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Original Paper

Functional Health Literacy, Invented Spellings, and MyPlate Representations of 2nd and 3rd Grade Children Learning about Breakfast Eating and Food Groups in Health Education

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Abstract

PURPOSE*: We had three purposes for this study: 1) to introduce 2nd and 3rd grade children to the concepts of breakfast and food groups in the MyPlate nutrition model while using an interactive constructivist approach; 2) to evaluate what foods children ate for breakfast over two days and to assess the visual-textual-lexical representations that they constructed to show their thinking about the MyPlate food model; and 3) to explore functional health literacy and inventive spellings from children who learned about food groups over two class sessions.* ***METHODS****: Pre to post student assessments focused on self-reported breakfast eating and ability to represent the MyPlate food model during the learning process. Student thinking about those topics were also elicited by multimodal approaches: oral language (conversations), written language (visual-textual-lexical illustrations), and body language (making nutritious snacks). For the latter, students constructed a snack to eat on both days at school and were encouraged to make the food at home to model nutritious eating behavior.* ***RESULTS****: Most children who participated in the lesson ate breakfast either at home or at school. Some students chose to communicate in words and pictures when asked to write about the foods they ate for breakfast. Many students illustrated and labeled food groups by drawing and using inventive spellings about their early understandings of the MyPlate food model. From the first to the second day of instruction, breakfasts with three food groups increased from 3% to 7% but breakfasts with two food groups declined from 55% to 41% due to more children (n = 60) eating breakfasts with only one food group on the second day.* ***CONCLUSIONS****: Some of the food items that students ate were not sufficient to*

produce an adequate nutritional benefit. The constructivist pedagogical approach assisted children with multimodal ways to communicate their understanding, including making two different snacks when planning a breakfast with multiple food groups. Functional health knowledge about a nutritious breakfast made with three food groups should be further aligned with functional health literacy skills of speaking and writing in multimodal ways in order to improve health behaviors. Inventive spellings demonstrated a developmental step in learning a vocabulary in a new domain. Use of written words and pictures reflected a positive way to learn health and nutrition, because children represented their understanding in more than one way. ***RECOMMENDATIONS****: By adding fruit to the breakfasts of children who participated in the lessons, almost one-half of the children would be able to increase their consumption from two food groups to three food groups when consuming an ideal breakfast. Future work should elaborate on the role of interactive health literacy in school and home contexts when children are learning about breakfast eating and food groups. Future integration of the MyPlate food model with the National Health Education Standards can foster new classroom assessments that will support students to practice observable nutrition behaviors that can lead to consistent health habits for personal, family, and school health.*

Keywords

food groups, nutrition, MyPlate food model, breakfast, constructivist theory, multimodal, functional health literacy, functional health knowledge, interactive health literacy

1. Introduction

A standard breakfast should contain 20% to 35% of daily energy requirements from at least three food groups such as milk and milk derivatives, whole grain cereals, and fresh fruit or juice without added sugar (Giovannini, Verduci, Scaglioni, et al., 2008). However, 10% to 30% of children and youth report skipping breakfast based on a systematic review of studies in 33 countries with five of those studies reporting a lower quality of dietary intake among the breakfast skippers (Monzani, Ricotti, Caputo, et al., 2019). Skipping breakfast was associated with poorer lipid profiles and blood pressure levels, including challenges with insulin-resistance and metabolic syndrome. Hence, skipping breakfast is thought to be a risk factor for metabolic diseases and a marker for overweight and obesity conditions (Manzani, Ricotti, Caputo, et al., 2019).

Adequate breakfast is connected to both psychological and physiological health benefits (Ferrer-Cascales, Sanchez-SanSegundo, Ruiz-Robledillo, et al., 2018). Breakfast is foundational to academic achievement and a higher cognitive performance (Rampersaud, Pereira, Girard, et al., 2005) which is measured by the ability to read, write, and reason. Breakfast eaters with adequate nutrients showed lower levels of stress and depression than breakfast eaters who ate a poor or very poor quality breakfast (Ferrer-Cascales, Sánchez-SanSegundo, Ruiz-Robledillo, et al., 2018). Child breakfast skippers (n = 36) have worse metabolic profiles when compared to child breakfast consumers (n = 76)

as indicated by insulin growth factor-1 (IGF-1), a modulator of lipid metabolism, while correlating negatively with LDL cholesterol ($r = -0.442$, $p = 0.024$) in breakfast skippers. Total and Low-density Lipoprotein (LDL) cholesterol, triglycerides ($p < 0.05$), and the triglyceride/HDL cholesterol ratio ($p < 0.001$) were higher, while the beneficial HDL cholesterol was lower in skippers ($p < 0.01$) when compared to consumers (Blasetti, Franchini, Castorani, et al., 2020).

