NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH Public Access
Author Manuscript
J Food Sci. Author manuscript; available in PMC 2014 October 01.

Published in final edited form as:
J Food Sci. 2013 October ; 12(4): 81–86. doi:10.1111/1541-4329.12016.

Food-based Science Curriculum Increases 4th Graders Multidisciplinary Science Knowledge

Jana A. Hovland, MS, RD, LD,
Assistant Professor of Dietetics, Marshall University, One John Marshall Drive, Huntington, WV 25755, 304-696-2507

Virginia G. Carraway-Stage, PhD, RD, LDN,
Assistant Professor/FoodMASTER Associate Director, College of Human Ecology, East Carolina University, 266 Rivers Bldg., Greenville, NC 27858, 252-737-2473 office

Artenida Cela, MS, RD, LDN,
Public Health Nutritionist (Nutritionist II), Wayne County Health Department, Goldsboro, NC 850-980-5511

Caitlin Collins,
Undergraduate Researcher, Department of Nutrition Science, East Carolina University, 272 Rivers Building, Greenville, NC 27858, 252-328-5698 office, 252-328-4276 fax

Sebastián R. Díaz, Ph.D., J.D.,
Diaz Consulting LLC, 203 West Main Street, Bruceton Mills, WV 26525-7113, 304-698-6780 cell

Angelo Collins, PhD, and
Director of the Center for STEM Education, East Carolina University, 319 Cotanche St. Building 159, Greenville, NC 27858, 252-328-6164 office, 52-328-6491 fax

Melani W. Duffrin, PhD, RD, LDN
FoodMASTER Director, PI, Director of Special Projects Center for STEM Education, East Carolina University, 272 Rivers Bldg., Greenville, NC 27858, 252-328-5698 office, 252-328-4276 fax

Jana A. Hovland: hovland@marshall.edu; Virginia G. Carraway-Stage: carrawaystagev@ecu.edu; Artenida Cela: artenidac@gmail.com; Caitlin Collins: collinscai08@gmail.com; Sebastián R. Díaz: Sebastian.Diaz@frontier net; Angelo Collins: collinsan@ecu.edu; Melani W. Duffrin: duffrinm@ecu.edu

Abstract

Health professionals and policymakers are asking educators to place more emphasis on food and nutrition education. Integrating these topics into science curricula using hand-on, food-based activities may strengthen students' understanding of science concepts. The Food, Math, and Science Teaching Enhancement Resource (FoodMASTER) Initiative is a compilation of programs aimed at using food as a tool to teach mathematics and science. Previous studies have shown that students experiencing the FoodMASTER curriculum were very excited about the activities, became increasingly interested in the subject matter of food, and were able to conduct scientific

Corresponding Author: Jana A. Hovland, MS, RD, LD, Assistant Professor of Dietetics, Marshall University, One John Marshall Drive, Huntington, WV 25755, 304-696-2507, hovland@marshall.edu.

observations. The purpose of this study was to: 1) assess 4th graders food-related multidisciplinary science knowledge, and 2) compare gains in food-related science knowledge after implementation of an integrated, food-based curriculum. During the 2009–2010 school year, FoodMASTER researchers implemented a hands-on, food-based intermediate curriculum in eighteen 4th grade classrooms in Ohio (n=9) and North Carolina (n=9). Sixteen classrooms in Ohio (n=8) and North Carolina (n=8), following their standard science curricula, served as comparison classrooms. Students completed a researcher-developed science knowledge exam, consisting of 13 multiple-choice questions administered pre- and post-test. Only subjects with pre- and post-test scores were entered into the sample (Intervention n=343; Control n=237). No significant differences were observed between groups at pre-test. At post-test, the intervention group scored (9.95±2.00) significantly higher (p=.000) than the control group (8.84±2.37) on a 13-point scale. These findings suggest the FoodMASTER intermediate curriculum is more effective than a standard science curriculum in increasing students' multidisciplinary science knowledge related to food.

