ORIGINAL ARTICLE

DENTAL SCIENCE KIT AS A SUPPLEMENTARY ORAL HEALTH EDUCATION TOOL: PERSPECTIVE OF MALAYSIAN TEACHERS AND SCHOOLCHILDREN

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ABSTRACT

Oral health education (OHE) is vital for improving children's oral health, as early education fosters lifelong healthy behaviours. Although school-based OHE has been implemented widely in Malaysia, integrating OHE into classroom learning remains challenging due to limited accessible and engaging resources. This study explored teachers' and schoolchildren's opinions on using science-based activities as a supplementary OHE tool. The Dental Science Module (DES-Kit), comprising 10 science-based activities, was developed through literature review and expert input, then validated and refined. Following implementation in two Malaysian public primary schools, Focus Group Discussions (FGDs) were conducted with 14 teachers and 16 schoolchildren aged 11 years. Transcribed data were coded and thematically analysed using QualCoder software. Three main themes emerged: 1) Content appropriateness, 2) Implementation feasibility, and 3) Learning experiences. Participants agreed that the activities were age-appropriate, aligned with the primary school curriculum, and adaptable beyond the classroom. Feasibility was supported by clear instructions, accessible materials, and manageable scheduling. Most activities were perceived suitable for independent completion by schoolchildren with minimal supervision. Learning experiences highlighted enjoyment, curiosity, teamwork, preference for colourful materials, and hands-on tasks that were perceived to enhance knowledge retention. Some safety concerns and a few boring or unpleasant activities were noted. Teachers also suggested potential integration of OHE into Science, Technology, Engineering, and Mathematics (STEM) education. Overall, the DES-Kit was positively received as an engaging, practical, and relevant tool. Findings provide insights for strengthening school-based OHE and may guide similar initiatives internationally. Further research should evaluate its effectiveness and scalability.

***Keywords:** Oral health education, Health promotion, Children, Teachers, Qualitative study.*

INTRODUCTION

The World Health Organisation (WHO) promotes the Health Promoting Schools approach as a strategy for advancing both general and oral health[1]. Globally, Healthy Schools have been established as platforms to enhance the health of school communities by reinforcing health education curricula and fostering supportive school environments[2]. Within this framework, oral health education (OHE) has long been recognised as a cornerstone in preventing oral diseases and inculcating healthy behaviours from an early age[3]. Schools in particular, provide an ideal setting for delivering OHE, as they offer structured access to children during their formative years, when health habits are being established. Traditional approaches to OHE in schools, such as health talks, posters, and exhibitions, have played a significant role; however, they are often criticised for being didactic and less interactive for young learners[3,4].

In recent years, there has been an increasing emphasis on incorporating interactive, hands-on, and experiential learning activities into health education. This includes the growing integration of Science, Technology, Engineering and Mathematics (STEM) education into the school curriculum, which encourages inquiry-based learning, critical thinking, and problem solving through practical applications[5]. Such approaches align well with the principles of active learning, which highlight that children are more likely to retain knowledge when they are actively involved in the learning process rather than being passive recipients of information[6]. OHE can be positioned as a relevant and engaging context for STEM learning, in which scientific principles are applied to real-life issues such as dental caries, oral hygiene, and the effects of diet on health. However, in many cases, oral health (OH) remains siloed as a standalone health topic rather than being integrated into broader learning activities.

Several studies have demonstrated the effectiveness of science-related educational activities in areas of health promotion, including nutrition, hygiene, and environmental health[7,8]. These approaches have not only enhanced children's understanding of health concepts but have also created opportunities for teachers to incorporate health promotion messages into existing teaching frameworks. However, the integration of active learning approaches into OH activities within school curricula remains limited, particularly in the Malaysian context. School-based OHE still relies heavily on annual dental visits from dentists who deliver lecture-style sessions to large groups of children[3,4]. As a result, knowledge retention and behavioural change outcomes may be limited and oral disease prevalence remains high among schoolchildren in Malaysia[4], prompting calls for more innovative and student-centred educational strategies. Although efforts have been made to integrate OH into the school curriculum, these have often been hindered by the lack of structured modules and the scarcity of resources in the local language.