Eating carbohydrates for breakfast after a night fast is beneficial for the brain because it reduces the production of the stress hormone, cortisol, which releases during a stress response by the body (Lee, Park, Ju, et al., 2009). When breakfast is consumed, the stress response in the body is reduced. Research has shown that "Adolescents who habitually consumed breakfast (> 5 days per week) had significantly reduced likelihood of disruptive behavior [Odds Ratio (OR): 0.29, 95% CI: 0.15–0.55] compared with those who ate breakfast less frequently (≤ 5 times per week)" (Adolphus, Lawton, & Dye, 2013). Carbohydrates for breakfast are converted to glucose which is "essential for the formation of tryptophan, a precursor protein for the synthesis of serotonin, which regulates depressive symptoms, irritable mood and cognitive functioning" (Lee, Park, Ju, et al., 2018; Miller, Maletic, & Raison, 2009). Cognitive functioning affords children and their social peers more developmental opportunities to think about and practice skill-based health education that leads to health behaviors such as nutrition and healthful eating. Health educators and elementary teachers can use the Whole School, Whole Community, and Whole Child framework (Lewallen et al., 2015) to invite guest speakers and nutrition educators from the community into classrooms to facilitate the teaching and learning of "health topics, concepts, and skills" (Ubbes, 2008). A health literacy approach in the curriculum also ensures the need for valid and reliable health information, product, and services (National Consensus for School Health Education, 2022, p. 8) from which to build a strong functional knowledge in healthy eating and other healthy behaviors (National Consensus for School Health Education, 2022, p. 20)

Constructivist theory in health education posits that learning through a social and collaborative way while using language as a tool will generate multiple perspectives among the learners, leading to understanding and meaning making that is constructed and determined by each learner (Ubbes & Ausherman, 2022). Using the metaphor of scaffolding that moves learners from a foundational lower-level understanding to a more sophisticated higher-level understanding, Vygotsky (1962) derived constructivist theory to include a Zone of Proximal Development where there are "guides on the side" to support each learner, but who do not do for the learner what the learner can do for themself. While in proximity to the learner, an effective educator will offer assistance to the learners as they construct meaning and reason out their understanding; students may need redirection during a moment of misunderstanding, or need more accurate information when faced with misconceptions. The supportive role that classroom teachers and health educators play in providing a culture of inquiry about health and nutrition is important for elementary children at an early age, because such factual and topical information builds a metaphorical scaffolding for learning important conceptions (or unsupported

misconceptions) about health. Significant "guides on the side" serving as social role models need to have developed functional health knowledge built on credible information. Learners will arrive there while using health literacy skills. The most frequently used scaffolding strategy in a child-centered study was inferential questioning, followed by eliciting, expansion, validation feedback, and drawing attention to relevant features of a problem or the environment (Zurek, Torquati, & Acar, 2014). Because constructivist theory suggests that "Learners who participate in both individual and collaborative processes can construct and reconstruct meanings about their health and educational status better than either process alone" (Ubbes, Black, & Ausherman, 2010, p. 96), the learning activities that are planned for health education should be assessed in ways that capture the thinking and knowing of the learners. As such, formative and summative assessments should employ written, oral, and body language using "snapshots" of the learning process which can indicate whether children have had adequate practice from session to session in their progression to health mastery.

Visual and tactile representations of healthy foods in contrast to poor quality discretionary foods can afford opportunities for elementary teachers and health educators to make learning more authentic for children. Beyond significant human role models that help children shape their learning outcomes, food models, simulated food props, and actual foods are concrete objects that help to scaffold learning for children. Two-dimensional photographic models can provide children with colorful printed props of realistic serving sizes for a variety of foods, and three-dimensional plastic or cloth replicas of foods can simulate the form and structure of certain foods for manipulation and sorting into food groups. For example, different iterations of the U.S. Department of Agriculture food models have changed over the years (Chang & Koegel, 2021), culminating with the most recent MyPlate campaign that divides a visual plate into food groups.

The use of educational models for teaching children about food portion sizes has been studied with variable results (Foster, Matthews, Lloyd, et al., 2008). However, no studies have posited whether food models afford children opportunities for language acquisition and vocabulary development. Hence, the current investigation explored the role of different food models as a priming effect for learning food names that are either eaten or planned to be eaten by children after two nutritional lessons on the topics of breakfast and food groups. By using language as a tool for thinking and learning (Roumell, 2018), children could potentially use new language patterns to interpret and internalize nutrition information into a new behavior of healthful eating. This priming effect (from food models) may increase the transfer of learning to new contexts through higher-order thinking and communication skills (Roumell, 2018). Learning transfer requires learners to apply their new knowledge and skills in a different context than the one in which the learning originally took place (Detterman, 1993).

The first purpose of the pilot study was to introduce 2nd and 3rd grade children to the concepts of breakfast and food groups found in the MyPlate nutrition model while using an interactive constructivist approach. The second purpose of the study was to evaluate what foods children ate for

breakfast over two days and to assess the visual-textual-lexical representations that they constructed to show their thinking about the MyPlate food model. The third purpose of the study was to explore functional health literacy and inventive spellings from children who had learned about food groups over two class sessions.

2. Method

2.1 Participants

Participants (N = 126) were children from two 2nd grade classrooms at two elementary schools and one 3rd grade classroom at another elementary school in the same Ohio school district. Ages of the children ranged from 7 to 8 years. Classroom instruction was led by the same faculty member, who was a registered dietitian and clinical instructor of a senior-level nutrition course at the referent university. The instructor contacted the local school district for the possibility of offering two nutrition education lessons in three of the district's elementary schools in a midwestern U.S. town. Access to the classroom was approved and coordinated by the district-level school health coordinator and the elementary teachers at each school. Informed consent was obtained through the Institutional Review Board at the referent university.