Keywords

Education; Food Science; Nutrition Education; Multidisciplinary Science Knowledge; Elementary

Introduction

The obesity epidemic in America is prompting health professionals, policymakers, and stakeholders to ask educators to place more emphasis on food and nutrition education (White House 2010). Additionally, food and nutrition have become hot topics and both children and adults want to understand the science behind them (Schmidt and others 2012). These trends are likely to prompt educators to seek guidance from food and nutrition scientists to aid in developing curricula that teach students to accurately understand scientific information related to food. Food and nutrition science professionals need to be prepared to share their expertise with educators in order to prepare students to understand and apply food and nutrition science in the context of healthy living (Contento and others 2010).

There are many food and nutrition science education programs available for K-12 students (Gower and others 2010; Johnston and others 2013; Kandiah and Jones 2002; Moreno and others 2004; Perry and others 1990; Powers and others 2005; Trexler and Roeder 2003; Wall and others 2011). Many programs focus on nutrition science and food safety, while others focus specifically on food science (Calder and others 2003; Chaiyapechara and Dong 2004). Commonalities across programs appear to be that 1) food and nutrition science is an important subject matter for students to learn, 2) K-12 environments are appropriate for reaching students, and 3) assessment of science knowledge gained from programs is important. Less common features found in only some programs are 1) offering engaging hands-on, active experiences for learners, 2) teaching food and nutrition science from a multidisciplinary science approach, 3) linking curricular content to National Science Education Standards, and 4) integrating the curriculum into existing science education.

A multidisciplinary body of science including biology, microbiology, chemistry, engineering, mathematics, and nutrition supports the study and application of food science (Edelstein 2013; Schmidt and others 2012). This makes food an ideal tool for teaching a variety of science and mathematics concepts. When reviewing the National Science Education Standards' eight categories of content standards - *Unifying Concepts and Processes in Science, Science as Inquiry, Physical Science, Life Science, Earth and Space Science, Science and Technology, Science in Personal and Social Perspectives, History and Nature of Science* (National Research Council 1996), one can see how the science of food spans across many categories. For example, oxidative browning is applicable to *Physical Science*, while measuring wheat flour by weight can be utilized as a topic for *Science and Technology*. Once a food scientist is prompted to think about using food as a tool to teach science and mathematics, the number of food science related subject matter areas and topics that fit within the eight categories almost seems infinite.

Recognizing the importance of food and nutrition science knowledge in K-12 settings, the Food, Math, and Science Teaching Enhancement Resource (FoodMASTER) Initiative set out to create a curriculum using food as a tool to teach multidisciplinary science. Integration of the food and nutrition science into the regular science curriculum is an important feature of the program, as researchers did not want to compete with other subject matter for implementation. This integrative approach has been discussed explicitly in relation to incorporation of food and nutrition into mathematics education (Hyman 2008; James and Adams 1998) and makes sense to do with science education (White House 2010). To encourage teachers to use the curriculum, all content was linked to National Science Education Standards (National Research Council 1996) and proficiency type questions were included at the end of each activity. The purpose of the study was to 1) assess 4th graders' food-related multidisciplinary science knowledge, and 2) compare gains in food-related science knowledge after implementation of an integrated food-based curriculum.

Methods

Program

FoodMASTER is a compilation of projects aimed at using food as a tool to teach mathematics and science. In the 2007–2008 academic year, 45 one hour-long food-based science lessons were piloted in 10 third-grade classrooms in Southeast Ohio (Duffrin and others 2010). Participating teachers and content experts provided program developers with formative feedback that informed lesson modification and final development of the current intermediate curriculum. FoodMASTER Intermediate is a 10-chapter curriculum with 24 hands-on, food-based science lessons geared towards children in grades 3–5. All of the curricular content is linked to National Science Standards and is designed to be integrated into science classroom teaching time.