To address this gap, the Dental Science Module (DES-Kit) was conceptualised as a set of activities in the Malay language for primary schoolchildren in Malaysia. The DES-Kit was developed through a multistage process. A literature review was conducted to identify science-based educational activities relevant to OH. This was followed by expert consultations with dental public health specialists, science educators, dentists and school teachers to ensure the content was suitable and aligned with the Malaysian primary school science curriculum. Prototype activities were pilot-tested and subsequently refined for clarity. The final DES-Kit comprised 10 interactive, hands-on experiments designed to convey key OH messages, supported with clear instructions and readily available materials[9]. This study explored participants' perceptions of its content appropriateness, implementation feasibility, and learning experiences following implementation of DES-Kit in the primary school setting. Input from both teachers, who act as the primary implementers, and schoolchildren, who are the ultimate beneficiaries, is crucial for providing guidance on future adaptations, scalability, and evaluation of such an intervention.

MATERIALS AND METHODS

Study Design

An interpretive descriptive qualitative study design, utilising focus group discussions (FGDs), was employed to capture in-depth perspectives from both teachers and schoolchildren regarding the use of the DES-Kit in school settings. This approach was selected as it is suitable for applied research, offering flexibility in data collection and analysis while allowing for identification of meaningful patterns and experiences. The methodology was reported based on the Consolidated Criteria for Reporting Qualitative Studies (COREQ) checklist[10]. Ethical approval was obtained from the Faculty of Dentistry Medical Ethics Committee, Universiti Malaya [DF CO2407/0017 (P)]. Permission was also granted by the Ministry of Education and school administrators. Written informed consent was obtained from all participants, and parental consent together with child assent was obtained for the schoolchildren prior to participation.

Study Setting and Participants

The study was conducted in two government primary schools in Kuala Lumpur, Malaysia. The DES-Kit module was implemented among a group of 11-year-old schoolchildren (n = 60), assisted by teachers and three dentists. Figure 1 shows examples of activities from the DES-Kit. A summary of the DES-Kit activities and learning outcomes are shown in Table 1.

After the implementation, participants were recruited for the FGDs, which included two stakeholder groups: (i) primary school teachers and (ii) schoolchildren aged 11 years. Purposive sampling was used to recruit teachers and students based on predefined inclusion criteria. The teachers were selected across different subjects, particularly in science education or STEM-related extracurricular activities with varying years of teaching experience. The schoolchildren were selected to represent diverse socio-economic backgrounds, varying educational attainment levels, and gender to ensure a broad range of perspectives. Teachers who had facilitated or observed the DES-Kit activities during implementation were also invited to participate due to their educational expertise and their role as key stakeholders in the DES-Kit's use. Upper primary schoolchildren aged 11 years were selected because the DES-Kit was designed for this age group, and children at this stage are generally able to express their thoughts and opinions clearly during group discussions.