2.1.1 Overall Procedure

Although the Michigan Model for Comprehensive School Health had been implemented as a curriculum throughout the school district ten years prior (Ubbes & Zullig, 2008; Zullig, Ubbes, Pyle, et al., 2006), the district was not encouraging their elementary teachers to teach health education more recently. As such, a registered dietitian involved her university students as co-instructors (n = 15) in implementing scripted nutrition lessons in the 2nd and 3rd grade classrooms. The lessons were organized and implemented over two days for a total of 2.5 hours of instruction. The nutrition instructors were introduced by the elementary teachers before sharing the purpose of the nutrition lessons with the children. The three elementary teachers remained in their respective classrooms during the lessons.

2.1.2 Day 1 Learning Process

The learning process on Day 1 included the following steps:

1) A written assessment was given to the children before any nutrition content was shared;

2) Instruction about the MyPlate food model began by drawing a MyPlate diagram on the white board and asking students what food groups made up the MyPlate;

3) Each child then selected a three-dimensional plastic food model from the food model box;

4) Children approached the whiteboard with their plastic food model and then wrote the name of their selected food where it belonged in the MyPlate diagram. If children needed guidance in writing, other students in the class offered to help them. In some classes, one or two children were chosen to write all of the food names on the whiteboard while other children in the class identified, named, and placed the food into the MyPlate diagram. Sometimes the classroom teacher suggested which students had legible

penmanship and spelling to write information on the board and sometimes the guest nutrition educators assisted in writing content on the board with oral language from the students;

5) The closing activity consisted of making a snack called yogonanas which contained rice cereal (grain), yogurt (dairy), and bananas (fruit). A class discussion followed after eating the yogonanas which included identifying and naming the food items included in the snack, and then sorting and categorizing which food group each ingredient belonged to; and

6) As an assessment during Day 1, children wrote down which foods they ate for breakfast that day, and the written handout was collected by the teacher.

2.1.3 Day 2 Learning Process

The learning process on Day 2 included the following steps:

1) As an opening discussion topic, students were asked whether they made the yogonana food at home for one of their family members then students reviewed which food groups made up the food;

2) Students were asked again what they ate for breakfast before school, their favorite breakfast foods, and the different food groups those foods belonged to;

3) As a summative assessment, students drew pictures and wrote names of food groups based on the MyPlate model they had learned about over the two days; and

4) The closing activity involved students making another nutritious snack to eat in the classroom. The snack consisted of several components: a tortilla (grain), cheese (dairy), turkey (protein), and vegetables. The lesson ended with students singing a “rap” song about the “wrap” snack.

3. Results

Data collected during the pre-assessment on Day 1 (n = 112) and post-assessment on Day 2 (n = 117) indicated that 84 children ate breakfast at home, 15 received breakfast at school, 6 reported eating at home or at school, and 4 students reported not eating breakfast at all. Composition of breakfast foods eaten by second graders (n = 109) and third graders (n = 17) are reported in Tables 1 (Pre-Assessment) and 2 (Post-Assessment). Table 1 shows an alphabetical list of breakfast foods using the exact words that students reported and listed for their breakfast that day. Column 1 shows the breakfast food by name, and Column 2 shows the number of students who reported eating the food for breakfast. Column 3 shows the potential number of food groups that the food represented using the MyPlate model.

Table 1. Pre-Assessment of Breakfast Foods in Alphabetical Order that Students Reported that They Ate for Breakfast on the Day of the Pre Test

Breakfast Foods in Alphabetical Order	Number of Students Eating the Food (n = 108)	The Number of Food Groups the Food Represents
Bacon	1	1
Bacon and eggs	1	1
Bagel	2	1
Bagel and apple	4	2
Bagel with cream cheese	3	2
Banana and yogurt	1	2
Birds nest or cereal	1	1
Bread and Nutella	1	1
Breakfast sandwich	3	2
Cereal	42	2
Cereal and apple	2	2
Cereal or donut	1	1
Cereal or toast	2	1
Cereal or yogurt	1	1
Cherry brownie	1	2
Croissant	1	1
Donuts or bagels	2	1
Eggs	3	1
Eggs and toast	1	2

Granola bar	1	1
Granola bars and milk	1	2
Hash browns, toast, and bacon	1	3
Hot chocolate	1	N/A
McDonald's	2	N/A
Milk, eggs, and bread	1	3
Oatmeal	6	1
Oatmeal, yogurt, or cereal	1	1
Pancakes	2	1
Pancakes with Nutella	1	1
Peanut butter and jelly	1	2
Peanut butter sandwich	1	2
Pop Tarts	3	1
Rice, bread, or cereal	2	1
Toast	2	1
Waffles	5	1
Yogurt	2	1
Yogurt and granola	1	2
Yogurt, granola, and berries or a smoothie	1	3

Summary results from the pre-assessment given on the first day of instruction for both second and third grade students (n = 112) indicated that 44 students ate one food group for breakfast; 62 students ate two food groups for breakfast; 3 students ate three food groups for breakfast; and 3 students were ambiguous in their reporting of breakfast eating.

