

Use of an eBook for Oral Health Literacy[®] Curriculum to Elicit Functional Health Knowledge, Decision Making, and Goal Setting Among School-Aged Children

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Abstract

An eBook for Oral Health Literacy[®] curriculum was used as a brief intervention to help school-aged children use their functional health literacy skills of reading, writing, and speaking to learn about oral health hygiene and the importance of choosing healthy food and beverages for their teeth. The curriculum focused on building functional knowledge about oral health hygiene and nutrition behaviors through a health literacy intervention that highlighted the need for reasoned actions when setting food goals for healthy teeth and making decisions to keep teeth healthy and strong. The aims of the study included: 1) determining what children learned about their teeth from two chapters of the eBook for Oral Health Literacy[®] curriculum and what they remembered from reading the oral health and nutrition stories; 2) determining whether children liked to read and what they liked about the words and the pictures of the stories, and; 3) determining whether children brushed their teeth in the morning and at night; had any cavities; had teeth or mouth pain; and visited the dentist every six months for a dental checkup. The visual textual narrative helped children to build a vocabulary about oral health when reading and writing about health. Children wrote about words and phrases that they recalled after reading each chapter. Their elaborations exemplified the importance of using a constructivist theoretical framework to elicit children's functional health knowledge about oral health and nutrition. Chi-square results showed that there was a moderate significant correlation between children who reported brushing their teeth in the morning and having been to the dentist in the past year ($p = .021$).

Keywords:

Oral Health Literacy, Nutrition, Health Education, Curriculum, Functional Health Knowledge, Functional Health Literacy

Introduction

Childhood dental caries are a preventable global issue that affects more than 600 million children annually (Tinanoff et al., 2019; Ramos-Gomez et al., 2020). Preventive approaches for tooth infections (e.g., dental caries) have included health education, regular dental checkups, better nutrition (Sharma et al., 2022), and school sealant programs



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(Griffin et al., 2017; Griffin, et al., 2016; Griffin et al., 2014). However, dental caries and gum inflammation do not only affect the mouth. A recent Oral Health report from the National Institute of Dental and Craniofacial Research (NIDCR, 2021) indicated that more than 50 systemic diseases begin in the mouth and contribute to lifelong chronic disease. Oral health promotion and disease prevention interventions are necessary across the lifespan because the prevalence of disease increases with age (NIDCR, 2021).

Oral Health Education

Lack of resources such as access to a toothbrush, toothpaste, floss, or dental checkups are critical issues that have not been adequately addressed for children in the U.S. (Brown et al., 2006). To date, public health plans to reduce dental caries in children include advocating for fluoridated water in community water supplies, imposing a sugar tax on high-caloric foods, increasing health literacy initiatives, implementing more dental services in school-based health clinics (Arenson et al., 2019), and changing the age of the first dental visit to one-year old to help children start school healthier (American Academy of Pediatrics, 2003). Because education predicts health literacy by 18% with health literacy serving as a mediator between socioeconomic status and health (Lastrucci et al., 2019), oral health education programs are essential in schools to give children of all socioeconomic backgrounds affordances to maximize their health and wellbeing. Results from the 2016 School Health Policies and Practices Study (CDC, 2017) indicated that 57.7% of school districts had adopted a policy stating that their elementary schools will teach oral health. As a result, health education curricula need to take a skill-based approach through decision making and goal setting in order to educate children on the oral health behaviors they can practice every day to become healthy (Ubbes et al., 2020a; Ubbes & Witter, 2021).

For school-aged children, proper dental hygiene and nutrition education can support cognitive development, school readiness, self-esteem, and a longer quality of life (Ramos-Gomez et al., 2020). Midstream influencers of children are elementary teachers and parents who can help to identify the underlying reasons for poor school attendance from dental pain (Jackson, et al., 2011). For example, missing school contributes to poor academic attendance by children (Eklund et al., 2022), which can affect academic performance in the form of overall test scores. And unfortunately, tooth pain can reduce children's ability to focus on classroom learning and homework completion when they are in school (Ruff et al., 2019). Untreated dental caries can cause pain and infection and ultimately lead to problems in eating, speaking, and learning (NIHCD, 2021).

Health Literacy

Health literacy has been defined as functional, interactive, and critical (Nutbeam, 2000) with more recent recommendations to "define health literacy in the context of quality school health education" and to "support school health education as a strategic avenue to achieve health literacy" (Videto & Dake, 2019). The Institute of Medicine's (IOM) report entitled *Health Literacy: A Prescription to End Confusion* stated that the "most effective means to improve health literacy is to ensure that education about health is a part of the curriculum at all levels of education" (Nielsen-Bohlman, Panzer, & Kindig, 2004, p. 149).

When considering health literacy for early childhood, the health literacy of a child's parents (or primary caregivers) is considered to be the most important because low parent and caregiver health literacy are linked to poorer health-related knowledge, behaviors, and health outcomes of their children (Morrison et al., 2019). Velardo and Drummond (2017) have advocated for child centric approaches in health literacy research and "the importance of working with children" (p. 9). This includes the need for school-based health literacy (p. 10) to include easily accessible health information that can be understood by younger age groups. There has also been a call to action on "understanding children's needs by including children as active participants in research...with the goal of understanding how children construe their social worlds" (p. 9) and how "children make sense of health messages" (p. 7).

Theoretical Framework

A constructivist theoretical framework in health education aims to teach concepts that focus on patterns and relationships in health-related information while encouraging students to take an active collaborative role in their learning by making meaning and constructing their own understanding and inferences about health (Ubbes et al., 2009). Children learn about health through the influence of their families and peers in a social context (Vygotsky, 1978). Making meaning of concepts related to health promotion and disease prevention requires the practice of functional health literacy skills (e.g., reading, writing, speaking) in order to build functional health knowledge at a foundational level in health education. Tappe et al. (2009) define functional knowledge as specific concepts and information that students need to know in order to engage in healthy behaviors. More recent descriptions of functional health knowledge includes "valid and reliable information and concepts that support health beliefs, skills, and behaviors" (National Consensus for School Health Education, 2022, p. 20).