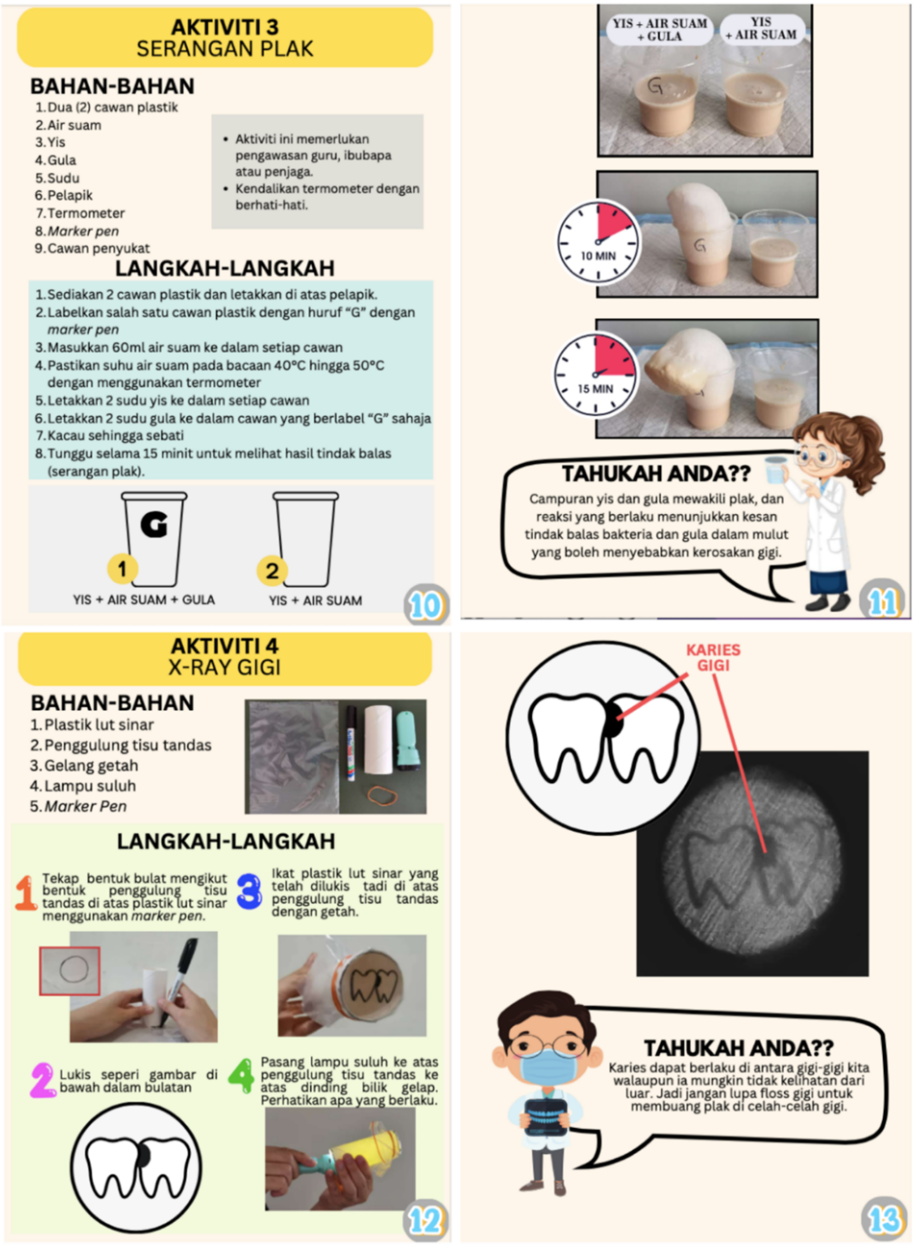

Figure 1: Example of activities from DES-Kit module

Table 1: Activities and learning outcomes of the DES-Kit module

Activities	Learning Outcomes
Activity 1: Know the Types and Number of Deciduous Teeth	To identify the types and counts of deciduous teeth
Activity 2: Permanent Teeth Arrangement	To understand the arrangement of permanent teeth
Activity 3: Plaque Attack	To demonstrate the effects of bacteria and sugar reactions in the mouth that can lead to tooth decay
Activity 4: Tooth X-Ray	To introduce the concept of radiography (X-ray) in dental science
Activity 5: Aina Fell	To demonstrate the procedure for managing an injured tooth
Activity 6: Colour Absorption	To understand the potential effects of food colouring on tooth colour/stains
Activity 7: Sugary and Acidic Beverages	To identify and select the healthy drink for teeth
Activity 8: Eggshell Experiment	To illustrate how different beverages affect tooth enamel
Activity 9: Bacteria and Toothpaste	To explain the role of fluoride toothpaste in protecting teeth from bacterial attacks
Activity 10: Dental Hygiene	To enhance skills in thorough toothbrushing and recognise its importance

A total of 14 teachers participated in three FGDs, while 16 schoolchildren took part in four FGDs. The number of FGDs was guided by the principle of data saturation, where discussions were conducted until no new themes emerged.

Data Collection

The FGDs were facilitated by two trained moderators with backgrounds in dental public health and qualitative research. The teachers' FGDs lasted an average of 40 minutes, while the children's took an average of 25 minutes. A semi-structured topic guide was used to facilitate the discussion, focusing on three main areas: (1) appropriateness of DES-Kit content, (2) feasibility of implementation in school settings, and (3) learning experiences and engagement with the activities. The FGD topic guide was developed based on literature, incorporating leading and probing questions. It then underwent face validation by a dental public health academician, a paediatric dentist and two primary school teachers. Prior to the main data collection, the topic guide was also pre-tested and piloted with a group of 11-year-old schoolchildren and teachers. Participants involved in the pilot study were not included in the main study. Minor refinement was made to the topic guide based on the feedback obtained.

