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Article

A Mixed-Methods Comparative Evaluation of a Multimedia-Enhanced Microteaching Intervention for Improving Oral Health Outcomes in Indonesian Elementary Schools

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Abstract

Background: Oral health issues in school-aged children persist as a global concern, particularly in underdeveloped nations. Despite numerous school-based health promotion initiatives, Indonesia still has a high rate of dental cavities and poor oral hygiene among elementary school kids. **Objective:** This study sought to assess, via a mixed-methods comparative design, the efficacy of a multimedia-enhanced microteaching training model for primary school educators in enhancing students' oral health knowledge, behavior, and clinical outcomes. **Methods:** A mixed-methods sequential explanatory design was utilized, integrating quantitative and qualitative data. A total of 582 students and their teachers from public elementary schools in Pohuwato District, Gorontalo, Indonesia, were recruited and divided into three groups: (1) multimedia + microteaching training (intervention 1), (2) multimedia-only training (intervention 2), and (3) a control group (no training). The Oral Hygiene Index Simplified (OHI-S), DMFT scores, and Knowledge–Attitude–Practice (KAP) questionnaires were utilized for quantitative evaluation. Friedman and Wilcoxon tests were used to look at the data. Focus Group Discussions (FGDs) qualitatively examined teachers' experiences. **Results:** The multimedia-enhanced microteaching group exhibited the most significant enhancement in students' oral hygiene ($p < 0.001$) and knowledge–attitude–practice scores ($p < 0.05$) when compared to both the multimedia-only and control groups. Qualitative studies indicated enhanced teacher confidence, improved communication with students, and increased sustainability of oral health behaviors. **Conclusion:** The multimedia-enhanced microteaching methodology was far better than traditional training at improving both behavioral and clinical oral health outcomes in primary school kids. This new idea provides a scalable mechanism for adding teacher-centered oral health education to health promotion programs in Indonesian schools.

Keywords: multimedia learning; teacher training; elementary school; microteaching; oral health education

1. Introduction

Oral health is an important part of general health that influences how to eat, talk, and interact with others. Poor dental health has been linked to pain, worse grades, and lower self-esteem in kids (Abuhaloob & Petersen, 2023; Baldi et al., 2023; Anil & Anand, 2017). Dental caries remains one of the most prevalent chronic diseases worldwide, commencing in early childhood and continuing throughout life (Hall-Scullin et al., 2017; Sheng et al., 2024). These global findings highlight the importance of early oral health education in forming lifelong habits and efficiently reducing dental issues (Baldwin, 2013).

Socioeconomic disparities greatly exacerbate oral health disparity. Children from economically disadvantaged families with lower educational attainment are more susceptible to poor oral hygiene and a higher incidence of dental caries, often due to insufficient health literacy and restricted access to preventive services (Cianetti et al., 2017; Asawa et al., 2018; Bolt-Evensen et al., 2018; Park et al., 2016). Oral health poses a substantial public health challenge in Indonesia. The prevalence of dental caries among school-aged children continues to be high, suggesting inadequacies in preventive strategies and limited efficacy of school-based health promotion programs (Dwiastuti & Kristianto, 2023). These characteristics highlight the imperative to improve the educational component of oral health interventions through the use of more engaging and pedagogically sound methodologies.

Schools are crucial places to promote oral health because they provide structured environments that help people develop healthy habits (Barnard, 2023; Chandrashekar et al., 2012; Tubert-Jeannin et al., 2012). Teachers meet students almost every day and can be good role models for teaching them good hygiene habits. However, many teachers have limited formal training in health education, which makes it hard for them to make learning fun and useful (Purohit et al., 2024; Darwita et al., 2011). Traditional oral health education, usually delivered through lectures or posters, tends to be didactic and passive, leading to minimal changes in students' behavior (Jackson, 2016). Giving teachers creative, student-centered teaching methods is important for making long-lasting changes in oral health behavior (Irwandi et al., 2016).

