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Development of Smart Toothbrush (VIT-Brush) to Improve Toothbrushing Behavior of Visually Impaired Children

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ABSTRACT Children with visual impairments are a group that requires special services related to motor skills. Sensory impairments in children with visual impairments can affect their ability to imitate movements, causing difficulties in understanding and mastering dental and oral hygiene techniques. Therefore, a smart toothbrush (VIT-Brush) with a multisensory approach based on movement, vibration, and audio was developed as an alternative. This study aims to develop a Smart Toothbrush (VIT-Brush) that is feasible and effective in improving tooth brushing behavior and reducing debris index scores in visually impaired children. This study uses the Research and Development (R&D) method using the application of quasi experiment pre and post test with control group design. The research subjects were 32 children with visual impairments aged 7-14 years, divided into intervention groups using Smart Toothbrush (VIT-Brush) and control groups using conventional toothbrushes, for 21 days. Independent variable is Smart Toothbrush (VIT-Brush), while dependent variable of tooth brushing behavior and debris index score of visually impaired children. Feasibility test analysis using Aiken's V and ICC, effectiveness test using Wilcoxon and Mann-Whitney. A smart toothbrush (VIT-Brush) has been developed based on the characteristics and inclusiveness of visually impaired children that is validated and feasible to implement with a V value = 0.941 very high validity category and high reliability with a value of 0.776 (p=0.000). The results of the application of smart toothbrush (VIT-Brush) are more effective in increasing knowledge (p=0.000), attitudes (p=0.000) and tooth brushing actions (p=0.000) and reducing the debris index score with a value of (p=0.000) compared to the use of conventional toothbrushes. The conclusion of this study is to produce a Smart Toothbrush (VIT-Brush) that is feasible and effective in improving tooth brushing behavior as measured by knowledge, attitudes and actions and reducing the debris index score of visually impaired children.

INDEX TERMS Smart Toothbrush (VIT-Brush), Tooth Brushing Behavior, Visually Impaired Children.

I. INTRODUCTION

Oral health is a very important component of overall health indicators. Many functions and impairments of oral health are directly and indirectly linked to heath alterations outside the oral cavity.[1] Damage to teeth can affect the health of other parts of the body. The presence of serious health issues within the oral cavity can lead to a decline in an individual's quality of life.[2] Neglecting oral health care and not making it a priority will result in a high prevalence of oral health problems.[3]

Children with visual impairments are a type of special needs child who have physical abnormalities that affect their vision, meaning they cannot see their surroundings and therefore require special services. It is a condition that can significantly impact all areas of a child's development, with education playing a critical role in determining their overall quality of life and long term social and economic position.[4] Visual impairment can occur due to several factors, such as age, genetics, childhood blindness, and virus infections.[5]

Recent research has shown that the prevalence of caries for primary and permanent teeth the average OHI-S was 15% and 46%, respectively, 2.43 ± 1.03 in different age groups in visually impaired children. In another study, mean OHI-S score was 1.51 ± 0.93 and mean Decayed, Missing, and Filled teeth (DMF-T) score was 0.94 ± 1.4 in the 7–17-year age group. In a recent study performed in China, the overall caries prevalence was 78.64%, and the mean caries count was 2.43 ± 2.75. The prevalence of caries was 65.22% in primary dentition and 71.84% in permanent dentition, respectively. Gingival bleeding rates were 44.66%, and dental calculus was 67.96%.[6]

Based on the results of a survey conducted in 15 provinces in Indonesia, the highest rate of blindness was found to be 4.4% in East Java.[7] According to data, of all children with special needs in Indonesia, there are 679,048 (21.42%) school-aged children.[8] Overall, the prevalence of caries in children with visual impairments was 92.6%, while in children aged 7-18 years, the prevalence of caries was 94.3% with an average DMF-T score of 4.8, which exceeds the WHO target of a DMF-T index of ≤ 1 tooth.[9],[10] The level of dental and oral hygiene among children with visual impairments in the poor category was 41%[11], while among those aged 12-16 years in the poor category, the average OHI-S index score was 4.02.[12]