Oral health literacy curricula are available to encourage elementary children to brush their teeth with fluoridated toothpaste twice a day, floss their teeth to reduce gum inflammation, eat healthy foods and beverages, and get a dental checkup every six months while building their functional health literacy skills (Ubbes et al., 2020a; Ubbes & Witter, 2021). If children do not brush their teeth and practice poor oral hygiene habits, plaque will build up on the surface of the tooth and cause the tooth to decay as evident by changes in oral bacterial flora (Butera et al., 2022).

Purpose of the Study

The eBook for Oral Health Literacy® curriculum was implemented with elementary children to teach them how to set goals and make decisions about their oral health hygiene and nutrition. The main goals of the study were: 1) determining what children learned about their teeth from two chapters of the eBook for Oral Health Literacy® curriculum and what they remembered from reading the oral health and nutrition stories; 2) determining whether they liked to read and what they liked about the words and the pictures of the stories; and 3) determining whether children brushed their teeth in the morning and at night; had any cavities; had mouth pain; and visited the dentist every six months for a dental checkup.

Method

Participants

Participants ($n = 39$) included a convenience sample of second grade ($n = 21$) and third grade ($n = 18$) students from a city school district in the Midwestern United States. Children were from intact classrooms in two different elementary schools from the same school district. Gender breakdowns for the participants ($n = 39$) included 19 girls, 18 boys, and 2 did not specify their gender. Second grade students ($n = 21$) read Chapter 6 of the curriculum called “Decisions to Keep My Teeth Healthy and Strong”. Third grade students ($n = 18$) read Chapter 6 and also read Chapter 5 of the curriculum called “Setting Food Goals for Healthy Teeth”.

Procedures

This pilot study assessed second and third grade children ($n = 39$) on their oral health vocabulary recall after reading and listening to the narration of two chapters of the e-Book for Oral Health Literacy® curriculum, specifically from Theme 2 entitled “Oral Health and Nutrition of Children”. Classroom instruction at the elementary schools was led by a faculty member from the local university, who was a registered dietitian and instructor of a senior-level nutrition course. Chapters 5 and 6 were read by the elementary students who advanced the slides at their own pace using their computer mouse. Each chapter

took one minute to read and then the children were asked to recall and write what they had learned from the e-Book chapters through an open-ended conversational process. Third graders ($n = 18$) read Chapters 5 and 6 of the curriculum whereas second graders ($n = 21$) read only Chapter 6 of the curriculum. Students responded to the survey questions that are explained below.

Survey Questions

There were two types of surveys for the elementary children. Children responded to four open-ended questions: What is something that you learned about your teeth today? What is something you remember about the pictures in the book? What is something you remember about the words in the book? What did you like about the book that you read? Children also responded to six multiple choice questions: (1) Did you brush your teeth this morning? (Yes, I did!; No, I did not.); (2) Have you been to the dentist in the last year? (Yes; No); (3) How many cavities (or fillings) do you have in your teeth? (Open ended response); (4) Have you ever missed school because your teeth or mouth hurt? (Yes; No); (5) Do you like to read? (Yes, all of the time!; Sometimes; No, not really); and (6) Gender.

Curriculum Materials

The eBook for Oral Health Literacy® is a theory-based intervention that encourages students to read about decision-making and goal-setting messages for improving their oral health and nutrition behaviors in tandem. The curriculum and supportive materials are found on the Digital Literacy Partnership website at Miami University (Ubbes & Miami University Libraries, 2022). The eBook for Oral Health Literacy® has been previously evaluated for its readability, suitability, understandability, actionability, and gist-based message design (Ubbes, et al., 2020) including eye tracking feedback from three audiences (Ubbes, et al., 2018c). The primary prevention curriculum with five themes was designed and targeted directly to children in order to shape their health-related beliefs, skills and, behaviors regarding oral health and nutrition practices in their everyday life. Overall, 17 chapters include visual-textual-gestural storylines that demonstrate healthy actions for brushing, rinsing, flossing, and going to the dentist for a 6-month checkup, including eating nutrient-dense foods and beverages. For the purposes of this study, only Chapters 5 and 6 of the curriculum were selected as a brief intervention in the elementary classrooms. Chapters 5 and 6 represented one curriculum theme with two synergistic health behaviors: oral health and nutrition.

Figure 1 shows the Cover Page of Chapter 5, entitled “Setting Food Goals for Healthy Teeth”. Chapter 5 encourages children to improve the health of their teeth by setting fresh food goals every day.

The following polysyllabic vocabulary words are integrated into 10 different sentences on 10 slides: yogurt, fibrous, fiber, remove, sugar, eating, visit, dentist, healthy, toothpaste, buying, evening, watching, brushes, improve, healthy, calcium, and grocery. Main generalizations and phrases of the chapter include: Set a food goal to improve the health of your teeth by eating healthy meals. Eat yogurt because calcium helps your teeth to grow strong. Eat fibrous fresh foods to remove plaque and sugar from your teeth. Brush your teeth after snacks and meals.

Figure 1.

Cover Page of Chapter 5 "Setting Food Goals for Healthy Teeth"



Figure 2 shows the Cover Page of Chapter 6, entitled "Decisions to Keep My Teeth Healthy and Strong". Chapter 6 focuses on food decisions for healthy and strong teeth. The following polysyllabic vocabulary words are integrated into 10 sentences on 10 slides: healthy, eating, drinking, morning, apples, candy, water, soda, sugar, decisions, vegetables, broccoli, calcium, nutritious, beverages, and family. Main generalizations and phrases include: Decide to keep your teeth healthy and strong. Eat your vegetables like broccoli because broccoli contains calcium for teeth. Drink your milk at lunch and at home. Eat apples instead of candy. Drink more water instead of sugary soda because water can rinse and clean your teeth and gums.