Multimedia-assisted instruction has gained more attention as an effective tool for health education. Multimedia can engage several senses by combining text, visuals, animation, and sound. This can lead to more active participation and better knowledge and memory retention (Kurniawati, 2018; Chang et al., 2012; Ampa et al., 2013). Its adaptive and engaging features promote personalized learning, allowing learners to absorb information at their own pace (Wiana, 2018; Rachmadtullah et al., 2019). Empirical studies demonstrate that multimedia-based learning improves learners' confidence, motivation, and conceptual comprehension, making it particularly advantageous in health promotion contexts (Mariño et al., 2016; Bajpai et al., 2019; Kenny et al., 2018). Multimedia interventions in oral health education have been shown to enhance children's knowledge and attitudes toward dental hygiene (Barber et al., 2018; Pei et al., 2017).

Microteaching is a well-known way for teachers to practice and improve certain teaching skills in a controlled, reflective setting (Bracksley-O'Grady et al., 2015; Mahsunah & Waryanto, 2018). It emphasizes the achievement of competency through succinct, focused educational sessions followed by assessment and enhancement. This cycle of practice and reflection makes teachers better at their jobs, more confident, and better at communicating with students (Chuenjitwongsa et al., 2018). Microteaching, in conjunction with multimedia, offers an innovative platform for experiential learning, allowing educators to gain understanding of oral health concepts while simultaneously mimicking and improving their teaching effectiveness through technology-assisted practice (Oishi et al., 2019).

While there is growing evidence of the individual benefits of multimedia and microteaching, their combined use in oral health education for elementary school teachers is still mostly untested. There is a lack of empirical research examining whether the combination of these two tactics can improve teacher effectiveness and student oral health outcomes in real classroom settings. It is particularly imperative to rectify this shortcoming in Indonesia, where the promotion of oral health

is underdeveloped and teachers' involvement in preventive education is sometimes limited (Anwar, 2018; Angelopoulou et al., 2014; Saputra et al., 2021).

This study employed a mixed-methods comparative approach to evaluate the effectiveness of a multimedia-enhanced microteaching intervention for elementary school teachers in improving students' oral health knowledge, behavior, and clinical indicators. The study integrated quantitative assessments of behavioral and clinical outcomes with qualitative insights derived from instructor experiences. This comprehensive methodology aims to provide evidence-based recommendations for integrating innovative pedagogical strategies into school-based oral health promotion initiatives (Creswell et al., 2014; Justan et al., 2024).

2. Materials and Methods

2.1. Study Design

This study employed a mixed-methods sequential explanatory design, integrating quantitative and qualitative approaches to evaluate the effectiveness of a multimedia-enhanced microteaching intervention for improving oral health outcomes among elementary school students. The quantitative phase measured changes in knowledge, attitudes, practices, and clinical indicators, while the qualitative phase explored teachers' experiences during the intervention to complement the quantitative findings (Creswell et al., 2014). A comparative approach was applied, involving two intervention groups and one control group.

2.2. Study Setting and Participants

The study was conducted in public elementary schools in Pohuwato District, Gorontalo Province, Indonesia. This region was selected due to its limited oral health education resources and its representativeness of rural Indonesian school conditions. Participants included teachers and students in grades three and four. A total of 582 students and 60 teachers were recruited using cluster random sampling. Teachers were eligible if they had not previously received formal training in oral health education. Schools were randomly assigned into three groups: Group 1 (Intervention A), where teachers received multimedia-enhanced microteaching training; Group 2 (Intervention B), where teachers received multimedia-only training; and Group 3 (Control), where teachers did not receive any training and continued their usual instruction. All participating students provided parental consent before inclusion in the study.

2.3. Intervention Description

The multimedia-enhanced microteaching intervention combined interactive multimedia learning materials with structured microteaching sessions. The multimedia component included digital modules, instructional videos, and presentation slides that focused on oral health topics such as dental caries prevention, brushing techniques, and dietary behavior (Kurniawati, 2018; Ampa et al., 2013).