Children with visual impairments face unique challenges in maintaining proper oral hygiene, relying predominantly on tactile sensations rather than visual cues. This reliance makes it difficult for dental professionals to teach and for children to adopt proper brushing techniques.[13] Visual impairment limits the daily lives of visually impaired children, ranging from poor motor skills to challenges in education and healthcare access. These restrictions impede their growth and impair their learning abilities to perform routine health and hygiene tasks such as dental hygiene.[14] Children with special needs require assistance in maintaining oral hygiene. They are unable to perform daily activities normally and therefore require assistance from others around them, including parents, family members, caregivers, and teachers at school. Children with special needs tend to still lack independence in performing personal hygiene tasks. Many still require assistance from teachers (at school) and parents (at home) when brushing their teeth.[15]

Behavior is an individual's reaction to external stimuli. Behavior is divided into three domains, namely knowledge, attitude, and practice. Meanwhile, health status is influenced by environmental factors, behavior, genetics, and medical services. This aligns with H. L. Bloom's theory, as outlined by Hendrik L. Bloom (1974).[16] In enhancing individual behavior, the underlying theory of behavioral change is the Theory of Planned Behavior (TPB), which states that an individual's actions are determined by their intention or intensity of action, subjective norms, and perceived behavioral control.[16] The main components of this theory are attitudes toward behavior, subjective norms, and perceived behavioral control. These factors influence behavioral intention, which ultimately leads to actual behavior.

Technological developments, especially in the field of health, include innovations in various types of toothbrushes. Some of them are designed and useful for individuals with physical and mental limitations.[17] Brushing teeth is one of the preventive measures against the risk of dental and oral diseases, especially for cleaning plaque and food debris. Its effectiveness is greatly influenced by the accuracy in brushing all surfaces of the teeth.[18] Currently, there are many types of toothbrushes available, but their use is not yet optimal for children with disabilities. Therefore, there is a need for a tool that can help children with special needs maintain good oral hygiene. Children with physical disabilities, visual impairments, and intellectual disabilities have motor skill deficiencies that make it difficult for them to brush their teeth properly and effectively. Therefore, the use of automatic toothbrushes can be a solution to help them maintain oral hygiene more easily and effectively.[19] Children with visual impairments find it difficult to visualize the correct way to brush their teeth. A multisensory approach using a motion-sensor toothbrush equipped with audio guidance for brushing is appropriate for children with visual impairments, helping them to brush their teeth correctly.

Based on this, efforts are needed to effectively improve toothbrushing behavior in children with visual impairments by providing education and preventive measures to children with visual impairments using sensor-based technology. Therefore, it is necessary to create an innovation and modification of the Smart Toothbrush (VIT-Brush) to improve toothbrushing behavior in children with visual impairments.

II. METHOD

This study uses the Research and Development (R&D) method, which aims to develop a Smart Toothbrush (VIT-Brush) for children with visual impairments. This method aims to test, develop, and create a specific product. In this study, the goal is to produce a smart toothbrush (VIT-Brush) development tool, test its effectiveness, and assess the feasibility of its development. The product is designed innovatively to improve children's toothbrushing behavior, particularly for those with visual impairments. Data collection for the research used a descriptive method, involving interviews and literature reviews, while the effectiveness of the product was tested using an analytical method. The R&D procedure consists of five main stages: 1) Information gathering, 2) Product design, 3) Expert validation and revision, 4) Product testing, and 5) Product results.[20]