All discussions were conducted in Malay or English, depending on participant preference, and were audio-recorded with prior consent. To ensure that each participant had the opportunity to contribute, the children were divided into small focus groups consisting of four participants per session, creating a comfortable environment that facilitated interaction and encouraged participation. Recordings were transcribed verbatim and translated into English. A note taker took field notes to capture contextual observations. The transcripts were subsequently emailed to the participants for confirmation.

Data Analysis

Thematic analysis was undertaken using an inductive approach. Transcripts were imported into QualCoder software for analysis. Two independent researchers coded the data to identify recurring patterns and emerging themes. Coding discrepancies were discussed and resolved through consensus. Where disagreement persisted, a third researcher reviewed the coding and assisted in reaching the final decision. The codes were then grouped into broader categories with three overarching themes: content appropriateness, implementation feasibility, and learning experiences. To enhance trustworthiness beyond inter-coder consensus, several strategies were employed. Credibility was strengthened through data triangulation by integrating perspectives from both teachers and schoolchildren, as well as through iterative discussions among the research team to refine codes and themes. An audit trail documenting coding decisions and theme development was maintained to support dependability. Reflexivity was also considered, with the researchers acknowledging and discussing their assumptions during analysis.

RESULTS

Participants' Profiles and Overview of Identified Themes

The demographic profile of the school teachers (n = 14) and schoolchildren (n = 16) who participated in the FGDs is presented in Table 2.

Table 2: Demographic profile of participants

Variable		Number of Participants, n (%)
School teachers (n = 14)		
Gender	Male	1 (7.1%)
	Female	13 (92.9%)
Ethnicity	Malay	7 (50.0%)
	Chinese	6 (42.9%)
	Indian	1 (7.1%)
Working Experience	1-10 years	3 (21.4%)
	11-20 years	7 (50.0%)
	More than 20 years	4 (28.6%)
Schoolchildren (n = 16)		
Gender	Male	8 (50.0%)
	Female	8 (50.0%)
Ethnicity	Malay	14 (87.5%)
	Indian	2 (12.5%)

Among the teachers, the majority of participants were female (92.9%), with only one male (7.1%). In terms of ethnicity, half of them were Malay (50.0%), followed by Chinese (42.9%) and Indian (7.1%). Half of the teachers (50.0%) had 11–20 years of teaching experience, while four (28.6%) had more than 20 years of experience. A smaller proportion (21.4%) reported 1–10 years of teaching experience. The gender of the schoolchildren was equally distributed, with eight males (50.0%) and eight females (50.0%). A large majority were Malay, with 14 (87.5%), and the remaining two (12.5%) were Indian. The analysis of the FGDs is organised into three main themes and sub-themes as shown in Table 3.

Theme 1: Content Appropriateness

This theme comprised three sub-themes: (Sub-theme 1.1. Age relevance), (Sub-theme 1.2. Curriculum integration), and (Sub-theme 1.3. Beyond the classroom), as summarised in Table 4

Table 3: Overview of themes and sub-themes

Themes	Sub-themes
Theme 1: Content appropriateness	1.1 Age relevance
	1.2 Curriculum integration
	1.3 Beyond the classroom
Theme 2: Implementation feasibility	2.1 Instructional clarity and visual support
	2.2 Materials and resources
	2.3 Scheduling of activities
	2.4 Safety considerations
	2.5 Supervision and learner independence
Theme 3: Learning experiences	3.1 Enjoyment and discovery
	3.2 Hands-on learning impact
	3.3 Teamwork
	3.4 Activity preferences

Table 4: Summary of sub-themes and corroborating quotes for Theme 1, content appropriateness