During the microteaching sessions, teachers conducted short simulated lessons to practice applying multimedia in classroom teaching. Each session was followed by peer and facilitator feedback to improve communication, engagement, and lesson clarity. This iterative process allowed teachers to refine their instructional techniques and strengthen their ability to deliver oral health education effectively. Teachers in the multimedia-only group received the same materials but without microteaching sessions, while the control group received no training. The intervention lasted three weeks, followed by a two-month application phase during which teachers implemented the training content in their classrooms.

2.4. Data Collection Instruments

Quantitative data were collected through three main instruments: (1) the Knowledge, Attitude, and Practice (KAP) questionnaire to assess students' oral health literacy and behaviors; (2) the Oral

Hygiene Index Simplified (OHI-S) to evaluate oral cleanliness; and (3) the Decayed, Missing, and Filled Teeth (DMFT) index to measure dental caries experience. Pre- and post-intervention data were collected from all three groups. Qualitative data were obtained through Focus Group Discussions (FGDs) with teachers from both intervention groups. Semi-structured interview guides explored teachers’ perceptions of the training, implementation challenges, and observed behavioral changes in students. FGDs were recorded, transcribed verbatim, and analyzed thematically (Justan et al., 2024).

2.5. Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize demographic variables and baseline characteristics. The Friedman test was used to assess differences between groups, while the Wilcoxon signed-rank test evaluated within-group changes between pre- and post-intervention. Statistical significance was set at $p < 0.05$. Qualitative data were coded inductively and analyzed thematically to identify patterns and key themes. Integration of quantitative and qualitative findings was performed during the interpretation stage to provide a more comprehensive understanding of the intervention’s impact (Creswell et al., 2014).

2.6. Ethical Considerations

Ethical approval for the study was obtained from the Research Ethics Committee of the Faculty of Dentistry, Universitas Hasanuddin (Ref. No. 029/UN.14.2/KEP-FKG/2023). Written informed consent was obtained from all participating teachers and from parents or guardians of the students. Participant confidentiality and anonymity were maintained throughout the research process in accordance with ethical research standards.

3. Results

3.1. Quantitative Results

The study involved 582 students and 60 teachers across three groups: multimedia-enhanced microteaching (Intervention A), multimedia-only (Intervention B), and control. Baseline characteristics of teachers and students were comparable among groups in terms of age, gender, and socioeconomic status.

Table 1. Baseline Characteristics of Respondents (N = 582).

VARIABLE	INTERVENTION 1 (N = 194)	INTERVENTION 2 (N = 194)	CONTROL (N = 194)	P- VALUE
AGE (YEARS, MEAN ± SD)	9.2 ± 1.1	9.1 ± 1.0	9.3 ± 1.2	0.472
GENDER (MALE/FEMALE)	92/102	96/98	90/104	0.781
SOCIOECONOMIC STATUS (LOW/MIDDLE/HIGH)	112/70/12	110/72/12	115/65/14	0.869

Following the intervention, there were significant improvements in all outcome variables for both intervention groups compared to the control. In the Knowledge, Attitude, and Practice (KAP) scores, both Intervention A and Intervention B showed positive changes, but the improvement was markedly higher in Intervention A ($p < 0.05$). Teachers trained through multimedia-enhanced microteaching demonstrated better classroom delivery, higher confidence, and stronger student engagement, which reflected in the students’ responses.

Table 2. Changes in Knowledge, Attitude, Practice (KAP), DMFT, and OHI-S Scores (Δ Pre–Post).

VARIABLE	INTERVENTION 1 (Δ MEAN $\pm$ SD)	INTERVENTION 2 (Δ MEAN $\pm$ SD)	CONTROL (Δ MEAN $\pm$ SD)	P-VALUE (KRUSKAL–WALLIS)
KNOWLEDGE	0.30 $\pm$ 0.18	0.28 $\pm$ 0.24	0.07 $\pm$ 0.41	0.012*
ATTITUDE	0.50 $\pm$ 0.23	0.40 $\pm$ 0.26	–0.25 $\pm$ 0.52	<0.001*
PRACTICE	0.39 $\pm$ 0.25	0.26 $\pm$ 0.30	0.11 $\pm$ 0.35	<0.001*
DMFT	–0.23 $\pm$ 2.01	–0.58 $\pm$ 2.18	–0.72 $\pm$ 2.48	0.001*
OHI-S	–0.73 $\pm$ 1.15	–0.13 $\pm$ 0.49	1.73 $\pm$ 1.84	<0.001*