A. STUDY DESIGN AND RATIONALE

The design used in this study is a quasi-experimental pre- and post-test with a control group. This design was used to analyze the Smart Toothbrush (VIT-Brush) in relation to behavior, including knowledge, attitude, and toothbrushing practices, as well as the debris index scores of children with visual impairments. The independent variable in this study is the Smart Toothbrush (VIT-Brush), while the dependent variables are behavior and debris index scores in children with visual impairments. The design in this study can be illustrated as follows :[21]

$$O_1 \rightarrow X \rightarrow O_2$$
$$O_3 \rightarrow C \rightarrow O_4$$

Description :

O_1, O_3 : Pretest
O_2, O_4 : Posttest
X : Intervention group using VIT-Brush
C : Control group using conventional toothbrush

The selected design allows for the evaluation of changes in subjects over time, which is appropriate for assessing the immediate effects of the tool's application on a population of children with visual impairments, even with a small sample size. Although this approach limits conclusions regarding long-term knowledge retention or behavioral changes, it provides important initial results regarding the effectiveness of the Smart Toothbrush (VIT-Brush) intervention. Considering the needs of children with visual impairments and a multisensory approach that combines audio with other sensory inputs.[22]

B. STUDY SETTING

This study was conducted at SLB-SMPLB A YPAB Surabaya and SLB Negeri Gedangan Sidoarjo from January to April 2025, covering the stages of preparation, information and data collection, implementation, and data analysis.

C. PARTICIPANTS AND SAMPLING METHOD

The study population in this study being children with visual impairments of school age (elementary to junior high school) in the Surabaya and Sidoarjo areas. The research sample is divided into two groups: Sample I includes the information collection phase using purposive sampling techniques, comprising the Principal at Special Needs School, Teachers at Special Needs School, Psychologists, Dental and oral therapist

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at the Community Health Center, and parents of children with visual impairments. Sample II consists of the expert validation and revision stage using purposive sampling, with a total of 4 individuals who are experts/specialists in the fields of electromedical technology, information technology, special education experts and psychology.

The product implementation and trial phase involved respondents who met the variables and inclusion requirements, namely children with visual impairments at SLB-SMPLB A YPAB Surabaya as the intervention group and children with visual impairments at SLB Negeri Gedangan Sidoarjo as the control group. The sample size was calculated using Lameshow's formula for two-group hypothesis testing.[23]

Based on previous research,[24] which was later adapted by subsequent researchers with the same respondents, namely children with special needs,[25] the number of respondents was calculated to be 14 responden. Anticipating respondent dropouts, the number of respondents was increased by 10% based on the dropout anticipation formula, resulting in 16 respondents in each group.[26] The inclusion criteria for selecting study respondents in this research, that is:

1. Children with visual impairments aged 7–14 years,
2. Classified as having partial blindness (low vision) or totally blind.
3. Without any other disabilities.
4. Willing to participate in the study by signing an informed consent form.

D. MATERIALS AND EDUCATIONAL INTERVENTION

The main medium used is a smart toothbrush (VIT-Brush), which is an electric toothbrush equipped with motion, vibration, and audio sensors designed for children with visual impairments. It aims to improve toothbrushing behavior in children with visual impairments, with product quality measured using David Garvin's Eight Dimensions of Quality.[27]

Combining sensors and initialization between ESP32C3 mini and GY-61 with ADXL335 chip, which is then programmed to brush teeth properly, correctly, and precisely. Brushing instructions can be heard through audio, accompanied by instructions for detecting correct and incorrect movements using an IMU (Inertial Measurement Unit) sensor.[28]

In the intervention group, smart toothbrush (VIT-Brush) was used with a duration according to programming, namely 8x brushing movements according to instructions on 11 tooth surfaces. Meanwhile, the control group used a conventional toothbrush.