Sub-themes	Corroborating Quotes
1.1 Age Relevance	*"Experiments are more suitable for upper primary students."* [Teacher T8, 23 years old, Malay female] *"It is suitable for Primary 1 to 3 because oral health is already part of the syllabus by Primary 3… Children can learn about the types of teeth and their consequences if not cared for, which is very relevant and helpful."* [Teacher T2, 42 years old, Malay female] *"I think the colouring activity is more suitable for preschoolers… The yeast reaction activity is suitable for many children...it will make them be like 'Wow'."* [Teacher T5, 41 years old, Malay female]
1.2 Curriculum Integration	*"It can be related to all subjects."* [Teacher T6, 44 years old, Indian male] *"We do thematic education… If we focus on health as a theme, all subjects must incorporate elements of health into the teaching and learning."* [Teacher T2, 42 years old, Malay female] *"Subjects like Bahasa Melayu and English have more teaching time allocated than science and mathematics, which have less. We struggle to cover the syllabus, so we cannot always include it in our subjects. Yes, Bahasa Melayu and English can do it. What morals do we learn today? What values do we learn today? [Such as] early oral health care. We can write essays [on these topics]."* [Teacher T5, 41 years old, Malay female] *"There is no technology element. The technology element needs to be there. Only then can we call it STEM."* [Teacher T4, 38 years old, Malay female]
1.3 Beyond the Classroom	*"I think this activity can be done not only at school but also at home."* [Teacher T4, 38 years old, Malay female] *"It is something to try at home."* [Schoolchild S8, Malay male] *"It can be done with parents and siblings at home."* [Schoolchild S1, Malay female and Schoolchild S12, Malay male].

Most participants agreed that the content was suitable and adaptable for primary schoolchildren. However, some activities were perceived as either too difficult or too easy for certain age groups. Some participants also noted that the DES-Kit could benefit lower primary schoolchildren, as it aligns with their learning curriculum and the school science syllabus. In particular, activities involving colouring and observing changes were considered more suitable for preschool settings.

The teachers provided valuable insights into integrating OHE across various subjects and activities within the school curriculum. Key subjects and activities were commonly cited by the teachers, with STEM, Science, and Mathematics being the most frequently mentioned. They also suggested the potential for integration into other subjects and existing programmes in schools, such as Bahasa Melayu (*Malay Language*), English, Nilam, Health, and the Young Doctors Club. The teachers believed that incorporating OH messages across different subjects or health-related subjects would enhance students' overall understanding and retention of the information. However, some teachers were also concerned about time constraints, as shorter teaching periods are allocated for science and mathematics compared to Bahasa Melayu and English subjects. They suggested integrating topics like dental health into language subjects. For instance, one teacher said:

> *"Subjects like Bahasa Melayu and English have more teaching time allocated than science and mathematics, which have less. We struggle to cover the syllabus, so we cannot always include it in our subjects. Yes, Bahasa Melayu and English can do it. What morals do we learn today? What values do we learn today? [Such as] early oral health care. We can write essays [on these topics]."* [Teacher T5, 41 years old, Malay female]

Additionally, most of the participants suggested that these OHE activities could also be conducted with parents and siblings at home. Extending OHE beyond the classroom allows families to empower their children and reinforce positive oral health behaviours. For instance, the children mentioned:

> *"It can be done with parents and siblings at home."* [Schoolchild S1, Malay female and Schoolchild S12, Malay male].

Theme 2: Implementation Feasibility

Participants reflected on the practicality of implementing the DES-Kit in school settings. This theme comprised five sub-themes: (Sub-theme 2.1. Instructional clarity and visual support), (Sub-theme 2.2. Materials and resources), (Sub-theme 2.3. Scheduling of activities), (Sub-theme 2.4. Safety considerations), and (Sub-theme 2.5. Supervision and learner independence), as summarised in Table 5.

Both schoolchildren and teachers found the instructions for the activities to be straightforward, easy to comprehend, and facilitating smooth implementation. However, some participants found specific activities challenging to understand without clear visual aids. Visual guidance, such as pictures and diagrams that are simple, intuitive, and easy to follow, was seen as useful for effective communication by both teachers and students.

The participants appreciated that the DES-Kit provided all necessary materials for the experimental activities, reducing the need to search for resources. They found it convenient to use these materials at home, with readily accessible resources. However, concerns were raised about the availability and cost of certain items, such as pipettes and syringes, suggesting that everyday household items could serve as substitutes, making implementation easier.

In planning the integration of these activities into school programmes, the teachers highlighted the need for proper scheduling. The duration of each activity was considered appropriate. However, they further emphasised the importance of focusing on a single objective per session to maintain clarity and knowledge retention. One teacher cited:

> *"If we want to teach about beverages, acid or alkaline, [for oral health] in one session. We focus only on one topic per session. We cannot mix the objective, which is difficult for students to understand."*
> [Teacher T2, 42 years old, Malay Female]

Safety was a key concern highlighted by both teachers and schoolchildren, especially in hands-on experiments. The teachers emphasised that although the activity seemed appropriate and enjoyable, proper material handling and maintaining safe distances were essential to ensure safety.