During the second day of instruction, breakfasts were discussed again in the context of the MyPlate food model. Table 2 shows that 60 students ate one food group for breakfast; 48 students ate two food groups for breakfast; 8 students ate three food groups for breakfast; and 1 student reported an ambiguous answer of breakfast eating.

Table 2. Post-Assessment of Breakfast Foods in Alphabetical Order that Students Self-Reported that They Ate for Breakfast on the Day of the Post Test

Breakfast Foods in Alphabetical Order	**Number of Students Eating the Food N = 118**	**The Number of Food Groups the Food Represents**
Bacon and waffle	1	2
Bagel	2	1
Bagel with cream cheese and raspberries or blueberries	4	3
Banana	2	1
Biscuits and gravy	3	1
Bread	2	1
Bread and Nutella	2	1
Cereal	40	2
Cereal and yogurt	3	2
Cereal; or eggs and bacon	2	1
Cereal or bread	2	1
Cereal or toast	1	1
Cereal or waffles, apple, and milk	2	3
Cereal or yogurt and granola	1	2
Cheese stick	1	1
Cinnamon roll	2	1

Cocoa bar	2	1
Croissant	1	1
Donut	3	1
Eggs	5	1
Eggs and bacon	2	1
Eggs and meat	1	1
Eggs, bacon, and toast	1	2
Granola bars and milk	1	2
Grapefruit	1	1
Honey bread	1	1
McDonald’s	1	0
Milk	1	1
Milkshake	1	1
Muffin	1	1
Oatmeal	3	1
Oatmeal or French toast	1	1
Oatmeal or yogurt	1	1
Oatmeal, strawberries	1	2
Oatmeal, yogurt, banana, and bread	1	3
Pancakes	2	1
Pancakes or waffles	1	1
Peanut butter banana toast, fruit	1	3
Pop tart	4	1

Rice or bread	1	1
Vegetables	1	1
Waffle	6	1
Yogurt	1	1
Yogurt or bagel	1	1

Figure 4 shows the pre-assessment results for the number of food groups that children ate for breakfast: 3% (n = 3) ate breakfasts with 0 food groups; 39% (n = 44) ate breakfasts with 1 food group; 55% (n = 62) ate breakfasts with 2 food groups; and 3% (n = 3) ate breakfasts with 3 food groups. Figure 5 shows the post-assessment results for the number of food groups that children ate for breakfast: 1% (n = 1) ate breakfast with 0 food groups; 51% (n = 51) ate breakfasts with 1 food group; 41% (n = 48) ate breakfast with 2 food groups; and 7% (n = 8) ate breakfasts with 3 food groups.

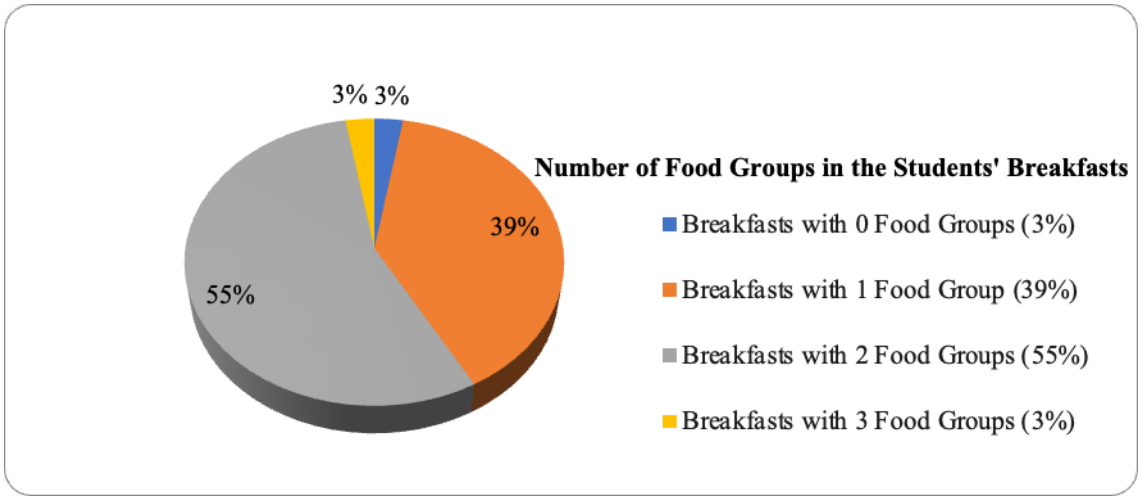

Figure 4. Number of Food Groups that Children Consumed for Breakfast During the Pre-Test