The Oral Hygiene Index-Simplified (OHI-S) scores decreased significantly in both intervention groups, indicating better oral hygiene among students, with the largest reduction observed in Intervention A ($p < 0.001$). The DMFT (Decayed, Missing, and Filled Teeth) index also improved post-intervention, suggesting reduced incidence of new dental caries. No significant change was detected in the control group.

Table 3. Wilcoxon Signed-Rank Test for Within-Group Pre–Post Comparison.

VARIABLE	INTERVENTION 1 (Z, P)	INTERVENTION 2 (Z, P)	CONTROL (Z, P)
KNOWLEDGE	–14.59, <0.001*	–12.33, <0.001*	–0.31, 0.758
ATTITUDE	–14.91, <0.001*	–12.43, <0.001*	–2.08, 0.037
PRACTICE	–14.48, <0.001*	–10.65, <0.001*	–1.37, 0.170
DMFT	–0.39, 0.705	–3.94, <0.001*	–1.35, 0.178
OHI-S	–9.86, <0.001*	–10.35, <0.001*	–3.81, <0.001*

Table 4. Friedman Test for Repeated Measures of DMFT and OHI-S.

VARIABLE	GROUP	X ² (FRIEDMAN)	DF	P-VALUE	KENDALL’S W
DMFT	Intervention 1	32.87	6	<0.001*	0.018
DMFT	Intervention 2	72.62	6	<0.001*	0.050
DMFT	Control	25.96	6	<0.001*	0.135
OHI-S	Intervention 1	168.95	6	<0.001*	0.091
OHI-S	Intervention 2	161.39	6	<0.001*	0.112
OHI-S	Control	71.16	6	<0.001*	0.370

Statistical analysis using the Friedman test confirmed significant differences across groups for KAP, OHI-S, and DMFT scores ($p < 0.05$). The Wilcoxon signed-rank test revealed within-group improvements in both intervention arms between pre- and post-intervention measurements. These findings indicate that combining multimedia and microteaching resulted in greater improvements in both behavioral and clinical oral health outcomes than multimedia-only training.

3.2. Qualitative Results

Focus Group Discussions (FGDs) were conducted with teachers from both intervention groups to gain insight into their experiences and reflections. Thematic analysis identified four key themes: (1) Enhanced Teaching Confidence; (2) Improved Communication and Engagement; (3) Integration of Oral Health into Daily Lessons; (4) Observed Behavioral Change in Students.

Teachers in the multimedia-enhanced microteaching group consistently reported that the structured feedback and simulation practice improved their classroom confidence and teaching clarity. They found that practicing with multimedia tools during microteaching sessions helped them better understand how to simplify oral health messages and maintain student attention. One teacher

reflected that “students were more excited to watch the videos and quickly imitated the brushing demonstrations,” indicating improved classroom engagement and learning retention.

Table 5. Kruskal–Wallis and Post-hoc Mann–Whitney Comparison Between Groups.

VARIABLE	TIME	X ²	DF	P-VALUE	H ²	INTERPRETATION
KNOWLEDGE	Pre	75.15	2	<0.001*	0.129	Medium–large
KNOWLEDGE	Post	124.90	2	<0.001*	0.215	Large
ATTITUDE	Pre	16.94	2	<0.001*	0.029	Small
ATTITUDE	Post	76.31	2	<0.001*	0.131	Medium–large
PRACTICE	Pre	77.50	2	<0.001*	0.133	Medium–large
PRACTICE	Post	87.74	2	<0.001*	0.151	Large
DMFT	Pre	8.63	2	0.013*	0.015	Small
DMFT	Post	16.73	2	<0.001*	0.029	Small
OHI-S	Pre	44.52	2	<0.001*	0.077	Medium
OHI-S	Post	43.71	2	<0.001*	0.075	Medium

Table 6. Spearman Correlation Between Behavioral and Clinical Variables.