In the 2009–2010 academic year, the newly revised lessons were implemented in 18 intervention (I) and 16 comparison (C) 4th grade classrooms in Ohio (I=9; C=8) and North Carolina (I=9;C=8). Previous work deemed the curriculum appropriate for 3rd–5th grade classrooms (Duffrin and others 2010; Hovland and others 2010). Fourth-grade was selected as informal discussions with elementary teachers in both Ohio and North Carolina revealed

4th grade is an ideal time to introduce the content emphasized in FoodMASTER Intermediate. North Carolina 4th grade teachers were particularly interested in the material, due to the nutrition knowledge requirements in the North Carolina Standard Course of Study for 4th grade at the time of the study (NC DPI 2009).

Curriculum

Teachers were instructed to integrate each of the twenty-four 45 minute-long lessons at any time during the academic year. The lessons were broken down into 10 food topic areas: *Measurement; Food Safety; Vegetables; Fruit; Milk and Cheese; Meat, Poultry, and Fish; Eggs; Fats; Grains; and Meal Management*. A teacher's manual was created to provide background information, answers to lesson activities/proficiency questions, and a guide linking curriculum content to the National Science Standards (National Research Council 1996). Each lesson (Figure 1) followed a similar format including a reading selection, a hands-on food-based *Scientific Inquiry* activity, and a *Try this at Home* page. The background reading selection featured *Doodle Bugs*, which asked students to do simple tasks to promote reading comprehension such as circling a key word. Next, students engaged in a *Scientific Inquiry* activity using food to explore science and mathematics concepts. For example, in lesson 17, students prepared vinegar and oil salad dressings to learn more about emulsifiers. Finally, *Try this at Home* pages contained a recipe and fun facts about food and nutrition that students could share with their parents. It should be noted that preparation of the take home recipe was not required as part of lesson completion. Proficiency questions relating to each lesson followed at the end of the chapter. Upon completion of each of the 10-topic area, teachers completed formative evaluations. The teacher's manual and student workbook are available to download free of charge from www.foodmaster.org.

Subjects

FoodMASTER State Directors recruited 4th grade teachers to participate in the program based on interest and location in Ohio and North Carolina. Efforts were made to select classrooms across both states to provide a mixture of rural, urban, and suburban settings. Ohio and North Carolina were selected because of the Principle Investigators' affiliation with Ohio University and East Carolina University at the time of implementation.

State Directors met with each teacher at the beginning of the school year to verbally discuss expectations of participation in the study. Each classroom teacher was provided with consent forms, exams, classroom materials, expectations, and directions for testing. Teachers were thoroughly instructed on information in a 2–3 hour session. State Directors made 1–3 site visits during the academic year to make observations and administer assessments. Classrooms in the same school or nearby with similar demographic characteristics were recruited to act as a control group for comparison. Teachers in the control group followed their standard math and science curricula. Control classrooms maintained the same protocol as the intervention group and received web-based access and hard copies of the student curriculum and teacher's manual at the completion of the study. There was no researcher control over what was taught in any of the classrooms other than the integration of the FoodMASTER curriculum over the course of the year. Teachers had communication access to directors for support at anytime during the academic year.

Measurement

A researcher-developed, 13-question multiple-choice exam was used at pre-and post-test to measure the multidisciplinary science knowledge of 4^{th} grade students. Each question had one correct response. Based on the National Science Education Standards (National Research Council 1996), multidisciplinary science questions were developed to address four of the eight categories of content standards. The exam included four subscales: five questions related to *Life Science*, two *Science in Personal & Social Perspectives*, three *Physical Science*, and three *Science and Technology* questions (See Table 1).

The intention of the exam was not to holistically measure each subscale, but to provide useful data to educators and curriculum developers interested in knowledge gains in food-related science areas. The *Life Science* subscale focused primarily on characteristics of organism such as functions of different plant parts. *Science in Personal & Social Perspectives* questions examined students' abilities to contextualize information and draw correct conclusions related to food choices. *Physical Science* questions explored properties of objects and chemical reactions; while, *Science and Technology* questions emphasized selecting suitable tools and techniques for measurement. Participating teachers reviewed the exam for content validity and age appropriateness prior to administration. Minor revisions were made to produce the final survey.