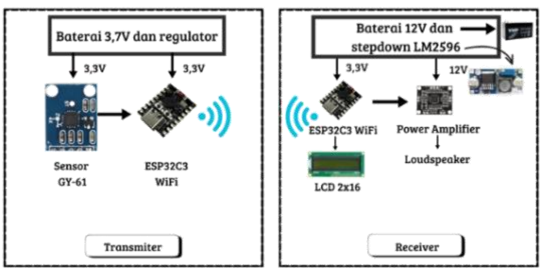

Figure 1. Transmitter and Receiver Block Diagram

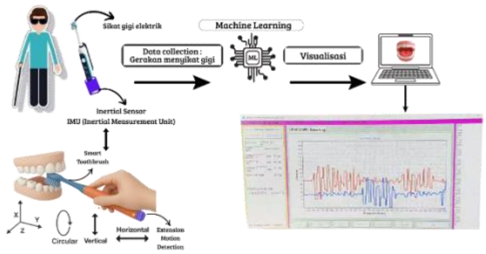

Figure 2. Input-Process-Output


Figure 3. The electric toothbrush is connected to a brush extension that contains a movement sensor.

E. DATA COLLECTION INSTRUMENTS AND PROCEDURE

The instruments used in this study consisted of a questionnaire assessing the feasibility of the Smart Toothbrush product by experts, a questionnaire on knowledge and attitudes toward maintaining dental and oral hygiene/brushing teeth in children with visual impairments, an observation sheet on toothbrushing actions/practices, and an examination sheet on the debris index in children with visual impairments. This questionnaire was adapted from a validated measurement tool and modified to suit the respondents, using simple language and Braille text. The product feasibility assessment questionnaire was evaluated by four experts to determine the feasibility of the smart toothbrush (VIT-Brush) before conducting a trial with children with visual impairments.[29] The feasibility of the smart toothbrush (VIT-Brush) was measured using the Aiken V validity test and ICC (Interclass Correlation Coefficient) with the following results:

a. 0,91 – 1 : Very high reliability
b. 0,76 – 0,90 : High reliability
c. 0,51 – 0,75 : Moderate reliability
d. ≤ 0,50 : Weak reliability

Before the intervention, children with visual impairments filled out a pretest questionnaire to assess their individual knowledge and attitudes under supervision to ensure the respondent's understanding. Debris index scores were examined and toothbrushing actions were observed. After the pretest, the intervention using a smart toothbrush (VIT-Brush) began the following day, starting with an introduction, training in the use of the device, and regular use for 21 days. The control group was given treatment using a conventional toothbrush. After 21 days of application, a posttest was conducted using the same method as the pretest.

F. DATA ANALYSIS

The data collected included interview results, feasibility test results, questionnaire pretest and posttest results, which were then analyzed descriptively and analytically. The data analysis techniques used in this study were the Wilcoxon test to determine the differences before and after the intervention. Meanwhile, to test the effectiveness between groups, the Mann-Whitney test were used.

G. ETHICAL CONSIDERATIONS

The ethical feasibility testing was conducted at the Ethics Committee of the Semarang Ministry of Health Polytechnic, following the applicable administrative procedures in accordance with the research location, with Ethics Approval No. 175/EA/F.XXIII.38/2025. Written consent was obtained through an informed consent form completed and signed by the parents or guardians of all research participants, following an explanation provided by the researcher.

Research ethics encompasses ethical principles that are applied primarily in relation to research participants. The ethical principles applied in this research include obtaining informed consent, maintaining confidentiality of respondent information and data, respecting human dignity, beneficence, and non-maleficence.[30]

III. RESULTS

Based on the information gathered, it can be concluded that children with visual impairments experience difficulties in visualizing the correct and proper way to brush their teeth, making them prone to dental and oral health problems. Government dental health programs already exist, but they are still general in nature and not tailored to individual needs. Effective learning for visual impairments requires practical, audio-based, and technology-based approaches. Technology is essential as an aid for independent toothbrushing, with support from teachers and parents to establish clean living habits.