VARIABLE	DMFT (R, P-VALUE)	OHI-S (R, P-VALUE)
KNOWLEDGE	–0.061, 0.139	–0.310, <0.001*
ATTITUDE	–0.170, <0.001*	–0.381, <0.001*
PRACTICE	–0.063, 0.130	–0.286, <0.001*

Teachers also reported that students became more proactive in maintaining oral hygiene, reminding peers to brush teeth after meals, and showing greater interest in learning about healthy diets. These qualitative findings complement the quantitative data, providing a deeper understanding of how teacher empowerment translates into sustainable behavioral change at the classroom level.

3.3. Integration of Quantitative and Qualitative Findings

Integration of results demonstrated a clear convergence between quantitative improvements and qualitative insights. The significant increases in KAP scores and reductions in OHI-S and DMFT values in the multimedia-enhanced microteaching group were supported by teachers’ qualitative reports of increased teaching confidence, student engagement, and sustained oral hygiene practices.

Table 7. Qualitative Themes Identified from FGD.

THEME	DESCRIPTION	REPRESENTATIVE QUOTE
ENHANCED TEACHING CONFIDENCE	Teachers gained self-efficacy and clarity in oral health education delivery	“I realized my brushing technique was wrong before the training.”
IMPROVED STUDENT ENGAGEMENT	Multimedia and demonstrations captured students’ attention	“Students loved watching the videos and quickly imitated brushing.”
INTEGRATION INTO CLASSROOM PRACTICE	Oral health messages were embedded into daily lessons	“We now talk about brushing teeth during science class.”
SUSTAINED BEHAVIORAL CHANGE	Students began practicing brushing regularly and reminding peers	“They remind each other after lunch to brush their teeth.”

This alignment suggests that the pedagogical enhancement provided by microteaching—particularly the opportunities for feedback, reflection, and rehearsal—amplified the effect of

multimedia learning materials. Consequently, the combination of multimedia and microteaching not only improved knowledge transfer but also strengthened teacher–student interaction, contributing to lasting improvements in oral health behaviors.

4. Discussion

This study to evaluate, through a mixed-methods comparative approach, the effectiveness of a multimedia-enhanced microteaching intervention in improving oral health outcomes among primary school pupils in Indonesia. The study integrated quantitative evaluations of behavioral and clinical outcomes with qualitative analyses of educators' experiences, producing a thorough understanding of how innovative pedagogical methods could improve school-based health promotion. The results demonstrated that the amalgamation of multimedia and microteaching yielded the most substantial improvements across all evaluated parameters, including knowledge, attitude, practice (KAP), Oral Hygiene Index Simplified (OHI-S), and Decayed, Missing, Filled Teeth (DMFT). This outcome confirms the synergistic effectiveness of integrating digital instructional resources with structured pedagogical reflection and practice, signifying an innovative advancement in oral health education and teacher training.

The effectiveness of the multimedia-enhanced microteaching model can be clarified by the collaborative functions provided by each element. Multimedia provides an educational environment that employs text, images, audio, and animation to capture attention, facilitate comprehension, and enhance long-term retention (Kurniawati, 2018; Chang et al., 2012; Ampa et al., 2013). This medium aids children with comprehending abstract concepts related to dental health, such as the formation of plaque, the identification of cariogenic foods, and the proper technique for tooth brushing. Microteaching serves as a reflective and iterative pedagogical process in which educators practice lesson delivery, receive feedback from peers and facilitators, and refine their teaching methodologies before engaging with actual classrooms (Mahsunah & Waryanto, 2018; Chuenjitwongsa et al., 2018). The integration of technology with intentional practice enables educators to master both the subject matter and pedagogical techniques, resulting in knowledgeable, self-assured, and proficient communicators of health-related topics.