To facilitate administration of the science knowledge exam, State Directors made site visits to help teachers administer the exam or provided teachers with verbal and written standardized survey administration protocol. The protocol provided teachers with specific instructions for administration, including a script to be read aloud during the administration process. Researchers instructed teachers to answer student questions if clarification was needed, but to not provide students with the answers. Intervention classrooms were required to administer the pre-test at the beginning of the school year, prior to beginning the FoodMASTER curriculum to obtain baseline knowledge. The post-test was administered at the end of the school year, following completion of the hands-on curriculum. Comparison teachers were required to administer the baseline and post-intervention science knowledge questionnaire to their students in the same timeframe as their paired intervention classroom. Each student was assigned a subject number that was used to match his or her pre-test and post-test. Only subjects with completed pre-test and post-test were entered into the sample.

Statistical Analysis

Descriptive statistics were used to calculate the percentage of correct responses at pre-and post-test for the intervention and control groups. Paired sample *t*-tests were used to examine mean score differences ($p<.05$) between intervention and control at pre-and post-test for the four content standards areas and for overall score. Paired sample *t*-tests revealed no significant differences between the intervention and control group at pre-test. This made it appropriate to analyze paired sample *t*-tests on post-test scores without adjusting for pre-test scores. Statistical analyses were performed using Statistical Package for the Social Sciences 20.0 (SPSS).

Results

The exam was issued at the beginning of the academic year to 641 students in intervention (I) and control (C) classrooms (I=380; C=261). At the end of the year it was issued to 650 students (I=372; C=278). Only students with pre-and post-test scores (N=580; I=343; C=237) were used in analysis of the data. Absenteeism on the day of survey administration resulted in students lacking a pre- or post-test score. Absenteeism was due to factors such as illness, changing schools, and entering the school mid-year.

The mean age and standard deviation (SD) of the sample was I = 10.05±0.57 years and C = 9.93±0.81. A total of 162 males (47%) and 181 females (53%) were in the intervention group, and 109 males (46%) and 112 females (47%) were in the control group. Sixteen (7%) students were missing data for gender in the control group due to non-response. Racial/ethnic composition was 19% African American (AA), 75% Caucasian (C), 4% Hispanic/Latino (HL), 1% Asian/Pacific Islander (A/P), and 1% Other (O) in the intervention group and composition of the control group was 14% AA, 70% C, 5% H, 1% (A/P), 3% (O), and 7% missing data due to non-response.

Percentages of correct responses for each item at pre- and post-test are presented in Table 1. Frequency of correct responses to each item at pre-test illustrates students' prior knowledge. At post-test, significant difference (p=.000) was observed between the intervention (9.95±2.00) and control group (8.84±2.37) on the overall 13-item exam. Similarly, significant differences were found between the intervention and control group on three of the four subscales at post-test: *Life Science*, *Science in Personal & Social Perspectives*, and *Physical Science*. As illustrated in Table 2, no significant differences were found between groups on the subscale, *Science and Technology*.

Discussion

The integrated food-based science curriculum increased 4th graders' overall multidisciplinary science knowledge. This finding suggests students exposed to integrative hands-on, food-based curricula may achieve higher gains on food-related science questions, based on the National Science Education Standards (National Research Council 1996), than students taught with a standard science curriculum. Food is an excellent teaching tool because everyone, no matter how elementary, has some preexisting contextual knowledge about food. Just as food scientists draw upon multidisciplinary science to practice their discipline, food can equally be drawn upon as a tool to teach multidisciplinary science (Duffrin and others 2010). Hands-on, food-based science curricula can build foundational information for many science disciplines. Biology, microbiology, chemistry, and engineering are some of the science fields that food scientists draw upon for ensuring industry standards (Edelstein 2013) and students can learn about through hands-on, food-based activities.