TABLE 1
Validation Test Results

Variable	Score	*p-value*	Category
Feasibility	94,75%		Highly desirable
Aiken V	0,941		Very high validity
ICC	0,776	0,000	High realiability

Based on **TABLE 1**, it shows that the product feasibility level is 94.75% in the highly feasible category, with an Aiken V validity test result of 0.941 in the very high validity category with a high reliability level of 0.776 (p=0.000).

TABLE 2
Frequency Distribution of Characteristics of Respondents with Visual Impairment

Characteristics	Intervention N	Intervention %	Control N	Control %	*p-value*
Gender					
Male	7	44	6	38	0,719
Female	9	56	10	62	
Age					
7-10 years	5	31	5	31	1,000
11-14 years	11	69	11	69	
Class Level					
Elementary School	9	56	11	69	0,465
Junior High School	7	44	5	31	

Based on **TABLE 2**, it can be concluded that most of the respondents with visual impairment were female. The majority of respondents were aged 11-14 years. In terms of grade level, most respondents were in elementary school. It can be concluded that these three characteristics had the same proportion and variance (p>0.05).

Based on **TABLE 3**, shows that there was an increase in the average score for the variables of knowledge, attitude, and behavior of children with visual impairments in both the intervention and control groups. The average knowledge score of children with visual impairments in the intervention group increased from 46.93 to 98.21, the average attitude score increased from 54.62 to 87.31, and the average behavior score increased from 42.81 to 97.37. Meanwhile, in the control group, the average knowledge score of children with visual impairments increased from 50.43 to 57.56, the attitude score increased from 57.93 to 64.25, and the behavior score increased from 37.12 to 44.81.

TABLE 3
Average Behavior and Debris Index Scores of Children with Visual Impairment

Variables	Intervention Pretest	Intervention Posttest	Control Pretest	Control Posttest
Knowledge				
Mean	46,93	98,21	50,43	57,56
SD	10,52	3,19	15,85	15,40
Min-Max	36-71	92,8-100	29-71	29-79
Attitude				
Mean	54,62	87,31	57,93	64,25
SD	7,35	6,88	7,45	9,68
Min-Max	46-70	79-100	46-71	46-80
Practice				
Mean	42,81	97.37	37,12	44,81
SD	18,53	5,95	17,97	16,67
Min-Max	8-75	83-100	17-75	25-75
Debris Score Index				
Mean	2,13	0,41	2,17	2,01
SD	0,46	0,21	0,33	0,30
Min-Max	1-2,8	0,2-1	1,7-2,7	1,5-2,5

There was a decrease in the average debris index score among children with visual impairments in both the intervention and control groups. In the intervention group, the score decreased from 2.13 to 0.41, and in the control group, it decreased from 2.17 to 2.01.

TABLE 4
Normality Test of Intervention Group and Control Group Behavior of Children with visual impairment

Variable	*p-value* Intervention Pretest	Intervention Posttest	Control Pretest	Control Posttest
Knowledge	0,036	0,000	0,008	0,041
Attitude	0,017	0,066	0,345	0,606
Practice	0,782	0,000	0,053	0,158
Debris Score Index	0,352	0,000	0,264	0,098

Based on **TABLE 4** shows that there are test results indicating that the data is normally distributed (p>0.05) and not normally distributed (p<0.05).

TABLE 5
Testing the Effectiveness of Smart Toothbrushes (VIT-Brush) in Improving Toothbrushing Behavior and Reducing Debris Index Scores in Children with Visual Impairments

Goup/ Variables	Pretest x̄ ± SD	Posttest x̄ ± SD	Δ	*p-value*
Intervention				
Knowledge	46,93 ± 10,52	98,21 ± 3,19	51,28	0,000
Attitude	54,62 ± 7,35	87,31 ± 6,88	32,69	0,000
Practice	42,81 ± 18,53	97,37 ± 5,95	54,56	0,000
Debris Score Index	2,31 ± 0,46	0,41 ± 0,21	1,9	0,000
Control				
Knowledge	50,43 ± 15,85	57,56 ± 15,40	7,13	0,004
Attitude	57,93 ± 7,45	64,25 ± 9,68	6,32	0,000