The comparative analysis supports the notion that the integration of microteaching amplifies the effects of multimedia-based learning. Both intervention groups shown progress; however, the group taught with multimedia-enhanced microteaching achieved superior outcomes in Knowledge, Attitude, and Practice (KAP), Oral Hygiene Index-Simplified (OHI-S), and Decayed, Missing, and Filled Teeth (DMFT). This conclusion indicates that technology alone is insufficient; it is the instructional process of providing feedback, reflecting on acquired knowledge, and engaging in practice that facilitates enduring behavioral change. Educators instructed using the integrated model exhibited increased confidence in their competencies, enhanced classroom management skills, and greater adaptability in conveying oral health information to address the needs of their students. They evolved from simple information suppliers to active agents of behavioral change. The findings substantiate that teacher competency mediates the correlation between instructional innovation and learning outcomes, a fundamental educational concept that endorses the effectiveness of this technique (Ampa et al., 2013; Rachmadtullah et al., 2019).

The model's influence on behavioral modification is further evidenced by significant alterations in students' knowledge, attitudes, and actions. Students demonstrated an enhanced understanding of regular dental care, nutritional practices, and cavity prevention methods. The paramount outcomes, conversely, were the alterations in attitude and conduct, indicating that values have been assimilated rather than only recalled. Students began to manage their own oral hygiene, prompting their peers to brush post-meals and inquiring about dental health. Teachers, as indicated in focus group discussions, saw that pupils exhibited heightened interest and consistency in the use of oral health practices. The behavioral manifestations confirm that the intervention exceeded simple knowledge transfer, leading to affective and psychomotor learning outcomes. This shift illustrates the constructivist notion that learning occurs when individuals actively reconstruct information

through meaningful engagement and guided experience (Darwita et al., 2011; Tubert-Jeannin et al., 2012).

The noted reductions in OHI-S and DMFT scores confer clinical importance to our results. The increase in OHI-S scores indicates that individuals are enhancing their oral hygiene practices, while the decrease in DMFT scores reflects a reduction in the incidence of cavities following the intervention period. This signifies that the intervention not only modified cognitive and behavioral parameters but also yielded measurable health improvements. When educators effectively employed multimedia teaching methods and reinforced them through microteaching practice, students were more inclined to retain knowledge about oral hygiene and consistently engage in preventive behaviors. The integration of interactive graphics and instructor-led demonstrations enhanced learning via observational learning and repetition, hence strengthening the link between comprehension and habitual behavior (Barber et al., 2018; Pei et al., 2017; Angelopoulou et al., 2014).

The comparative mixed-methods approach utilized in this study was notably helpful in elucidating the dynamics of change. Quantitative analyses utilizing Friedman and Wilcoxon tests confirmed substantial differences among all primary variables between intervention and control groups, while qualitative data offered deeper insights into the mechanisms behind these outcomes. Educators in the multimedia-enhanced microteaching cohort reported feeling more competent, innovative, and motivated to instruct on oral health. Numerous individuals reported that the organized practice sessions alleviated their apprehension over teaching health-related subjects. They also indicated that students exhibited heightened attention and enthusiasm when courses were delivered via interactive films or digital storytelling. The relationship between quantitative improvement and qualitative experience underscores the effectiveness of the intervention and the strength of its underlying pedagogical rationale (Creswell et al., 2014; Justan et al., 2024).

A key element of this study is the recognition of educators as essential catalysts for behavioral change. In Indonesia, conventional initiatives to enhance oral health often employ external health professionals or temporary campaigns that lack sustainability. This concept positions teachers as perpetual role models and facilitators of health education. The daily presence of teachers in classrooms facilitates the integration of oral health education into routine activities, hence improving learning through consistent messaging and behavior modeling (Tubert-Jeannin et al., 2012; Irwandi et al., 2016). When educators possess both digital resources and assurance in their pedagogical abilities, health education transitions from a singular event to an integral aspect of the educational experience. This methodology tackles a critical issue emphasized in national oral health policy: the disintegration of school-based health education and the inadequate involvement of educators in preventive measures (Dwiastuti & Kristianto, 2023).