In addition, participants expressed mixed views on the balance between supervision and independence in conducting DES-Kit learning activities. Thirteen participants stressed the importance of fostering independence, others highlighted the need for supervision, either by dental professionals, teachers when activities were conducted in school, or parents when activities took place at home.

Table 5: Summary of sub-themes and corroborating quotes for Theme 2, implementation feasibility

Sub-themes	Corroborating Quotes
2.1: Instructional Clarity and Visual Support	*"[It is] easy, straightforward, [and] understandable at once. [I] already know what to do."* [Teacher T1, 46 years old, Malay female] *"Make it simpler. Maybe include pictures, like arrows pointing. Pictures are necessary [to guide us]."* [Teacher T5, 41 years old, Malay female] *"It is easy to understand if you read it carefully, and follow the given instructions. It is quite easy and simple. If you leave it to us [to the teacher], we can implement it in class. Useful module, we can run it."* [Teacher T1, 46 years old, Malay female]
2.2: Materials and Resources	*"It seems to be easy. If the kit is complete with all materials, we do not need to go here and there to search for the materials."* [Schoolchild S6, Indian female] *"If possible, provide more material options in the module. Tools like the pipette may not always be available, what alternative materials can be used? Hmm... Syringes can also be difficult to find... for example, they can be replaced with a spoon but include measurement suggestions [1 teaspoon]. Give more information on the use of alternative materials for the activities."* [Teacher T6, 44 years old, Indian male]
2.3: Scheduling of Activities	*"We focus only on one topic per session. We cannot mix the objective, which is difficult for students to understand."* [Teacher T2, 42 years old, Malay Female] *"If we want to teach about beverages, acid or alkaline, [for oral health] in one session. We focus only on one topic per session. We cannot mix the objective, which is difficult for students to understand."* [Teacher T2, 42 years old, Malay Female] *"Timing, duration of activities are important too"* [Schoolchild S6, Indian female]
2.4: Safety Considerations	*"Hmm...it is dangerous…the eggs in vinegar."* [Schoolchild S12, Malay male] *They [schoolchildren] maybe should not have sat too close [for safety reasons]."* [Teacher T3, 28 years old, Malay female] *"We need to wear appropriate protective gear."* [Schoolchild S5, Malay female]
2.5: Supervision and Learner Independence	*"[It is] possible because to do it independently. It is more or less the same way of giving instructions using our textbooks."* [Teacher T6, 44 years old, Indian male] *"[I am] afraid mom will get angry if [there is] spillage of these items at home."* [Schoolchild S10, Malay female] *"If the dentist or nurses are there… if we do not understand, we can ask questions."* [Schoolchild S7, Malay male]

Theme 3: Learning Experiences

Most schoolchildren expressed enjoyment and happiness with the DES-Kit activities. They found the learning process fun and enhanced their knowledge about OH. Commonly cited quotes related to learning experience are depicted in Figure 2**.** This theme comprised four sub-themes: (Sub-theme 3.1, Enjoyment and discovery), (Sub-theme 3.2, Hands-on learning impact), and (Sub-theme 3.3, Teamwork) as summarised in Table 6.

The teachers highlighted the impact of hands-on activities in enhancing knowledge retention. They observed that interactive methods enabled schoolchildren to develop a clearer and more relatable understanding. Similarly, the schoolchildren provided specific examples of knowledge gained from the activities and they believed that hands-on learning reinforced their understanding.

"They can apply what they have learned. When they see the effects in hands-on, like how acid harms teeth, they understand its dangers." [Teacher T2, 42 years old, Malay female]

"I can learn about different types and functions of teeth like molars, canines, and incisors." [Schoolchild S4, Indian male]

The schoolchildren highlighted teamwork as a positive aspect of the DES-Kit activities, noting that *"We want to learn together," "We could do it with friends," "We could work in groups," and "We can do more activities together."*

In contrast, a few activities were less favoured due to perceived challenges or lack of interest. For example, although most schoolchildren enjoyed the "Plaque Attack Activity", two disliked it due to the unpleasant odour resulting from the interaction between yeast and sugar. Another two students disliked the bacteria and dental hygiene activities, saying that "it is boring, and it looks dirty."