The science knowledge exam provided baseline data describing existing student science knowledge. Pre-test scores are useful in identifying starting points for educators (Moreno and others 2004). Educators can use the information to begin scaffolding information for students (Trexler and Roeder 2003). Since the data was collected in Ohio and North Carolina, teachers in these states might find the results to be particularly helpful in identifying areas that might need increased focus in classrooms or curricula. While based on the National Science Education Standards, it is important to note the exam was not intended to holistically measure subscale content areas, but to provide data that might be useful to educators and curriculum developers interested in knowledge gains in these food-related science areas.

Pre-test outcomes revealed the content areas of *Life Science* and *Physical Science* as more challenging for students. This was expected at the beginning of the academic year, as students will scaffold more information in these content areas as studies progress. On 7 of the 8 questions included on the subscales, *Life Science* (5) and *Physical Science* (3), less than 60% of students responded correctly at pre-test. At post-test, the intervention group had significant gains on both subscale content areas, while the control group did not have any significant gains in scores. A limitation of this information is that the control classes might have emphasized other *Life Science* and *Physical Science* content not related to food. However, the value in this information is that the curriculum did improve students' knowledge in the areas of *Life Sciences* and *Physical Science* as it relates to food. The benefit of increasing students' knowledge in the aforementioned areas is to prepare these students to progress to higher-level subject matter (National Research Council 2012) and to aid them in understanding and applying food and nutrition science in the context of healthy living.

Pre-test revealed more than 80% of all students responded correctly at the pre-test in the content areas of *Science and Technology* and *Personal and Social Perspectives*. Students in both the intervention and control groups demonstrated gains in the percentage of correct responses in both *Science and Technology* and *Science in Personal and Social Perspectives.* However, the gains were only significant for students in the intervention group on the *Science in the Personal* and *Social Perspectives* subscale. This informs researchers that the integrated food-based curriculum, FoodMASTER Intermediate, was more robust in emphasizing *Science in Personal* and *Social Perspectives* as measured by the researcher developed exam questions. Both questions in *Science in Personal* and *Social Perspectives* were designed to provide students with contextual information and then prompt students to think about what the information means. The significant gains on this content area subscale for students in the intervention group illustrates the curriculum may be effective in prompting students to think about information and draw correct conclusions. Teachers might recognize FoodMASTER Intermediate as a useful tool for improving knowledge proficiency related to *Science in Personal & Social Perspectives.*

While the percentage of students with correct responses in the content area of *Science and Technology* did increase, the gains were not significant. Questions in *Science and Technology* were primarily focused on weights and measures. These results could be due to the overall design of the curriculum. Weights and measures were introduced as a single topic as the first lesson in the set of 24 lessons. By post-testing, students might have forgotten skills learned earlier in the curriculum. This finding is particularly important to note as mastery of foundation knowledge in weights and measures is important in scaffolding new scientific information as a student progresses in their studies (Trexler and Roeder 2003). Curriculum developers and teachers alike may consider placing more emphasis on weights and measures throughout implementation of the FoodMASTER Intermediate curriculum to further enhance and reinforce skill development.

An important feature of the FoodMASTER Intermediate curriculum is that teachers are not asked to implement the program as a separate course of study. This method allows teachers to stay within the scope of what they teach about science without having to compete with other subjects for instructional time. Many teachers commented they were pleased with the integrative approach and felt they could devote more time to food and nutrition science when it was connected to other science standards. While the concept of integration of food, nutrition, and cooking for teaching science and mathematics is not novel (Hyman 2008; James and Adams 1998; Walters and Stacey 2009), our concept of using food as a tool to teach science and mathematics can add to this body of literature.

Strengths and Limitations

The teachers provided approximately 18 hours of food-based content over the course of the academic year by implementing twenty-four 45 minute-long lessons. The food-based, hands-on, minds-on curriculum enabled students to learn multidisciplinary science content. Proficiency type questions were included at the end of each activity to ease teachers' anxieties about the curriculum integration distracting from skills that would assist with end of grade testing.

A limitation of the study was the distance between classroom locations, creating site visit challenges for the State Directors. State Directors could not be present as site visitor at all times of survey administration and had to depend on classroom teachers to follow protocol. It was also necessary to rely on teacher and school volunteerism to obtain a realistic sample or what would be considered a sample of convenience for the study. School policy about food or electrical equipment in the classroom proved to be challenging in some cases, and sometimes local school policy prevented teacher participation. In most cases, researchers were able to negotiate solutions to implementation issues.