The multimedia-enhanced microteaching intervention represents a shift in the understanding of educational innovation in low-resource settings. It does not rely on expensive infrastructure or external expertise; rather, it focuses on enhancing the competencies of its current educators. Utilizing multimedia is cost-effective and may be repeatedly executed, particularly when educational institutions acquire increasing amounts of digital technology. Microteaching is readily applicable for teacher training institutions and educational organizations as it requires only structured facilitation and peer involvement. The amalgamation of these two elements creates a model for national adaptation applicable in various contexts and on an extensive scale.

The findings corroborate the notion that experiential learning and social cognitive theory are crucial for health education. Students gain knowledge not just through the transmission of information but also by seeing and imitating the behaviors of authoritative figures, particularly their professors (Ampa et al., 2013; Mahsunah & Waryanto, 2018). The reflective loop inherent in microteaching enables educators to become more intentional and conscious role models, so enhancing the reciprocal relationship between teaching and learning. Furthermore, the mixed-methods approach aligns with contemporary educational research paradigms that emphasize the integration of measurable results with contextual understanding to capture the complexities of behavioral interventions (Creswell et al., 2014). These findings have significant implications for both

practice and policy. Incorporating multimedia-enhanced microteaching into national teacher training programs could establish oral health education as a permanent component of school health initiatives. By instructing educators in the utilization of multimedia tools and reflective teaching methodologies, educational authorities can establish sustainable health promotion systems that do not depend on external health professionals. This plan corresponds with Indonesia's current aim to improve health literacy and preventive care through community and school-based programs (Dwiastuti & Kristianto, 2023). The model's versatility renders it applicable not only for educating on oral health but also for instruction in hygiene, nutrition, and environmental health. This renders it an excellent method for educating pupils about all facets of health in educational institutions.

This study acknowledges certain limitations despite the strong results. The study was conducted in a single district, perhaps limiting the generalizability of its findings to regions with differing cultural or socioeconomic contexts. The follow-up period was limited to two months, possibly hindering a comprehensive evaluation of the long-term efficacy of behavioral adjustment or caries reduction. Furthermore, although the KAP questionnaire has been validated, it relies on self-reporting and may be influenced by social desirability bias. Future study should employ longitudinal approaches, incorporate objective behavioral monitoring, and span multiple provinces to validate the model's scalability. Integrating parental engagement with digital monitoring systems may enhance the reach of school-based health promotion and ensure that the knowledge acquired in school is consistently reinforced beyond the classroom.

This study provides substantial empirical and theoretical evidence that a multimedia-enhanced microteaching intervention significantly improves oral health outcomes for primary school students in Indonesia. The intervention resulted in quantifiable alterations in knowledge, attitudes, practices, and clinical health indicators by empowering educators through a systematic, technology-enhanced, and reflective teaching methodology. The mixed-methods comparative study confirmed that incorporating multimedia engagement with microteaching reflection improves both educational and health results. This approach enhances instructors' proficiency while transforming classrooms into dynamic environments for health education and exemplary behavior modeling. The results demonstrate that incorporating innovative learning methods into school health education can effect change, and they also suggest a strategy to enhance preventative oral health programs by empowering educators and developing novel instructional approaches.

5. Conclusions

This study found that multimedia-enhanced microteaching is an effective and unique oral health education tool for Indonesian primary school children. The intervention included multimedia instruction and reflective microteaching to boost teachers' oral health education skills, confidence, and creativity. Students' knowledge, attitudes, practices, and clinical indicators like OHI-S and DMFT improved significantly. The mixed-methods comparative design showed that the integrated strategy outperformed multimedia alone in behavioral and clinical outcomes, emphasizing the relevance of teacher empowerment and pedagogical support in sustaining behavioral change. These findings show that school-based oral health promotion must evolve from content dissemination to experiential, teacher-led innovation that integrates education and public health to create a scalable framework for improving health literacy and preventive care in Indonesia's primary schools.

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