Figure 2: Word cloud related to learning experience

Table 6: Summary of sub-themes and corroborating quotes for Theme 3, learning experiences

Sub-theme	Corroborating Quotes
3.1 Enjoyment and Discovery	*"We could learn things we did not know before. For example, acid and alkaline; I am excited to know some beverages are acidic. I never knew it. I have been drinking without looking at the labels. Now I see it."* [Teacher T1, 46 years old, Malay female] *"The graphics, text and arrangement look organised. It can attract schoolchildren's interest because the graphics are clear, there are colours… and a clear and large font activity sheet, suitable for schoolchild. Discover new things"* [Teacher T8, 23 years old, Malay female]
3.2 Hands-on Learning Impact	*"They can apply what they have learned. When they see the effects in hands-on, like how acid harms teeth, they understand its dangers."* [Teacher T2, 42 years old, Malay female] *"We use our teeth daily. They will remember the knowledge gained from this activity."* [Teacher T8, 23 years old, Malay female] *"I can learn about [the] function of teeth."* [S6, Malay female] *"I can learn about different types and functions of teeth like molars, canines, and incisors."* [Schoolchild S4, Indian male] "*I can teach my siblings not to drink too many sugary drinks."* [Schoolchild S8, Malay male]
3.3 Teamwork	*"We want to learn together."* [Schoolchild S3, Malay Male] *"We could do it with friends,"* [Schoolchild S16, Malay Male] "*We can do more activities together."* [Schoolchild S14, Malay female] *"They could work in groups,"* [Teacher T3, 28 years old, Malay female]
3.4 Activity preferences	*"It looks like a real X-ray. Wah…it is interesting"* [Schoolchild S3, Malay male] *"I do not want my mouth to smell bad like this yeast."* [Schoolchild S12, Malay male] *"I don't really like the yeast activity, it smells bad"* [Schoolchild S2, Malay female] *"It is boring, and it looks dirty"* [Schoolchild S9, Malay female and Schoolchild S10, Malay female].

DISCUSSION

The findings of this study highlight the potential of relatable science-based activities to complement existing OHE methods, and to address challenges of engagement and sustainability in school-based dental programmes. Content appropriateness was a consistent theme across both stakeholder groups. The participants noted that the activities were suitable for the target age group and aligned with the existing primary school curriculum in Malaysia. This

alignment is crucial, as a common barrier to implementing health-related programmes in schools is their perceived disconnection from formal learning objectives[4,11].

The suitability of activities for primary schoolchildren also resonates with developmental theory. This is because at this stage, children are increasingly capable of logical thought, teamwork, and understanding cause-and-effect relationships[12]. These abilities make them especially receptive to hands-on, experiment-based activities that translate abstract health concepts into tangible experiences. Experiential learning approaches have been shown to be effective in school-based oral health education, as they promote active engagement and improve learning outcomes compared with traditional lecturing methods[12]. The involvement of schoolteachers during the DES-Kit validation ensured that the activities were aligned with the Malaysian primary school curriculum and setting. Collaborating with teachers to co-design and embed OH concepts within familiar science-based activities can therefore strengthen children's OH knowledge and the implementation of health promoting schools[4].

Implementation feasibility is another important aspect for the integration of activities in a school setting. The teachers appreciated the clarity of instructions, accessibility of materials, and flexibility in scheduling, which made it easier to accommodate additional tasks within their school programme. These elements are critical in ensuring that programmes can be sustained without excessive reliance on external resources or specialist expertise[1]. For example, many school-based OHE programmes expect teachers to play an active role in ensuring programme sustainability, but the lack of local resources within target communities often hinders their involvement[4]. Teachers, in particular, expressed that the DES-Kit was practical to integrate into their lesson plans without requiring extensive preparation, thereby addressing common barriers such as unclear materials, time constraints, and heavy workloads, which often limit the delivery of OHE in schools[11,13]. The DES-Kit offered multiple activities, but did not require all to be delivered at once; teachers could select, modify and sequence the most relevant activities according to their preference. This flexibility is consistent with literature showing that presenting too much information at once can overwhelm learners, underscoring the importance of focusing on single, well-defined objectives in each session[14,15]. Unlike studies conducted in Portugal and Poland, which used laboratory equipment for teaching OH concepts[7,8], DES-Kit translates similar scientific principles into child-friendly activities using everyday materials. This approach enhances practicality for classroom implementation, reducing reliance on dental professionals for school visits and supporting programme sustainability[16].

