of eye health. The intervention, involving a digital pop-up book on eye health, was conducted once in a single session lasting approximately 45 minutes. During this session, following the intervention, students completed the post-test to ascertain any changes in their knowledge. To minimize potential bias, all students were given equal exposure to the intervention, with the same instructions and facilitation. All participants and their guardians provided informed consent for the study, with ethical approval granted by the Medical Research Ethics Commission (KEPK) of Universitas Bakti Tunas Husada (reference number 080/E.01/KEPK-BTH/V/2023). The data was analyzed using the Wilcoxon Signed Rank Test using free statistical software.

The data were analyzed using the Wilcoxon signed-rank test, as the data were not normally distributed. Additionally, the effect size (r) was calculated. This provided insight into the magnitude of the intervention's impact. Descriptive statistics, including pretest and posttest score distributions, were presented using tables and visualized through scatter plots to illustrate knowledge improvement trends.

RESULT

Vision problems are a significant concern for school-age children. Proper vision is crucial for academic performance, as students rely heavily on visual tasks such as

reading, writing, and using computers in the classroom [15]. Using a pop-up book focused on eye health education can serve as an innovative educational tool, leveraging the unique characteristics of pop-up media to enhance learning and retention among various age groups. The pop-up book digital media was developed to educate students about eye fatigue and its causes, eye examination, nutritious food for eye health, 20-20-20 rules, and various types of refractive error. Pop-up book digital media is an interactive form of digital storytelling that combines traditional pop-up book elements with digital technology [11]. This innovative medium enhances educational experiences by providing engaging, three-dimensional visualizations that can effectively convey complex information.

The effectiveness of the pop-up book digital media in enhancing students' knowledge of eye health was assessed through pretest and posttest evaluations. A total of 56 students (30 males and 26 females) aged 11-12 participated in the study. The pretest measured their baseline knowledge of eye health, followed by an educational session using a digital version of the pop-up book presented via projector, with explanations provided by an optometrist. The post-test then assessed knowledge improvement.

Table 1 shows the results of the analysis of differences in the average knowledge scores before and after eye health education using pop-up book media.

Table 1. Results of analysis of differences in knowledge for students

Variables	Measurement Result (n = 56)	p-value*
Pretest		
Mean ± SD	34.6 ± 14.1	
Median	30	
Posttest		<.001 (Z = -6.533)
Mean ± SD	86.6 ± 11.4	
Median	90	

*Wilcoxon Signed-Rank Test

Table 1 presents the results of the analysis of differences in knowledge among students before and after the intervention. A significant increase in knowledge scores was observed following the intervention. The mean pretest score was 34.6 ± 14.1, which increased to 86.6 ± 11.4 in the posttest, demonstrating a substantial improvement of 52 points. The Wilcoxon Signed-Rank Test confirmed the effectiveness of the pop-up book, with a p-value < 0.001, indicating a significant enhancement in students' understanding of eye health. The findings revealed that students' initial knowledge of eye health was limited, as corroborated by their feedback regarding insufficient prior exposure to eye health education from schools or healthcare services. The effect size was calculated resulting in $r = 0.87$, which indicates a large effect according to Cohen's guidelines. This suggests that the intervention had a substantial impact on participants' performance. The interactive and visual nature of the pop-up book filled these knowledge gaps, making the educational content more accessible and engaging. Students reported increased motivation and interest, likely contributing to their improved scores. For further analysis, the depiction of students' results on the pretest and post-test is presented in Figure 1.

Figure 1 visually depicts the pretest and post-test scores for 56 participants. The blue line, representing the pretest scores, shows wide variation, with most scores concentrated below 50. In contrast, the red line for post-test scores demonstrates a marked improvement, with most students scoring above 80 after the intervention. The annotation "p-value: 0.00" highlights the statistical significance of the results. Together, the table and graph emphasize the positive impact of the pop-up book intervention on students' understanding of eye health.

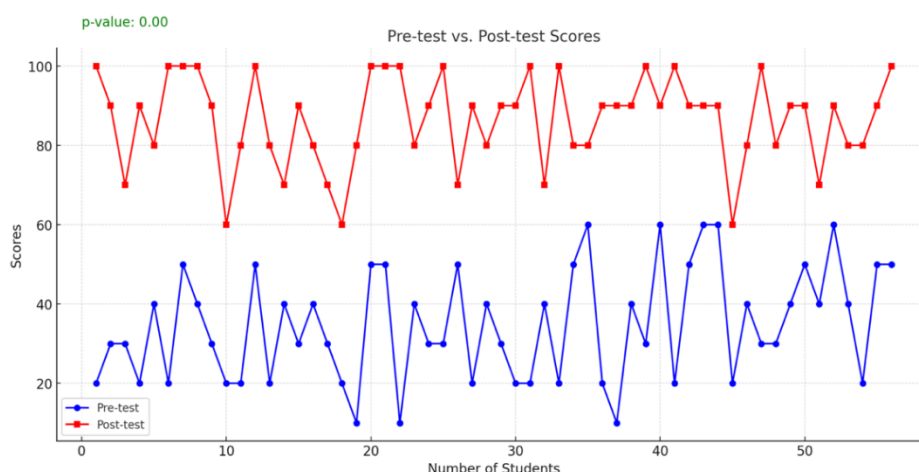


Figure 2. Comparison of Pre-Test and Post-Test Scores of Participants (N = 56)