Figure 2.

Cover Page of Chapter 6: "Decisions to Keep My Teeth Healthy and Strong"



Data Analysis

Data analysis was conducted using SPSS Version 25 (IBM Corporation). Significance was set at $p \geq 0.05$. For the Chapter 5 multiple choice questions, Shapiro-Wilk normality tests were performed to evaluate the type of correlation needed. Spearman rank order correlations were run because the data were skewed and thus, a non-parametric statistic was needed. The non-parametric Chi-square statistic, was used to analyze group differences because the dependent variable was measured at a nominal level (McHugh, 2013). For the Chapter 5 multiple-choice questions, several statistical tests were run, including frequencies, Shapiro-Wilk normality, Spearman rank order correlations, and a Chi-square test. Chapter 6 involved open-ended written responses and elaborations and did not require statistics.

Results

Six multiple choice questions formed the basis for our second and third research goals. Frequency results for the question, "Did you brush your teeth this morning?", 15 students selected, "Yes, I did!" and 3 selected "No, I did not". For the question, "Have you been to the dentist in the last year?", 17 said "Yes" and 1 selected "No". A test of Shapiro-Wilk normality for all six variables was run from the Chapter 5 multiple choice questions ($n = 18$). The 6 variables were: Did you brush your teeth this morning?; Have you been to the dentist in the past year?; Gender; Have you ever missed school because your teeth hurt?; How many cavities (or fillings) do you have in your teeth?; and Do you like to read? One of the reasons that the data were not normally distributed was because it is difficult to have high variability when the number of participants were less than fifty. The normality test was run in order to determine the proper correlation test that should be used for further testing of the data. If the data were normally distributed, a Pearson product moment correlation would have been run; however, the data were skewed, so a nonparametric Spearman correlation was run. All the variables were considered not normally distributed as the significance values were all less than 0.05. According to a source, "The Shapiro-Wilk test is a more appropriate method for small sample sizes (<50 samples) although it can also be used on larger sample size while Kolmogorov-Smirnov test is used for $n \geq 50$ " (Mishra et al., 2019, p. 70).

Table 1 shows the results of the Spearman rank order correlations for Chapter 5 Multiple Choice questions with six variables. The two questions, "Did you brush your teeth this morning?" and "Have you been to the dentist in the last year?" were significant ($p = 0.020$). The correlation coefficient was 0.542 which shows that there was a moderate, positive relationship between the two variables, $r(16) = 0.542$, $p = 0.020$, because the higher the correlation coefficient, the stronger

the relationship. No other values had significant correlations because their *p*-value was ≥ 0.05 .

Table 2 represents Chi-square results for the variables, Did you brush teeth in the morning? and Have you been to the dentist in the last year? The Pearson Chi-square test was run in order to test if the variables

were associated with each other. Results for the Pearson Chi-square test indicated a 5.294 value with a two-sided *p*-value of 0.021. Because the *p*-value is less than the significance level of $p < 0.05$, the relationship between these two variables was significant. In other words, morning teeth brushing and going to the dentist in the last year were associated with each other.

Table 1.
Spearman Rank Order Correlations for Chapter 5 Multiple Choice Questions

Multiple Choice Questions		Did you brush your teeth this morning?	Have you been to the dentist in the last year?	How many cavities (or fillings) do you have in your teeth?	Do you like to read?	Have you ever missed school because your teeth hurt?	Gender
Did you brush your teeth this morning?	Correlation Coefficient	1.000	.542*	.052	-.123	.108	-.100
	Significance (2-tailed)		.020	.839	.626	.668	.693
Have you been to the dentist in the last year?	Correlation Coefficient	.542*	1.000	-.168	-.301	.059	-.217
	Significance (2-tailed)	.020	.504	.224	.817	.387	
How many cavities (or fillings) do you have in your teeth?	Correlation Coefficient	.052	-.168	1.000	-.070	.168	.155
	Significance (2-tailed)	.839	.504		.781	.504	.539
Do you like to read?	Correlation Coefficient	-.123	-.301	-.070	1.000	-.351	.278
	Significance (2-tailed)	.626	.224	.781		.153	.264
Have you ever missed school because your teeth hurt?	Correlation Coefficient	.108	.059	.168	-.351	1.000	-.271
	Significance (2-tailed)	.668	.817	.504	.153		.276
Gender	Correlation Coefficient	-.100	-.217	.155	.278	-.271	1.000
	Significance (2-tailed)	.693	.387	.539	.264	.276	

*Correlation is significant at the 0.05 level (2-tailed); n=18

Table 2.
Chi-Square Results for Brush Teeth in the Morning? and Been to the Dentist in the Last Year?

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	5.294 ^a	1	.021		
Continuity Correction ^b	.847	1	.357		
Likelihood Ratio	3.905	1	.048		
Fisher's Exact Test				.167	.167
Linear-by-Linear Association	5.000	1	.025		
N of Valid Cases	18				

a. 3 cells (75%) have expected count less than 5. The minimum expected count is .17.
b. Computed only for a 2x2 table.

Figure 3 shows the results for the Spearman rank order correlation between: Did you brush your teeth this morning? and Have you been to the dentist in the last year? ($n = 18$). All the students that brushed their teeth in the morning had been to the dentist in the past year. Only one student did not go to the dentist in the last year, and that student did not brush their teeth in the morning. This correlation was significant with a p -value of 0.02.

Figure 3.
Bar Graph of Spearman Rank Order Correlation between "Did you brush your teeth this morning?" and "Have you been to the dentist in the last year?"