Practice	37,12 ± 17,97	44,81 ± 16,67	7,69	0,005
Debris Score Index	2,17 ± 0,33	2,01 ± 0,30	0,16	0,093

Based on **TABLE 5**, the results on the variables of knowledge, attitude, and behavior of children with visual impairments in the intervention group showed p-values of 0.000, 0.000, and 0.000, respectively. From these results, it was found that $p < 0.05$, indicating that the smart toothbrush (VIT-Brush) is effective in improving the knowledge, attitude, and behavior of children with visual impairments regarding toothbrushing.

For the debris index score variable in children with visual impairments in the intervention group, the p-value was 0.000 ($p < 0.05$), indicating that the smart toothbrush (VIT-Brush) is effective in reducing the debris index score in children with visual impairments compared to the control group.

IV. DISCUSSION

The results of information gathering obtained through interviews led to the conclusion that children with visual impairments are a classification of children with special needs who experience problems or obstacles with their sense of sight. Sensory disorders in children with visual impairments result in limitations in mobility and the ability to imitate movements, thereby hindering motor development. This is influenced by a lack of visual stimulation.[31] The main objective of this study was to develop a viable Smart Toothbrush (VIT-Brush) and analyze its effectiveness in improving toothbrushing behavior and reducing debris index scores in children with visual impairments. The results of the study indicate a significant improvement in behavior, as measured by knowledge, attitude, and action, as well as a reduction in debris index scores among children with visual impairments before and after the implementation of the Smart Toothbrush (VIT-Brush) intervention.

The expert validation results yielded a value of V=0.941, indicating that the smart toothbrush (VIT-Brush) as an effort to improve toothbrushing behavior in children with visual impairments has a very high level of validity. Furthermore, in the ICC (Interclass Correlation Coefficient) test as a reliability test, a value of 0.776 was obtained, indicating high reliability with a significant p-value of 0.000, meaning that the smart toothbrush (VIT-Brush) as an effort to improve toothbrushing behavior and reduce debris index scores in children with visual impairments is relevant as a tool/product that can be implemented. To test the effectiveness of the smart toothbrush (VIT-Brush), a control group was involved that used conventional toothbrushes. The trial of the smart toothbrush (VIT-Brush) on behavioral changes in children with visual impairments can be seen from the increase in the knowledge, attitude, and behavior scores of children with visual impairments before and after treatment.

The results of the analysis of the average increase in knowledge, attitude, and behavior of children with visual impairments after the intervention were obtained. The success in improving the knowledge, attitudes, and behaviors of children with visual impairments is attributed to the implementation of the smart toothbrush intervention (VIT-Brush). The effectiveness of the intervention for children with visual impairments can be achieved through a multisensory approach based on audio, vibration, and movement, which facilitates children with visual impairments in understanding the toothbrushing procedure. This aligns with research findings indicating that children with visual impairments can maintain acceptable levels of oral hygiene when taught using specialized, tailored methods such as a multisensory approach that creatively utilizes other senses, which has proven more effective than unisensory methods.[32]

The appropriate approach to oral health care for children with visual impairments involves practical, demonstrative, guided, and continuous toothbrushing techniques that adapt to advancements in technological innovation. Children with visual impairments differ from typical children in their ability to visualize demonstrated movements. This aligns with previous research indicating that children with visual impairments are less able to maintain proper oral hygiene and are not yet proficient in performing the correct steps for brushing their teeth, such as applying toothpaste or rinsing their mouths before brushing.[33]