Beyond the quantitative analysis, the qualitative insights gained from a brief interview conducted with students and teachers were invaluable. Students reported increased motivation and engagement, attributing their learning improvement to the interactive and visual nature of the digital pop-up book. Teachers highlighted its potential to complement traditional teaching methods by making abstract concepts more tangible and relatable. Some students also expressed that prior to this study, they had received minimal formal education about eye health, emphasizing the importance of such interventions.

DISCUSSION

The pretest results indicated a need for further education regarding eye health among the student population. The researcher sought to corroborate this finding, noting that their past exposure to eye health education from teachers and health services was insufficient. This lack of education may have contributed to the students' limited knowledge about eye health. The utilization of pop-up books as an educational medium for eye health provides students with a novel experience that can facilitate the acquisition of knowledge and address any existing gaps in their understanding.

The increase in post-test scores suggests that the pop-up book was effective in enhancing students' comprehension of the subject matter. However, it is important to acknowledge potential confounding factors that might have influenced these results. For instance, the effect of repeated testing (test effect) may have contributed to score improvement, as students became more familiar with the assessment format. Additionally, the Hawthorne effect—where students performed better due to increased attention during the study could have played a role [16]. The involvement of teachers or facilitators in delivering the material may have also contributed to the observed improvements. Future studies should incorporate control groups or alternative assessment methods to mitigate these potential biases.

This interactive and engaging approach has the potential to enhance students' comprehension of the subject matter. This was evidenced by an increase in the scores of students, potentially attributable to the interactive and visual nature of the pop-up books. Students indicated that they felt more motivated and interested in the material when using these interactive tools. Feedback from students and teachers corroborated the efficacy of the pop-up book as an engaging learning tool. Teachers observed its potential to supplement conventional teaching methods by rendering abstract or complex concepts more concrete and relatable. Students valued the novelty and interactivity of the medium, which facilitated their comprehension and enhanced their enjoyment of the subject matter.

The findings illustrate the potential of pop-up book media as a transformative educational instrument. The interactive and visually appealing format encourages active engagement, which effectively enhances comprehension and retention. The study demonstrated that students who interacted with the pop-up books exhibited superior information retention compared to those who utilized conventional educational techniques. This indicates that the incorporation of interactive elements into educational materials may result in more effective learning outcomes. The extant research indicates that pop-up books can significantly improve students' motivation and learning outcomes. For example, Yulia et al. indicate that the interactive nature of pop-up books encourages active student participation, thereby enhancing the meaningfulness and enjoyment of the learning experience [17]. This is consistent with the findings of Kustiawan and Yafie, who highlight that the visually stimulating aspects of pop-up media can facilitate language development and positive attitudes in early childhood education. Such engagement is crucial when addressing health topics, as it can enhance understanding and retention of critical information [18].

The development of pop-up books with a specific focus on health promotion has been explored in a number of different contexts. For example, the study by Rizkiyah et al. focused on the creation of pop-up books as a health promotion medium for elementary students and successfully conveyed important health messages in an engaging format [11]. This approach can be adapted to eye health, utilizing pop-up books to educate children about the importance of eye care, proper hygiene, and regular check-ups. Moreover, the research by Haryani and Siregar lends further support to the proposition that pop-up books can effectively enhance knowledge about health topics [19]. This reinforces the idea that this medium can be beneficial for promoting eye health awareness among students. This finding suggests that incorporating pop-up books into educational programs may be valuable for improving eye health literacy in young populations by incorporating relevant information and engaging narratives.

The impact of educational interventions, such as pop-up books, on the promotion of eye health education in schools is significant and complex. These interventions serve to augment students' knowledge and attitudes with regard to eye health while simultaneously engendering behavioral modifications that can enhance eye care practices among children. Firstly, the incorporation of pop-up books as a pedagogical tool for ocular health education can markedly enhance children's comprehension of eye care principles. Research conducted by Rizkiyah et al. indicates that pop-up books are an effective method of conveying health information in an engaging manner, which can lead to increased knowledge and awareness among elementary school students [11]. This is consistent with the findings of Paudel et al., who demonstrated that school-based eye health promotion significantly improved children's eye health literacy [20]. This suggests that interactive educational tools can be instrumental in fostering a culture of eye health awareness in schools. By making learning enjoyable and interactive, pop-up books can capture students' attention and encourage them to engage with the material more deeply.