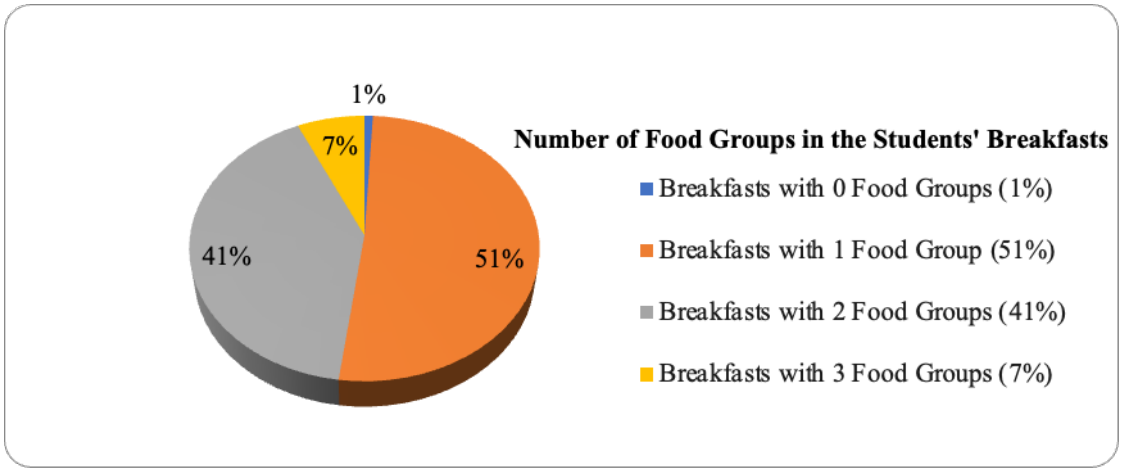

Figure 5. Number of Food Groups that Children Consumed for Breakfast During the Post-Test

4. Discussion

The first purpose of the pilot study was to introduce 2nd and 3rd grade children to the concepts of breakfast and food groups in the MyPlate nutrition model while using an interactive constructivist approach. Results on the pre-assessment showed that 42 children ate cereal for breakfast, and 40 children ate cereal for breakfast on the post-assessment. Children did not name the type of cereal they ate, so the sugar content of the cereal could not be distinguished between high-sugar versus low-sugar content. Only three children reported eating a breakfast of three food groups on the pre-assessment, but eight children reported eating a breakfast of three food groups on the post-assessment. However, if the children who reported eating cereal for breakfast would choose to pair fruit with their cereal, 40 more children would have consumed a breakfast with three food groups resulting in a more nutritious meal to start their day.

Eating a balanced breakfast is the key to starting off the day with adequate nutrition. Breakfast consumption is linked to a healthier Body Mass Index (BMI), higher grades, higher energy levels, and higher rates of on-task behavior in children (Adolphus, Lawton, & Dye, 2013). Adolphus, Lawton, and Dye (2013) found a significant difference when individuals consumed at least three food groups for breakfast, which included eating cereal grains paired with both milk and fruit. Cereal has been categorized as a core food rather than a discretionary food, which is defined as extra calories above the daily nutritional needs (Manohar, Hayen, Scott, et al., 2021).

Eating an adequate breakfast influences many factors in a child's life. Unfortunately, household food insecurity and insufficient access to nutritious foods can negatively impact child health and nutrition. Household food insecurity has been linked to child developmental risks in intelligence and cognition, which are directly related to lower academic abilities in vocabulary and mathematics (Shankar, Chung, & Frank, 2017). Household food insecurity has also been linked to poorer motor development and inadequate school readiness (de Oliveria, de Almedia, Gubert, et al., 2020). Mozaffarian, Fleischhacker,

and Andrés (2021) claim that U.S. policies toward hunger and food insecurity need to move beyond sufficient calories and food quantities to addressing *nutrition security*, which is "defined as having consistent access, availability, and affordability of foods and beverages that promote well-being and prevent disease".

The lessons in breakfast eating and MyPlate representations aimed to focus on nutrition improvement over two days of classroom instruction. Although instructors were not privy to issues of food insecurity, the school district is situated in a 48% poverty zone so food insecurity has been addressed by weekly backpack programs where food is sent home for low-income families. During the COVID-19 pandemic, families drove their cars to school to pick up weekly food portions for each child member at home; this program was called a "drive up and drive away" program. Social workers and the district health coordinator also made special deliveries to low-income families each week. According to the Children's Defense Fund-Ohio (2020), 15% of children lived in poverty in the county of the study and 23% of children received the Supplemental Nutrition Assistance Program (SNAP) benefits. Thus, community nutrition programs, school breakfast and lunch programs, and supplemental nutrition programs (e.g., SNAP) must be coordinated and implemented to ensure that children and their families are able to access and consume the foods that their bodies and brains need.

The second purpose of the study was to evaluate what foods children ate for breakfast over two days and to assess the visual-textual-lexical representations that they constructed to show their thinking about the MyPlate food model. Over the two days of instruction, children reported a variety of breakfast options. Some of the most frequently repeated foods were cereal, waffles, oatmeal, eggs, or a bagel with cream cheese and fruit (See Table 1 and 2). After the educational sessions, the majority of children remained in the category where their breakfast included one or two food groups; however, the number of children who ate a breakfast with three food groups almost tripled (from 3 to 8 children). Research highlights the importance of examining the impact of daily meals in whole rather than for only one part of the diet like for breakfast or for single nutrients (Manohar, Hayen, Scott, et al., 2021). However, dietary choices like whole-grain cereals and fresh foods are known to be more expensive (Kant & Graubard, 2013). Coulthard, Palla, and Pot (2017) found that children who consumed breakfast on a regular basis had an improved nutrient profile with higher intakes of fiber, folate, vitamin C, calcium, iron, and iodine compared to children who skipped breakfast and fell short of obtaining the functional nutrients. For example, calcium is necessary for bone growth and mass during development (Coulthard, Palla, & Pot, 2017). Other examples include: fiber is necessary for digestion; folate is needed for red blood cell production; vitamin C helps to support the immune system; iron promotes bone growth; and iodine is needed for the production of thyroid hormones, which regulate metabolism.