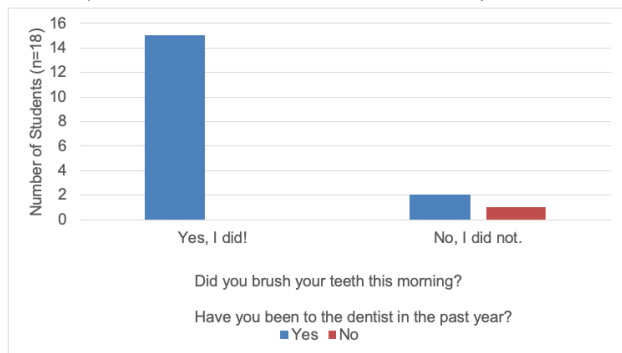


Figure 4 displays the Spearman rank order correlation for the variables, Do you like to read? and Gender? These questions were asked because students had to read and listen to the chapter from the eBook for Oral Health Literacy© curriculum to learn about their oral health. When answering the attitudinal question, "Do you like to read?", 18 participants indicated "Yes, all of the time" (4 girls, 2 boys); "Sometimes" (5 girls, 3 boys); and "No, not really" (1 girl, 3 boys). In general, girls ($n = 10$) liked to read more than boys ($n = 8$), but it was not significant.

Figure 4.
Spearman Rank Order Correlation between "Gender?" & "Do you like to read?"

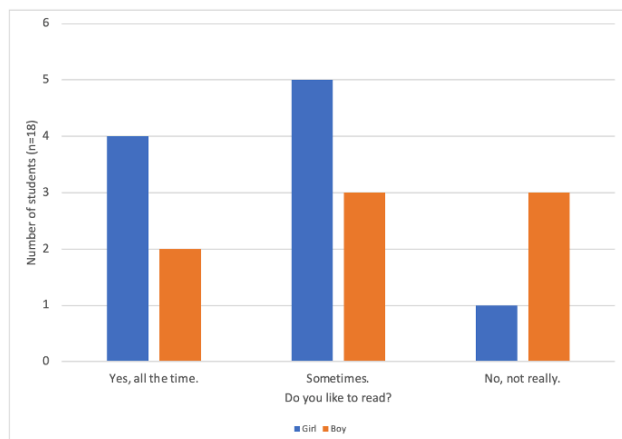
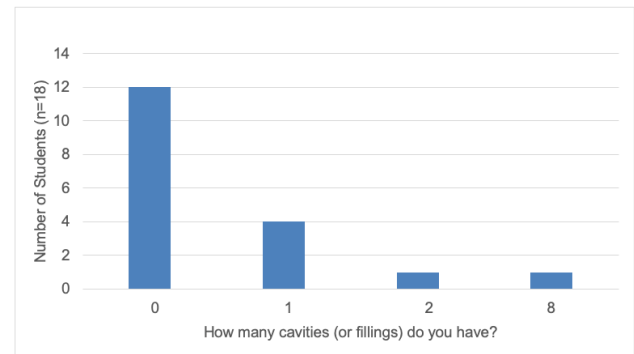


Figure 5 shows the frequency results for the number of cavities that the students self-reported. When asked the question "How many cavities (or fillings) do you

have in your teeth?"; 12 students reported that they did not have any cavities, 4 students reported one cavity, 1 student reported two cavities, and 1 student reported 8 cavities in their teeth. Although not indicated in Figure 5, when students were asked, "Have you ever missed school because your teeth hurt?", only one student answered "Yes" and seventeen students answered "No".

Figure 5.
Bar Graph for "How many cavities (or fillings) do you have in your teeth?"



Results for Chapter Elaborations

Students were encouraged to write their thoughts about the Chapter 5 and Chapter 6 eBook stories. Written responses included vocabulary from the stories and certain phrases they recalled from reading a story one time. The written elicitations from students provided a form of qualitative responses that go beyond the objective multiple-choice responses that they also provided. The results below will explain the Chapter 5 and Chapter 6 vocabulary words and phrases that represented their functional health knowledge, including what elaborations that students remembered about the pictures and words from the book, what they liked about the book, and what they learned about their teeth.

Chapter 5 Elaborations

After reading the Chapter 5 eBook, some of the most frequently reported vocabulary words were: calcium, healthy, dentist, goal, and yogurt. Some students not only listed a singular word but wrote the vocabulary word in a phrase similar to what they read in the book and recalled from their memory. Some examples are "setting goals for brushing and flossing teeth", "going to the dentist every 6 months", "it said I set a goal to eat yogurt which has calcium because calcium helps my teeth to grow strong.", "calcium helps my teeth grow." "set a goal to visit and talk with my dentist every 6 months.", "That fiber and calcium help your teeth stay healthy." These self-reported vocabulary words and phrases were important because the students only read the one-minute story once then recalled and wrote down words that stood out to them or seemed meaningful to them. The data showed that

students were able to draw upon their memory and use a working vocabulary which represented their functional health knowledge from the curriculum.

Chapter 6 Elaborations

After reading Chapter 6 only once, some of the most frequently written vocabulary words were: eating, healthy, dentist, calcium, and yogurt. Other written answers included: decisions, choices, floss, broccoli, brush teeth, and clean teeth. When asked what they learned from reading Chapter 6, the children wrote the following phrases and tips: “do not eat as much sugar”; “eat an apple instead of candy”; “drink lots of water”; “drink milk everyday”; “eat fruits and vegetables.” Others said, “When you go to the store buy a toothbrush” and “brush them every day”. By asking more open-ended questions for elaborations, students were able to remember key words and phrases which may help them make healthier choices to benefit both their nutrition and oral health. Elaborations indicated that students were able to recall and comprehend basic health information in the form of nutrition and oral health vocabulary words and phrases, which represented their functional health knowledge from the curriculum.