Moreover, the involvement of parents and teachers is crucial in reinforcing the messages conveyed through these educational interventions. Liu et al. highlighted that parental involvement in eye health interventions positively impacted children's and parents' knowledge and attitudes towards eye care [21]. This suggests that school-based programs should target students and include components that engage parents, thereby creating a supportive environment for promoting eye health. Similarly, Yashadhana et al. emphasized the importance of training school staff and healthcare professionals to deliver eye health education effectively, which can help mitigate negative perceptions about eye care services [22]. Additionally, the implementation of school-based eye health programs can address systemic barriers to eye care. Burnett et al. noted that effective

coordination between education and health systems is essential for establishing appropriate referral pathways and follow-up mechanisms for students requiring eye care [23]. This highlights the need for schools to collaborate with health organizations to ensure that students have access to necessary eye care services, thereby reinforcing the educational messages delivered through interventions like pop-up books. Furthermore, the findings from Latorre-Arteaga et al. suggest that community health advocacy, with active participation from teachers, can enhance the effectiveness of eye health education initiatives [24]. By positioning teachers as advocates for eye health, schools can create a more robust framework for promoting eye care practices among students. This approach not only empowers educators but also fosters a community-wide commitment to improving children's eye health. The findings suggest that incorporating eye health education into school learning can have a significant impact on the overall well-being of students.

This study focused on a specific demographic, limiting the generalizability of its findings. Future research should include diverse populations across various educational settings to assess the broader applicability of pop-up books as health education tools. Investigating the long-term impacts of such interventions on students' knowledge retention and health behaviors would also provide valuable insights. Additionally, exploring the integration of emerging technologies, such as augmented reality, with pop-up book media could further enhance their educational impact.

Furthermore, the participation of parents and educators is of paramount importance in bolstering the messages conveyed through these educational initiatives. As Liu et al. have demonstrated, parental involvement in eye health interventions has a beneficial effect on children's and parents' knowledge and attitudes towards eye care [21]. This indicates that school-based programs should aim to engage students and incorporate components that involve parents, thereby fostering a supportive environment for promoting eye health. Similarly, Yashadhana et al. underscored the significance of training school personnel and healthcare professionals in the effective delivery of eye health education, which can assist in the reduction of unfavorable perceptions about eye care services [22]. Furthermore, the implementation of school-based eye health programs can address systemic barriers to eye care. Burnett et al. [23] observed that effective coordination between education and health systems is crucial for establishing appropriate referral pathways and follow-up mechanisms for students requiring eye care. This underscores the necessity for schools to collaborate with health organizations to guarantee that students have access to essential eye care services, thereby reinforcing the educational messages conveyed through interventions like pop-up books. Moreover, the findings of Latorre-Arteaga et al. indicate that community health advocacy, with active involvement from educators, can augment the efficacy of eye health education initiatives [24]. By positioning teachers as advocates for eye health, educational institutions can establish a more comprehensive structure for promoting eye care practices among students. This approach not only empowers educators but also fosters a community-wide commitment to improving children's eye health. The findings indicate that the incorporation of eye health education into school curricula can have a considerable impact on the overall well-being of students.

From this research, it was known that the pop-up book digital media was an innovative educational tool that helped students gain and enhance knowledge about eye health. The present study focused on a specific demographic, which limits the generalizability of its findings. To assess the broader applicability of pop-up books as health education tools, future research should include diverse populations across various educational settings. Furthermore, investigating the long-term impacts of such interventions on students' knowledge retention and health behaviors would provide valuable insights. The results advocate for integrating interactive media like pop-up books into school learning

as an effective means of health promotion. Moreover, increasing knowledge about eye health at an early age can lead to better preventive behaviors and early detection of eye problems, reducing long-term health burdens. Additionally, exploring the integration of emerging technologies, such as augmented reality, with pop-up book media could enhance their educational impact.

CONCLUSION

This study demonstrates that digital pop-up books are effective in enhancing elementary school students' understanding of health education. With their interactive features, these books successfully capture students' interest and visually clarify health concepts. The practical implication of this research is the integration of digital pop-up books into the elementary school health education curriculum. Educators can use them as complementary teaching media alongside conventional methods, enriching students' learning experiences. Additionally, teachers can adapt the content to suit specific classroom needs and subjects. For future research, it is recommended to explore the long-term impact of digital pop-up books on students' knowledge retention and comprehension. Furthermore, the development of additional technologies, such as augmented reality, could be considered to create a more immersive and interactive learning experience.

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