After an inquiry-based lesson on food patterns, children reproduced or copied the MyPlate model when asked to represent their functional health knowledge of food groups. Children made a visual

representation of what they had learned to demonstrate their recall and understanding of the lesson. Figure 1 shows how one child understood the five food groups in the context of a plate with a dairy beverage. The colorization of the different food groups emphasized the differentiation between the groups. Mirroring the food model that was shared in class, the child provided visual-textual-lexical representations of food categories in the form of colors, shapes, and words without drawing pictures of specific foods.

Figure 1. MyPlate Drawing from a Child Depicting a Visual-Textual-Lexical Representation of Food Groups

In contrast, Figure 2 shows a specific food illustrated by another student. A breakfast pizza was depicted with an ingredient from each of the food groups: cheese from the dairy food group, pepperoni as the protein, peppers as the vegetable, pizza crust as the grain, and pineapple (and olives) as fruits. Student visual-textual-lexical drawings depict the essence of constructivist theory (Vygotsky, 1962), because the student was able to take the new information learned about different food groups and construct a summative picture of a food through learning transfer. Before learning about food groups, the child may have known that a pizza had many different toppings, but the child might not have known that different toppings belonged to various food groups. After learning about the food groups, the child was able to categorize the toppings and recognize where they belonged by labeling them on the slice of pizza. This transfer of knowledge from one form to another is called knowledge transfer. Visual-textual-lexical information provides health and nutrition educators with insights into young children's thinking when they make their thinking public. This representation of information in words and pictures demonstrates the functional health knowledge needed for a breakfast meal that represents more than one food group.

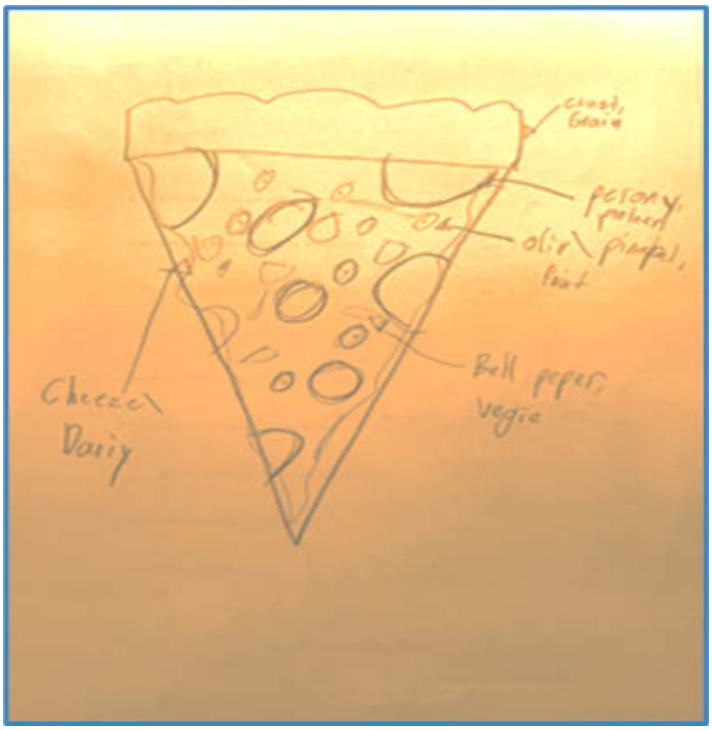

Figure 2. Pizza Drawing from a Child Depicting a Visual-Textual-Lexical Representation of Food Groups

The United States Department of Agriculture promotes the importance of food groups to help visualize daily food recommendations using the MyPlate model. This allowed children to organize foods based on food groups rather than specific nutrients in the food model to fulfill their daily dietary needs. Chang and Koegel (2021) highlighted this advantage of the MyPlate model, "...it's much easier to try to eat two cups of fruit a day than 75 milligrams of vitamin C and 25 grams of fiber" which are found in the fruit. By simplifying how the five food groups are represented on the MyPlate model, children were able to look at their own plate of food and determine what was missing in comparison. This is an example of priming effects because the nonlinguistic representation of the MyPlate model could help children reason out what might be missing on their plate by comparing it against their mental model (or schema in their memory) and a physical copy of a MyPlate picture. With practice during each of their meals throughout a week, children would be able to identify that the food group, fruits and vegetables, are missing if their plate only contained grain, dairy, and protein.

Health and nutrition educators play an important role in building the background knowledge of their students. Background knowledge can be increased when health educators use a variety of valid and reliable resources about nutrition in the form of books, audiovisuals, podcasts, and posters in the lesson design (Ubbes & Ausherman, 2022). When educators provide multiple representations of educational content, such as food group models in addition to making and eating a breakfast food option in the

classroom, children learn how to elaborate on their learning through new skills, use of new vocabulary words (lexicon), and multiple ways to practice what they have learned. At first, functional health literacy is developed, which is reading, writing, and speaking about health (Ubbes, Dillhoff, & Maldonado, 2018, p. 50, p. 56, p. 59), but students must also be able to "demonstrate health literacy by accessing valid and reliable health information, products, and services to enhance health" (National Consensus for School Health Education, 2022, p. 8). In a nutrition context, students can read and talk about instructional brochures, food models, and food labels in order to learn word knowledge and image recognition of valid and reliable sources of food products. Through formal and informal social interactions, students can write and talk about valid and reliable nutrition information while using real food, interactive props, and print or electronic media for developing their interactive health literacy skills around food groups and breakfast choices.