Remembering the Pictures in the Book

When second and third graders ($n = 39$) were asked “What is something you remember about the pictures in the book?”, the students wrote: “They all contain kids/adults making good and healthy choices”, “Lettuce is good for your teeth.”, “A boy eating an apple.”, “Brushing teeth and flossing.”, “Girl drinking water.”, “They all include kids doing healthy choices.”, “Someone smiling”, “They include nutritious pictures.”, “Every picture had a healthy food in it.”, “Eating yogurt.”, and “They were all doing something about their teeth.”

Remembering the Words In the Book

When second and third graders ($n = 39$) were asked, “What is something you remember about the words in the book?”, the students wrote: “Floss.”, “Fiber.”, “Calcium helps my teeth grow strong.”, “I buy toothpaste with my mom and floss.”, “It said I set a goal to eat yogurt which has calcium because calcium helps my teeth to grow strong.”, “Set a goal to visit and talk with my dentist every 6 months.”, “Setting goals for brushing and flossing teeth.”, “They talk about food that is healthy for your teeth.”, “They talk about fruit.”, “You need to keep your teeth healthy.”, “The words are all about teeth.”, “Food goals.”, “Milk is healthy for your teeth.”, “Fruit is good.”, “Nutritious beverages.”, “They told us about healthy food.”, “Going to the dentist every 6 months.”, “Healthy goals.”, “Yogurt has calcium.”, “When you go to the store buy a toothbrush.”, “They all talk about kids making their choices about being

more healthy.”, “They make healthy goals.”, and “They talk about healthy choices.”

Remembering What Children Liked About the Book

When second and third graders ($n=39$) were asked, “What did you like about the book that you read?”, the students wrote, “I love my teeth.”, “It had vegetables.”, “It has healthy tips for you.”, “It taught me to do healthy choices, keep my teeth healthy.”, “Tips.”, “The girl and the mom buying toothpaste and floss.”, “The pictures.”, “It was cool.”, “To set healthy goals.”, “I like that it helps me remember brush your teeth.”, “It helps you learn how to keep your teeth clean.”, “All of it.”, and “To help us be healthy.”

Remembering What Children Learned About Their Teeth

When second and third graders ($n = 39$) were asked, “What is something that you learned about your teeth today?”, they wrote: “Brush every day.”, “Calcium helps my teeth grow strong.”, “Floss your teeth.”, “That fiber and calcium help your teeth stay healthy.”, “That you always need to brush your teeth.”, “To go to the dentist every 6 months.”, “Always floss.”, “Brush your teeth to keep them clean.”, “Calcium makes your teeth strong.”, “Fill in cavities.”, “Clean my teeth.”, “Go to the dentist every 6 months.”, “How to brush your teeth.”, “To not eat as much sugar.”, and “You can keep your teeth clean if you eat certain foods sometimes.”

Discussion

There is an ongoing need to offer more preventative oral health education for U.S. children, especially since 51 million hours of school time are missed annually because of dental-related problems (USDHHS, 2000), and children with fair or poor oral health are 2.8 times more likely to lose greater than one hour of school time compared to children with very good oral health (Naavaal & Kelekar, 2018). Moreover, there are limited empirically tested school-based caries programs with adequate training support for teachers and school staff to ensure fidelity to program implementation (Sharma, et al., 2021). In the current pilot study to investigate the feasibility of introducing the eBook for Oral Health Literacy® curriculum to second and third graders, a dietitian serving as a guest nutrition educator found it easy to implement two chapters in the classroom and build additional content around the stories. Because a lack of oral hygiene and inadequate nutrition are risk factors for systemic diseases that begin in the mouth (NIDCR, 2021), school curricula should promote the integrative connections between oral health, nutrition, and disease prevention in order to boost children’s functional health knowledge, skill development, and health behaviors across the lifespan.

The eBook for Oral Health Literacy® curriculum is aligned to the National Health Education Standards with a specific focus on developing decision making and goal setting skills. The National Health Education Standards focus on what students should know and be able to do with an emphasis on demonstrating health-enhancing skills and behaviors to reduce risks, promote health, and prevent disease (Joint Committee on National Health Education Standards, 2007). Results from the 2016 School Health Policies and Practices Study (CDC, 2017) indicated that 77.1% of school districts had adopted a policy stating that their elementary schools will teach decision making, and 69.2% of school districts had adopted a policy to teach goal setting. Decision making is defined as “the ability to select between two or more alternatives to reach the best outcome in a specified time frame. Decision making requires the use of accurate and reliable information while progressing through a set of steps intended to take deliberate actions to enhance health” (National Consensus for School Health Education, 2022, p. 20). Goal setting is defined as “the process of determining a desired health-related behavior or practice to achieve over a specific time period. This process is more deliberate than desires and momentary intentions and involves committed thoughts, emotions, and behaviors toward attaining the goal” (National Consensus for School Health Education, 2022, p. 21).

The National Health Education Standards (Joint Committee on National Health Education Standards, 2007, p. 63) suggested that students in prekindergarten to grade two receive 40 hours of instructional time per academic year which is approximately one hour per week. Instructional time for students in grades three to twelve were recommended to receive 80 hours of instructional time per academic year, which is approximately two hours per week. In the current study, health education was not occurring at all. Therefore, the second and third-grade children in the current study would benefit greatly from 1 to 2 hours of health instruction each week (Joint Committee on National Health Education Standards, 2007). The fact that the eBook for Oral Health Literacy® curriculum only requires one-minute intervals to read in order to instruct children on both their oral health and nutrition behaviors could be a perk for children so they learn more functional health knowledge while also learning health-related skills.