Implications for Research and Practice

The food and nutrition science educators of the future are likely to encounter unique opportunities to impact the acquisition of science knowledge in K-12 education. How we teach and students learn food and nutrition science is an important consideration for educators, scientists, policymakers, and stakeholders. Food is an effective teaching tool for engaging students in retaining information about multidisciplinary science concepts. This study supports the potential for food and nutrition science subject matter to garner more K-12 classroom instruction time when curriculum developers are able to align materials with Next Generation Science Standards (Achieve, Inc. 2013) and demonstrate knowledge acquisition through standardized testing. Continued discussion and research across science and education disciplines is warranted.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Acknowledgments

FoodMASTER is supported by a Science Education Partnership Award (SEPA) from the National Institutes of Health (NIH). The content is solely the responsibility of the authors and does not represent the official views of the NIH.

Authors would like to acknowledge the participating teachers in Ohio and North Carolina who made this study possible.

References

Achieve, Inc. Next generation science standards. Achieve, Inc; 2013. Available from: http://www.nextgenscience.org/ [Accessed 2013 June 3]

Calder B, Brawley SH, Bagley M. National Science Foundation graduate teaching fellows promote food science education in K-12 schools in Maine. J Food Sci Educ. 2003; 2(4):58–60.10.1111/j.1541-4329.2003.tb00029.x

Chaiyapechara S, Dong FM. Science content courses: Workshop in food chemistry for 4th grade school teachers. J Food Sci Educ. 2004; 3(4):59–68.10.1111/j.1541-4329.2004.tb00046.x

Contento IR, Koch PA, Lee H, Calabrese-Barton A. Adolescents demonstrate improvement in obesity risk behaviors after completion of Choice, Control & Change, a curriculum addressing personal agency and autonomous motivation. J Am Diet Assoc. 2010; 110(12):1830–9.10.1016/j.jada.2010.09.015 [PubMed: 21111093]

Duffrin MD, Hovland J, Carraway-Stage V, McLeod S, Duffrin C, Phillips S, Rivera D, Saum D, Johanson G, Graham A, Lee T, Bosse M, Berryman B. Using food as a tool to teach science to 3rd grade students in Appalachian Ohio. J Food Sci Educ. 2010; 9(2):41–46.10.1111/j.1541-4329.2010.00090.x [PubMed: 20975982]

Edelstein, S. Food science: An ecological approach. Burlington, MA: Jones & Bartlett Learning; 2013.

Gower JR, Moyer-Mileur LJ, Wilkinson RD, Slater H, Jordan KC. Validity and reliability of a nutrition knowledge survey for assessment in elementary school children. J Am Diet Assoc. 2010; 110(3):452–456.10.1016/j.jada.2009.11.017 [PubMed: 20184997]

Hovland JA, McLeod SM, Duffrin MW, Johanson G, Berryman DE. School-based screening of the dietary intakes of third graders in rural Appalachian Ohio. J Sch Health. 2010; 80(11):536–43.10.1111/j.1746-1561.2010.00539.x [PubMed: 21039552]

Hyman B. Integrating math and nutrition education: Teaching with the FDA food label. Am J Health Educ. 2008; 39(2):113–17.

James D, Adams TL. Curriculum integration in nutrition and mathematics. J Sch Health. 1998; 68(1):3–6. [PubMed: 9553899]

Johnston CA, Moreno JP, El-Mubasher A, Gallagher M, Tyler C, Woehler D. Impact of a school-based pediatric obesity prevention program facilitated by health professionals. J Sch Health. 2013; 83(3):171–91.10.1111/josh.12013 [PubMed: 23343318]

Kandiah J, Jones C. Nutrition knowledge and food choices of elementary school children. Early Child Dev Care. 2002; 172(3):269–73.