The third purpose of the study was to explore functional health literacy and inventive spellings from children who had learned about food groups over two class sessions. The instruction about food groups, categorized by the MyPlate food model, afforded the classroom teachers, the registered dietitian, and guest nutrition educators some observations and insights into the receptive and expressive language skills of children in a health and nutrition context. During the educational lessons, children actively participated by using oral language as they talked about, sorted, and manipulated the food models, then they later used written language to list what they ate for breakfast. As such, the children used expressive language skills through oral and written communication to elaborate on their knowledge through multimodal symbol systems (Taylor & Leung, 2020). Some children (n = 25) represented their food options using either words or pictures, and others used words and pictures by drawing and labeling pictures of food as a written example of their functional health literacy. Students elaborated on their functional health knowledge by representing what they knew and understood about breakfast and food groups in more than one symbol system (National Consensus for School Health Education, 2022).

Drawing is a precursor to writing and serves as an important way for children to elaborate on their learning. Drawings are an effective way to communicate "language beyond the sentence" (Strasser & Río, 2014), and pictures can help children increase their vocabulary and understand health-related information that they learn (Bray, Blake, Protheroe, et al., 2021). Comprehension, referred to as understanding what was learned, can be similar across different learning modalities such as listening, viewing television, and reading written stories (Kendeou, Bohn-Gettler, White, et al., 2008; Lynch, van Den Broek, Kremer, et al., 2008; Tompkins, Guo, & Justice, 2013). Although critical or creative thinking can be used when interpreting a picture, children can learn many words to describe and communicate their ideas from a single image. The pairing of written depictions (i.e., illustrations) with vocabulary words enhances the child's understanding and recall of the information using multimodal representations. Children need to connect different modes of communication at a young age so that their vocabulary (word knowledge) and drawing elaborations (schema) expand into more sophisticated

ways of knowing as they grow and develop. Students who participated in the lessons were able to demonstrate their comprehension (understanding) by practice this pairing of drawing and labeling images of the MyPlate food picture when prompted to “list the food groups” (Figure 3).

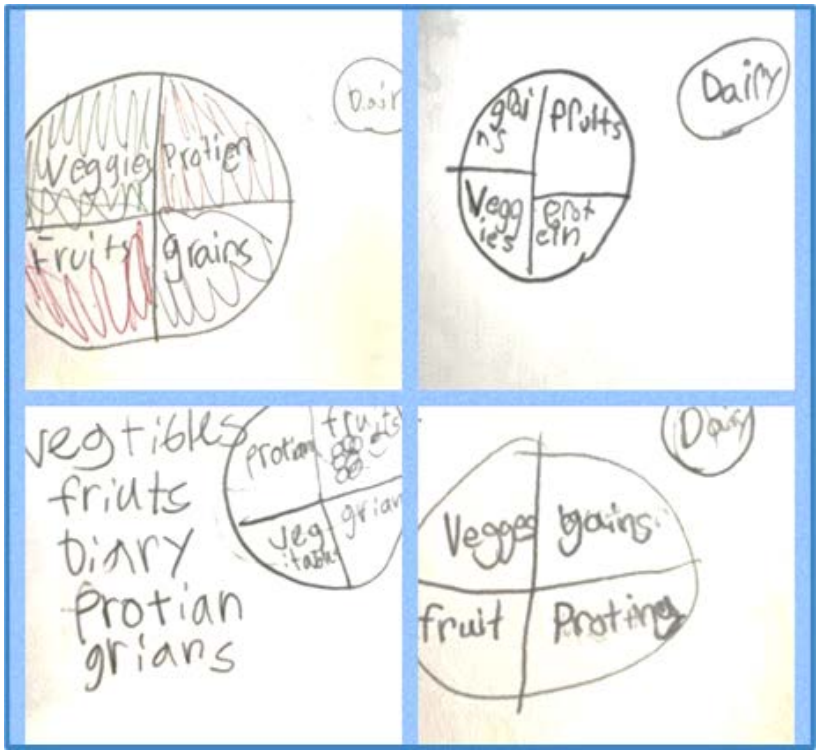

Figure 3. Invented Spellings that Show What a Child Knew about Food Groups After Learning about the MyPlate Food Model

Figure 3 highlights the invented spellings that the 2nd and 3rd grade children used to represent their emerging understanding of food groups. Invented spellings are a lexical form of word knowledge (vocabulary) (Treiman, 2017). Lexical representations contain overlapping phonological (sounds), orthographic (spelling), semantic (meaning) and syntactic information (grammar) (Perfetti, 2007)—all four are inherent in morphemes or the smaller units of meaning within a language (Levesque, Breadmore, & Deacon, 2021).