The eBook for Oral Health Literacy® curriculum combines declarative sentences and a vocabulary about oral health and nutrition to teach elementary children about health education concepts and skills. The curriculum focuses specifically on cognitive skill development by underlining the words ‘decision making’ (Chapter 5) and ‘goal setting’ (Chapter 6) on each page for promoting children’s awareness of

these skill-based verbs to help them take personal and social actions toward practicing their oral health hygiene and consuming healthy food and beverages. Questions, cues, and advanced organizers are known to be an evidence-based instructional strategy (Clemons et al., 2010). On each page, underlined cues for the words “decision making” and “goal setting” can also be described as a priming effect, which involves the activation of a mental concept in memory to increase the likelihood that the concept will be used again when processing information (Farrar et al, 2022). Priming effects have been successfully applied in early childhood vocabulary (Avila-Varela et al., 2021). Additionally, the concluding page in each story is intended to be a form of skill-based cuing to provoke further action. Chapter 5 reads “How about you? Will you set a food goal for healthy teeth too?” whereas Chapter 6 reads “I’ve made the decision to keep my teeth healthy and strong! How about you? Have you made the decision too?”. These question cues are an example of interactive health literacy between the writer (narrator) and the reader in first-person narrative. Future research will have to determine the effects of priming on food goals and oral health hygiene behaviors among children exposed to the oral health literacy curriculum.

In the current study, health education instruction by the classroom teacher was limited so the health literacy intervention occurred when a dietitian visited the classroom. In this situation, expertise from the nutrition community helped to promote the importance of nutrient-dense food and beverages in tandem with oral health education which is an example of how to advance community involvement and health education using the Whole School, Whole Community, and Whole Child model (Lewallen et al., 2015). Finding ways to implement the eBook for Oral Health Literacy® curriculum in other places in the school day could be advantageous since children’s elaborations showed that they learned and recalled content knowledge in the form of vocabulary and health-related phrases after reading only one chapter (Grade 2) or two chapters (Grade 3).

The vocabulary and linguistic readiness of children to learn a specific domain of health within their academic studies is paramount. Health-related words like decay, infection, cavities, flossing, rinsing, and brushing need to be named and understood (e.g., comprehension) through functional health literacy skills (e.g., reading, writing, and speaking) before children can operationalize or demonstrate their functional health knowledge and skill development toward healthy behaviors. By repeating daily health behaviors each day and practicing the skills leading to the behavior based on feedback from teachers and parents, children can form important habits of health. Research shows that feedback both regulates and is

regulated by motivational beliefs (Nicol & Macfarlane-Dick, 2006). External feedback has been shown to influence how students feel about themselves (positively or negatively), and what and how they learn (Dweck, 1999). Students need to practice oral health patterns every day to meet standards for brushing, rinsing, and flossing their teeth (Thornton et al., 2019; dos Santos et al., 2011). Oral health requires children to learn functional knowledge of what hygiene is (and what it is not) while also demonstrating procedural knowledge of how to do it. Contextual knowledge is also necessary so students know when, where, and to what extent they should practice the oral health behaviors of brushing, rinsing, flossing, AND eating and drinking nutrient-dense food and beverages for healthy teeth.

Written feedback from second and third graders indicated that the eBook for Oral Health Literacy® curriculum may have provided opportunities for students to increase their functional knowledge and vocabulary about oral health hygiene and healthy eating. Students were able to access visual role models on each page to increase their awareness of social norms that lead to healthy behaviors. Students also experienced auditory cues when the story was read to them which aimed to build their understanding of words and how they are pronounced. Children benefit from multimodal educational approaches that integrate visual, textual, auditory, and gestural representations when learning about their health (Ubbes, 2008). The design of the eBook for Oral Health Literacy® even goes beyond multimodal approaches to include multisensory, multigenre, and multidisciplinary elements for teaching about oral health hygiene, nutrition, and dental checkups (Ubbes et al., 2018).

Health educators who learn how to adopt a constructivist pedagogical perspective (Ubbes et al., 2009) will be able to seek out how students are thinking about a topic and reflect on how they make meaning from the lesson. Health education interventions have traditionally focused on knowledge, attitudes, and behaviors in a didactic manner. However, child-centric approaches that adopt elicitations through oral conversations and open-ended written responses may help educators to uncover the motivations and attitudes of children when they are learning skill-based health education. The National Health Education Standards (National Consensus for School Health Education, 2022) focus on skills like interpersonal communication, decision making, and goal setting, to name a few. So, asking students to talk and write about their learning experiences after reading chapters from the eBook for Oral Health Literacy® curriculum can provide insights into how children practice cognitive skills leading to oral health behaviors. Such elicitations can also

be aimed at helping children to elaborate on their attitudes, beliefs, and feelings about specific health behaviors like oral health and nutrition. Elaborations through written and spoken conversations can help children to make progress in practicing health-related behaviors which are the key outcome of any health education curriculum, but children can also be taught to explicitly work on two behaviors at once by realizing similar patterns between oral hygiene and nutrition for building healthy teeth, mouth, and gums. With limited time to teach health education in the school day, the curriculum can also extend to home-based implementation around mealtime, nap time, and bedtime routines.

Although the main outcome of a skill-based health education curriculum is healthy behavior (Joint Committee on the National Health Education Standards, 2007), schools can also use literacy time across the curriculum to construct meaning about health. In second and third grade, children build their literacy and reading proficiency by “learning to read”. However, by fourth grade, children should have strong literacy skills as they shift toward “reading to learn” more disciplinary content knowledge (Wright, 2019, p.4). According to the Ohio Department of Education (2020), “language and literacy acquisition and achievement [are] foundational knowledge that supports student success”. As such, literacy skills should be fully developed at the second and third grade levels so that they may serve as a foundation for further literacy development. The national public health initiative, Healthy People 2030 (USDHHS, 2020), indicates that only 48% of fourth graders read at their grade level in the United States.