Beyond these practical considerations, participants also reflected on their experiences with the DES-Kit. Enjoyment, curiosity, and teamwork were recurrent themes, and these attributes are well recognised in the educational literature as facilitators of effective learning. The schoolchildren expressed a strong preference for attractive and interactive materials, which further highlights the importance of tailoring OHE interventions to enhance attention, understanding, and engagement in learning. Studies consistently show that colourful, visually appealing resources are more engaging than traditional text-based materials[14,15,17]. Younger children, in particular, rely more heavily on visual cues for remembering and learning[18]. As a result, activities featuring bright colours, visible reactions, and interactive visuals can help sustain their attention and improve comprehension, which should be taken into account when developing OHE initiatives[19].

Despite these positive experiences, participants also noted challenges, particularly related to safety and discomfort, though overall feedback suggested that the DES-Kit could be managed within the existing classroom environment. For instance, the unpleasant smells associated with "plaque-attack" related experiments initially triggered sensory discomfort in some children. Nevertheless, this activity remained popular as it provided a simple analogy of how bacteria (yeast) react with sugar to produce acids that cause tooth decay[7-8]. Even for those who found the experience less pleasant, the negative reactions may reinforce memorable lessons about the consequences of poor oral hygiene. To maintain comfort while preserving this educational impact, practical measures such as providing gloves or facemasks could be incorporated, which also mimic elements of science-based classroom activities[5,7,20].

Although safety was a concern, participants acknowledged that opportunities for autonomy could be beneficial. Children were perceived as capable of carrying out some activities

independently, while still recognising the reassurance of guidance from teachers, parents, or dental professionals when needed. This reflected the diversity of learning styles among schoolchildren benefiting from dentist-led, teacher-guided, hands-on, and peer-supported learning[3,21]. In particular, classroom-based activities that encouraged peer interaction and teamwork were highlighted as making learning more meaningful and reinforcing knowledge through shared discussions. This aligns with research showing that peer-led approaches can achieve outcomes comparable to dentist-led strategies and, in some contexts, even surpass teacher-led and self-learning methods in shaping oral health behaviours[21,22].

Comparable findings have been observed with science-based educational tools in nutrition and general hygiene, where the interactive format fosters greater engagement than traditional lecture-style teaching[3,7,8]. The DES-Kit promotes active learning strategies, encouraging schoolchildren to discuss, reflect on, and apply knowledge, all of which have been shown to enhance learning outcomes[23]. By encouraging active involvement rather than passive learning, it empowers individuals to take control of their own oral health knowledge and practices. These features also resonate strongly with STEM education, which also emphasises collaboration and hands-on exploration[24]. The DES-Kit incorporates some STEM components, similar to the approach demonstrated by Kamiński (2024), who integrated OHE into STEM through an eggshell model experiment[8]. Several studies further highlight that STEM-based approaches, especially those involving application-driven activities, are effective in improving learning outcomes and sustaining engagement[24]. It is recommended that future development of OHE materials be aligned with STEM approaches, thereby making them more relatable and engaging for school programmes.

Findings from this study provide useful insights for scaling up the programme at the national level, as they demonstrate the potential of the DES-Kit to complement existing school-based OHE and to be integrated into the broader education curriculum. However, several limitations are acknowledged. The study was conducted in only two schools in Kuala Lumpur, which may limit the generalisability of findings. Although in-depth stakeholders' perceptions were explored, no quantitative measures of learning outcomes or behaviour change were assessed. Additionally, as this study explored participants' perceptions following a single implementation, it does not constitute a comprehensive usability evaluation. Nevertheless, these findings offer valuable user insights to inform the refinement and optimisation of the DES-Kit prior to wider implementation. Future studies should evaluate the impact of these OHE activities on oral health knowledge, behaviours, and clinical outcomes over time.

CONCLUSION

This study provides encouraging evidence that a structured module with science-based activities is a feasible, acceptable, and engaging tool for enhancing OHE in primary schools. It shows potential for integration into the school curriculum and for application within STEM education, offering innovative avenues for programme sustainability. These findings provide valuable data to optimise the use of DES-Kit, support its adoption on a larger scale, and offer insights for other schools or dental teams seeking to implement similar initiatives.

Conflict of interest
The authors declare no potential conflict of interest.

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