The use of innovative toothbrushes tailored to the characteristics of children with visual impairments can serve as a medium for learning how to brush teeth properly and as a preventive measure in maintaining the dental and oral health of children with visual impairments. Similarly, it is stated that educational tools are aids used to support the learning and teaching process to make it more effective and efficient, enabling students to absorb the material effectively. Educational tools serve as a visualization of material that is difficult to understand through verbal explanation alone. Educational tools are categorized into several groups: print-based educational tools, audio-visual educational tools, computer-based educational tools, and combined educational tools.[34] The use of technology-based innovations and sensors in the form of movement and audio for children with visual impairments can provide an easier learning model. This aligns with previous research indicating that the development of inclusive technology continues to be tailored to the needs of children with visual impairments through a multisensory approach that combines audio with other sensory inputs.[22] Meanwhile, movement can be programmed using an IMU (Inertial Measurement Unit) sensor, which can detect movements such as brushing teeth.[28] Multisensory interaction supports learning, inclusion, and collaboration by accommodating diverse cognitive and perceptual needs. This integration combines information from multiple senses, such as sight, hearing, touch, and proprioception, into a unified experience, especially when the sensory inputs are similar.[35]

The results of the trial of the smart toothbrush (VIT-Brush) on changes in the debris index scores of children with visual impairments before and after treatment can be seen from the decrease in the debris index scores of children with visual impairments. In this case, it shows that the intervention group showed a much better decrease in debris index scores between before and after treatment compared to the control group. The results of the effectiveness test of debris index scores before and after treatment in children with visual impairments show that the p-value for the intervention group is 0.000 ($p<0.05$), while for the control group the p-value is 0.093 ($p>0.05$), meaning that the smart toothbrush (VIT-Brush) is more effective in reducing debris index scores in children with visual impairments compared to the control group.

A significant decrease in debris index scores was influenced by the proper use of a smart toothbrush (VIT-Brush), as it has motion and audio sensors to visualize the correctness of movements, which can help children with visual impairments brush their teeth. This aligns with previous research indicating that the development of inclusive technology continues to be tailored to the needs of children with visual impairments through a multisensory approach that combines audio with other sensory inputs.[22] Audio as a guide and music have been proven to motivate tooth brushing activities. The use of an "instructed tooth brushing program" through Braille, audio, and music-based brushing systems has shown improvements in dental hygiene and a reduction in plaque in children with visual impairments.[36]

This study provides a valuable contribution to the development of literature emphasizing the importance of maintaining dental health through technology-based media for children with special needs, specifically those with visual impairments, focusing on the role of multisensory approaches. It is hoped that future research will be more comprehensive, including advancements in sensor technology, design, features, a larger sample size [5], and a longer intervention period to assess the long-term effectiveness of the tool's application. However, limitations in the study of the smart toothbrush (VIT-Brush) for children with visual impairments include threshold issues, a non-waterproof enclosure box, and the need for parental supervision.

V. CONCLUSION

The conclusion of this study is that the smart toothbrush (VIT-Brush) is worth developing based on information gathering and literature studies as an effort to improve toothbrushing behavior and reduce the debris index score of children with visual impairments. The smart toothbrush (VIT-Brush) is effective in improving toothbrushing behavior as measured by knowledge, attitude, and action, as well as reducing the debris index score of children with visual impairments.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

The researchers designed and formulated this study, collected data, and participated in data analysis and interpretation. They contributed to the development of the smart toothbrush (VIT-Brush) tool, supervised the implementation of the intervention, and contributed to the writing and revision of the manuscript. They analyzed and interpreted the data and provided critical input on the manuscript. All participated in the literature review, data collection, and manuscript editing. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work, ensuring integrity and accuracy.

DECLARATIONS

ETHICAL APPROVAL

The ethical feasibility testing was conducted at the Ethics Committee of the Semarang Ministry of Health Polytechnic, following the applicable administrative procedures in accordance with the research location, with Ethics Approval No. 175/EA/F.XXIII.38/2025. Written consent was obtained through an informed consent form completed and signed by the parents or guardians of all research participants after receiving an explanation from the researcher. All procedures conducted adhered to ethical guidelines for research involving human subjects.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare no competing interests.

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