Functional health literacy depends on the basic skills of reading, writing, and speaking about health (Ubbes et al., 2018b), so functional health literacy serves as an integrated pathway for learning two disciplines, e.g., literacy and health, at the same time. Although health educators are not responsible for the direct teaching of reading, writing, and speaking in a literacy sense, health educators would be using these functional forms of literacy, albeit functional health literacy, when providing examples of individuals learning about health and how to practice healthy behaviors. Children need to experience and practice these functional forms of literacy across the school curriculum so they can communicate and make meaning when learning about health. Hence, learning to read and reading to learn become symbiotic processes from early childhood into middle childhood and beyond. Therefore, the eBook for Oral Health Literacy® curriculum may be helpful in increasing functional knowledge, vocabulary, and reading proficiency about health, which could result in higher student achievement and lifelong learning. The narration of the chapter stories help children on a developmental

level to be able to learn health education at their own pace as they advance to the next page as assisted by teachers, peers, and/or parents as guides on the side.

Goal 1. To determine what children learned about their teeth from two chapters of the eBook for Oral Health Literacy® curriculum and what they remembered from reading the oral health and nutrition stories

This study not only aims to educate students about oral health habits, but also help to build their healthy literacy skills. One of the multiple-choice questions asks students, "Do you like to read?" About 20% of students said that they do "not really like to read". This could be for several reasons, one of which being that they are not comfortable reading due to a lack of literacy skills. By implementing the eBook for Oral Health Literacy® curriculum, students can learn to build both their health literacy and self-efficacy which would hopefully promote a liking for reading and increase the amount of time spent reading. When looking further into the results if the students like to read, girls generally liked to read more than boys did. When answering the question, "Do you like to read?", four girls versus two boys selected "Yes, all of the time"; five girls versus three boys selected "Sometimes"; and only one girl versus three boys selected "No, not really." Although these findings were not statistically significant when the Spearman rank order correlation was run, there is prior research to build on the idea that girls generally enjoy reading more than boys (Ubbes et al, 2018b).

By allowing children to respond to open-ended questions rather than only multiple-choice questions, they were able to recall what stood out to them as they read the eBook. Open-ended questions also allow teachers and parents better insights into what the children know, feel, and show interest in. Written language is an expressive language that affords teachers and parents insights into what children know and think about, especially when the curriculum is used as a vehicle for sharing new vocabulary words that lead to functional health knowledge. Expressive written language also gives teachers and parents insights into what children are feeling and how motivated they are to practice daily oral hygiene and eating nutritious foods.

For the Chapter 5 eBook, some of the most frequently reported vocabulary words were calcium, healthy, dentist, fruit, vegetable, and yogurt. For Chapter 6 of the eBook, some of the most reported vocabulary words were: eating, healthy, dentist, calcium, and yogurt. Other words frequently reported were goals, decisions, choices, floss, broccoli, brush teeth, and clean teeth.

Based on the children's responses, they were able to recall multiple vocabulary words as well as other words that were mentioned throughout the eBook chapters around the topics of oral health and nutrition. Some of the words used in the chapters might not have been familiar to the children. This forced the children to recall from memory what they had heard, as well as remember the context in which the word was used, in order to spell it out in their open-ended answers. This chain of thought relates to higher order thinking skills. In a different study it was said that "...in its simple form, HOTS (higher order thinking skills) in storytelling was developed in young learners through open-ended question[ing], a strategy which enables students to practice speaking through giving opinion, comment, and imagination while analyzing and evaluating the story" (Setyarini et al., 2018). There are many advantages to using open-ended questions, because questions elicit children to tell a story and practice various ways of thinking. Children who wanted to communicate their thoughts via lists and sentences, had to spell out their ideas (this study) and/or drew an illustration (our first study). A couple of students drew pictures to express what stood out to them; for example, one student drew a picture of a toothbrush. Hence, higher order thinking skills can prompt children to practice functional health literacy as an expressive language for communication.

Goal 2. To determine whether children liked to read and what they liked about the words and the pictures of the oral health stories

This study focused on oral health literacy and a more specific type of functional health literacy that emphasized reading and writing about health. Results showed that 80% of students said that they liked to read, which supported the value of the eBook for Oral Health Literacy® as a vehicle for supporting literacy skills and oral health behaviors in tandem. The eBook narrates the story to children which can help them learn new vocabulary words leading to reading fluency. Fluency is a critical predictor of literacy. By implementing the eBook for Oral Health Literacy® curriculum, students learned to build their functional health literacy which would hopefully promote an ease and liking for reading and increase the amount of time they spend reading to learn facts, topics, and concepts about oral health.

The open-ended questions in this study, prompted students to elaborate on their liking of two chapters in the eBook for Oral Health Literacy® curriculum. For the purposes of this study, liking was conceptualized as a plain language word that helped children to identify their feelings, attitudes, or preferences for something. Often children do not prefer things that are new or foreign to them (e.g., vegetables), which has been coined "neophobia" (Chawner & Hetherington, 2021).

For example, when children say they don't 'like' milk, nutrition educators can talk about and differentiate between dairy and nondairy milk examples and help them to understand that each serving of milk provides 25% of the calcium needed each day (National Dairy Council, 2019). Such information allows educators to examine children's preferences so they can reframe their thinking on why an item they disliked may actually be important, helpful, or healthy for them; ultimately this interactive health literacy process can help children build their functional health knowledge even more. After understanding why some children may not "like" milk, health educators can talk about the benefits of milk to reframe the children's beliefs; this interactive health literacy process of talking and/or reading about milk also increases children's functional health knowledge as long as educators use valid and reliable health information and concepts.