Moreno NP, Denk JP, Roberts JK, Tharp BZ, Bost M, Thomson WA. An approach to improving science knowledge about energy balance and nutrition among elementary and middle school students. Cell Biol Educ. 2004; 3(2):122–30. [PubMed: 15257340]

National Research Council. National science education standards. Washington, DC: The National Academies Press; 1996.

National Research Council. A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academies Press; 2012.

North Carolina Department of Public Instruction (NC DPI). [Accessed 2013 Mar 25] K-12 curriculum and instruction: NC standard course of study. NC Board of Education. 2009. Available from: http://www.dpi.state.nc.us/

Perry CL, Stone EJ, Parcel GS, Ellison RC, Nader PR, Webber LS, Luepker RV. School-based cardiovascular health promotion: The child and adolescent trial for cardiovascular health (CATCH). J Sch Health. 1990; 60(8):406–13. [PubMed: 2255198]

Powers AR, Struempler BJ, Guarino A, Parmer SM. Effects of a nutrition education program on the dietary behavior and nutrition knowledge of second-grade and third-grade students. J Sch Health. 2005; 75(4):129–33.10.1016/j.jneb.2008.06.002 [PubMed: 15987006]

Schmidt SJ, Bohn DM, Rasmussen AJ, Sutherland EA. Using food science demonstrations to engage students of all ages in science, technology, engineering, and mathematics (STEM). J Food Sci Educ. 2012; 11(2):16–22.10.1111/j.1541-4329.2011.00138.x

Trexler CJ, Roeder D. Using qualitative research methods to ascertain elementary students' understandings of food safety. J Food Sci Educ. 2003; 2(2):25–31.10.1111/j.1541-4329.2003.tb00022.x

Wall DE, Least C, Gromis J, Lohse B. Nutrition education intervention improves vegetable-related attitude, self-efficacy, preference, and knowledge of 4^{th} grade students. J Sch Health. 2012; 82(1):37–43.10.1111/j.1746-1561.2011.00665.x [PubMed: 22142173]

Walters LM, Stacey JE. Focus on food: Development of the Cooking with Kids experiential nutrition education curriculum. J Nutr Educ Behav. 2009; 41(5):371–3.10.1016/j.jneb.2009.01.004 [PubMed: 19717122]

White House Task Force on Childhood Obesity. [Accessed 2012 Nov 18] Solving the problem of childhood obesity within a generation: Report to the President. 2010. Available from: http://www.letsmove.gov/sites/letsmove.gov/files/TaskForce_on_Childhood_Obesity_May2010_FullReport.pdf

Chapter 1: Measurement
(1) Measuring Up
Scientific Inquiry: Cups, Spoons and Scales
Scientific Inquiry: Liquid Measurement
While You Wait: Fractional Math
Try this at Home: Oatmeal Cake
Proficiency Questions

Chapter 2: Food Safety
(2) Safe Kitchen Cooks
Scientific Inquiry: Temperature and Microorganisms
While You Wait: Kitchen Clean Up
Try this at Home: Clean Kitchen Test
(3) Healthy Hands
Scientific Inquiry: Hand Washing
Try this at Home: Wash Away Germs
Proficiency Questions

Chapter 3: Vegetables
(4) Vegetable Jungle
Scientific Inquiry: Starting the Facts About Vegetables
Try this at Home: Ants on a Log
(5) Vegetable Rainbow
Scientific Inquiry: Color Changes in Acids and Bases
Try this at Home: Copious Carrots
(6) Eating Vegetables
Scientific Inquiry: Scientific Soup
Try this at Home: Silly Chili
Proficiency Questions

Chapter 4: Fruits
(7) Fruit Groups
Scientific Inquiry: Pomes, Drupes, Berries, Melons and Citrus Fruit
Try this at Home: Fruity-licous Pops
(8) Fruit Reactions
Scientific Inquiry: Browning
While You Wait: Fruit Salad
Try this at Home: Fruity Fusion
(9) Perfect Prune
Scientific Inquiry: Plump Plums and Pit-less Prunes
Try this at Home: Prune-tastic Trail Mix
Proficiency Questions