In addition to drawing a visual representation of the MyPlate food model after learning about it, four different children also wrote words to name the different food groups—even though some of those words were spelled incorrectly. Unconventional spellings indicated that children had some knowledge of the sounds and spellings of written words (Treiman, Kessler, Pollo, et al., 2016) and could make a connection between the visual form of words and their corresponding sounds (Morais, 1995). Cunningham and Cunningham (1992) stated that “Writing with invented spelling should be a regular part of every basic reading program”, because writing letters and words support children as they learn

to decode words and learn a vocabulary. Decoding involves children listening for the sounds in words to guide and improve their invented spelling (Clay, 1985). Invented spelling leads to better reading but not the other way around (Ouellette & Sénéchal, 2017). Nagy, Berninger, Abbott, et al. (2003) found that 4th graders needed to work "to coordinate orthographic, phonological, and morphological cues in written words", and that oral vocabulary and spelling were significantly related to the ability of 2nd graders to read words. In summary, by representing new topics and concepts about nutrition and healthy eating using literacy skills, students are learning to read, write, and speak about health and thus, learning to develop their functional health literacy skills.

In summary, food options for breakfast were the focus of a nutrition lesson in three elementary classrooms from one Ohio school district. The MyPlate food model was used to plan a healthy breakfast from more than one food group, and two-dimensional food models were used to name and categorize a variety of foods into five food groups. Nutrition educators and children used both receptive language (e.g., listening) and expressive language (e.g., speaking, writing, spelling, and drawing) to learn nutrition. Children drew pictures using visual-textual-lexical representations to show what they knew about breakfast eating and food groups. Invented spellings were evident as children labeled different foods on their MyPlate drawings, highlighting that the 2nd and 3rd graders were learning new vocabulary about certain foods while writing these words phonetically for the very first time. Implications for earlier and more frequent instruction in nutrition education is warranted with an emphasis on giving children more time to use their expressive language to write, draw, and talk about the foods that they ate through an inquiry-based constructivist approach.

The food-making lessons, visual-textual-lexical writing activities, and classroom conversations provided children with opportunities to transfer their nutrition knowledge from school to home environments where they could continue to practice their functional health literacy with their families. However, future work should also elaborate on the role of interactive health literacy in school and home contexts when children are learning about breakfast eating and food groups. By adding fruit to the breakfasts of children who participated in the lessons, almost one-half of the children would be able to increase their consumption from two food groups to three food groups when consuming an ideal breakfast. Students could write and then discuss among their peers and their family members how to go about improving their fruit intake for breakfast while practicing their interactive health literacy skills.

There are three recommendations for this study. Future lessons could introduce sociocultural variance in food selections for breakfast and discuss the benefits of eating breakfast at school while being mindful of perceived social stigmas associated with it (Soldavini & Ammerman, 2019). Another way to address cultural variance in the classroom is to acknowledge that students can "analyze the influence of family, peers, culture, social media, technology, and other determinants on health behaviors" when guided by the performance expectations of the National Health Education Standards for grades preK-2, grades 3 to 5, and so forth (National Consensus for School Health Education, 2022). Second, students

in this study were between the ages of seven to nine years old (2nd and 3rd grade), which limited their ability to obtain and prepare nutritious foods without the assistance of an adult. If this instructional program is repeated, children could "show parents what they know" during parent-teacher conferences or at a school open house, and teachers could distribute children's picture book lists about food and nutrition to parents so they can learn together with their children at home (Ubbes & Spillman, 2000) while developing their interactive health literacy skills (National Consensus for School Health Education, 2022, p. 8). Parents and their own health habits strongly influence and determine the health behaviors of their children. If the parents of the children are not practicing healthy eating habits, the children are likely to disregard what they have learned and continue to follow the health modeling of their parents. Therefore, future instructional lessons might involve parents in several ways by validating what children ate at home for breakfast, by agreeing to post the MyPlate picture on their refrigerators at home, and by taking the model with them when grocery shopping as a family. Third, prior to the instructional lessons, children did not receive nutrition education or health education in the classroom. Classroom nutrition lessons aligned to the National Health Education Standards using a literature-linked approach (Ubbes & Spillman, 2000) can support children in practicing interpersonal communication, making decisions, and setting goals for eating the most nutritious food options available to them. Two of the revised National Health Education Standards (National Consensus for School Health Education, 2022) also outline that preK-12 students can be taught to "demonstrate observable health and safety practices" and "advocate for behaviors that support personal, family, peer, school, and community health". To those points, elementary children can be encouraged to transfer their functional health knowledge about food groups and breakfast from the school classroom to home settings through planned "show and tell" conversations with their families, supported by multimodal food models and snack making, which has the potential to foster their interactive health literacy skills. Children can use these social interactions around snack making and the sharing of their written depictions of the MyPlate model to elaborate on their own learning in a new context through a priming effect. In this context, a priming effect through the use of a food model and snack making can help children increase the transfer of learning from school to home through concrete to abstract thinking and communication skills (Roumell, 2018). As such, this type of learning transfer enables students to apply their new knowledge and skills in a different context than the one in which the learning originally took place (Detterman, 1993). Beyond interactive health literacy applications that employ a priming effect for learning transfer, health and nutrition educators can implement new curriculum standards for building stronger connections between how they teach and what they teach. Hence, future integration of the MyPlate food model with the National Health Education Standards can foster new classroom assessments that will support students to practice observable nutrition behaviors that can lead to consistent health habits for personal, family, and school health.

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