When children were asked the question, "Do you like to read?" ($n = 18$), six children said that they liked to read all the time and eight students said that they sometimes liked to read. These children were able to recall and write about what they liked and learned from the book after a short one-time exposure, as well as being able to recall words and pictures that stood out to them from the eBook for Oral Health Literacy® curriculum. These findings are supported by a study by Zullig et al (2017) who found that oral health behaviors were significantly related to reading behaviors among 7th and 8th graders. If health educators teach about oral health topics earlier in the elementary school curriculum using a meaningful multimodal intervention that is easily recalled (Ubbes et al, 2018c), children will have a stronger foundation for their oral health and overall general health since the two are inextricably linked (National Institute of Dental and Craniofacial Research, 2021).

Functional health literacy is the ability to read, write, and speak about health (Ubbes & Ausherman, 2018). Even if children can read and write at requisite levels for schooling, few children have been exposed to enough health-related topics and concepts to have a strong vocabulary about health. Low vocabulary in health education limits the transition from basic literacy to health literacy. Studies have shown that vocabulary knowledge is requisite to reading comprehension and meaning making (Dong et al., 2021). An important educational goal would be to focus on functional knowledge about nutrition and oral health that includes valid and reliable information from which to function in everyday situations and routines. As such, the process of reading about valid and reliable health information can support children in their development of more background knowledge from which to communicate and act on health information, set goals, and make decisions about health.

Goal 3. To determine whether children brushed their teeth in the morning; had any cavities; had teeth or mouth pain; and visited the dentist in the last year for a dental checkup

Eighteen third grade students answered four multiple choice questions and one open-response question regarding their oral health habits. All but one student replied "Yes" when asked, "Have you been to the dentist in the last year?" Although it is positive that only one student had not "been to the dentist in the last year", everyone is recommended to see a dentist every six months. Twelve students reported that they did not have any cavities. Specifically, four students reported that they had one cavity, one student had two cavities, and one student had eight cavities. Based on the small sample of students, it can be concluded that one in three third grade students had at least one cavity. With oral caries being a completely preventable infectious disease, this statistic is troubling. Despite the high number of students with at least one cavity ($n=6$), only one student reported missing school because their teeth hurt.

Other results showed that fifteen third grade students brushed their teeth in the morning whereas three students replied "No". Results showed that one in five students (20%) brushed their teeth in the morning. Guidelines suggest that this number can and should be much higher due to the recommendation that children should brush their teeth twice a day with fluoridated toothpaste (Thornton-Evans et al., 2016). Brushing one's teeth is an important habit for students to adopt, which should be added to their daily routine in the morning and at night. Research indicates that there are several barriers that keep children from brushing their teeth (Duijster et al., 2015), including lack of knowledge, poor accessibility to dental products (e.g., toothbrush, toothpaste, and floss), and limited role models. Although dental products are often distributed to children during a dental checkup, not all children have access to dental checkups due to geography, transportation, and/or financial barriers. School-based health clinics may be one of the most important and easily accessible ways that children can be supported with their overall health and oral health hygiene, specifically (Knopf et al, 2016). The placement and use of the eBook for Oral Health Literacy® curriculum in school-based health clinics should be studied in the future.

Limitations

The main limitation of the study was a small sample size ($n < 50$). Future studies will need to be conducted beyond a convenience sampling in order to have more participants and a control group used in the research. The second limitation was that reading or writing were not directly assessed in this study. The acquisition of literacy leads to functional changes in

several cortical structures in the brain, including white matter interconnections that are predictive of reading performance (Lopez-Barroso et al., 2020; Thiebaut de Schotten et al., 2014). Moreover, the ability to gain access to reading and writing scores of children for health education research is fraught with challenges. Child-centric surveys that measure recognition of oral health words and reading of health-related terminology in different contexts should be developed to address student gains in functional health literacy in oral health, nutrition, and other health behaviors. The third limitation was that we were not privy to classroom conversations that occurred between the dietitian and the elementary children. As such, we only have written answers from students to determine how much learning occurred. Since functional health literacy addresses the ability to “read, write, and speak about health” (Ubbes & Ausherman, 2018; Ubbes et al., 2018b), future research should attempt to transcribe verbal and nonverbal communication of children in the classroom when teaching other multimodal chapters of the curriculum. Understanding how much reading, writing, and speaking occurs in the health education classroom by children may be helpful for establishing instructional parameters for how functional health knowledge contributes to the development of functional health literacy (and vice versa). Investigative studies that assess the synergy between health literacy and functional health literacy may ultimately lead children to make decisions and set goals for their health once they understand the noun and verb vocabularies that inform their actions to do so. As such, noun and verb cues like ‘decision’ and ‘to decide’, or ‘goal’ and ‘to set a goal’, respectively, become key lexical milestones for that informs the development of functional health literacy.

Conclusion

An eBook for Oral Health Literacy© curriculum was used as a brief intervention to help school-aged children use their functional health literacy skills of reading, writing, and speaking to learn about oral health hygiene and the importance of choosing healthy food and beverages for their teeth. The curriculum focused on building functional knowledge about oral health hygiene and nutrition behaviors through a health literacy intervention that highlighted the need for reasoned actions when setting food goals for healthy teeth and making decisions to keep teeth healthy and strong. The visual-textual-gestural narrative helped children to build a vocabulary about oral health when reading and writing about health. Children wrote about words and phrases that they recalled after reading each chapter. Their elaborations exemplified the importance of using a constructivist theoretical framework to elicit children’s functional health knowledge about oral health and nutrition. Chi-square results showed that there was a moderate

significant correlation between children who reported brushing their teeth in the morning and having been to the dentist in the past year ($p = .021$). The use of the eBook for Oral Health Literacy© curriculum can help children to learn functional health knowledge about brushing, flossing, and rinsing teeth, eating nutrient-dense foods and beverages, and going to the dentist for a checkup, including skill-based vocabularies about making decisions and setting goals for health.

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