Chapter 5: Milk and Cheese
(10) Many Milks
Scientific Inquiry: Comparing Milk
Try this at Home: Bananas and Milk
(11) Making Cheese
Scientific Inquiry: Curds and Whey
While You Wait: Tasty Cheese
Try this at Home: Cottage Cheese and Lime Gelatin Salad
Proficiency Questions

Chapter 6: Meat, Poultry, and Fish
(12) Hamburger Hints
Scientific Inquiry: Lean and Fat
Try this at Home: Pizza Casserole Please
(13) Hot Diggity Dog
Scientific Inquiry: Healthier Hotdog
Try this at Home: Hot Diggity Dog Soup
(14) Something is Fishy
Scientific Inquiry: Fish in the Kitchen
While You Wait: Oh My! Omega
Try this at Home: Super Salmon Patty
Proficiency Questions

Chapter 7: Eggs
(15) Egg-ceptional Eggs
Scientific Inquiry: Egg Facts
Try this at Home: Creamed Eggs
(16) Fantastic Foams
Scientific Inquiry: Peaks, Peaks, Peaks
While You Wait: Egg-citing Egg Foams
Try this at Home: O-mazing Puffy Omelet Squares
Proficiency Questions

Chapter 8: Fats
(17) Dress it Up
Scientific Inquiry: Reading Labels
Try this at Home: Garden Vegetable Dressing
(18) Emulsify This
Scientific Inquiry: Immiscible
Try this at Home: Rainbow Pasta Salad
(19) Mmmm Creamy
Scientific Inquiry: We All Scream for Ice Cream
Try this at Home: Chocolate Coffee Can Ice Cream
Proficiency Questions

Chapter 9: Grains
(20) Selecting Cereal
Scientific Inquiry: Label Logic
Try this at Home: Crunchy Munchy Cereal Bar
(21) Rice Review
Scientific Inquiry: Nice Rice
While You Wait: Main Grain
Try this at Home: Bountiful Brown Rice Casserole
(22) Pasta Perfection
Scientific Inquiry: Cooking Pasta
While You Wait: Brainy Grains
Try this at Home: Snazzy Spaghetti and Meatballs
Proficiency Questions

Chapter 10: Meal Management
(23) Menu Madness
Scientific Inquiry: Money Matters
Try this at Home: My Menu
(24) Nutrition and Delicious
Scientific Inquiry: Let's do Lunch
Try this at Home: Magnificent Menu
Proficiency Questions

Glossary

Figure 1.
FoodMASTER Intermediate table of contents

Table 1

Percentage of correct responses at pre-and post-test

	Pre-test		Post-test	
Questions	**Intervention**	**Control**	**Intervention**	**Control**
Life Science				
Which part of the plant stores the plant food?	49%	49%	47%	40%
Which fruit is a citrus fruit?	52%	54%	74%	61%
Where do microorganisms (like bacteria) grow fastest?	41%	47%	72%	52%
Which plant is used for food?	79%	83%	89%	84%
Which plant part sends the plant's food to other parts of the plant?	54%	55%	66%	59%
Mean	55%	58%	70%	59%
Science in Personal & Social Perspectives				
Sarah gives everyone in the class a piece of cheese. She asks the other students to taste the cheese and guess if the cheese is low-fat or regular. What is Sarah trying to find out?	80%	79%	87%	81%
Kate wants to buy a lower fat salad dressing. Based on the table above, which choice is the best for Kate?	87%	87%	95%	87%
Mean	84%	83%	91%	84%
Physical Science				
Tom adds green broccoli and an acid (vinegar) to cooking water. The broccoli turns brown in the water. What best explains the change in color?	57%	66%	74%	66%
Which describes a chemical reaction?	53%	49%	66%	58%
What makes apples and bananas brown when they are cut?	30%	33%	62%	41%
Mean	47%	49%	67%	55%
Science and Technology				
Which tool can be used to measure the volume of sugar?	88%	88%	88%	84%
You want to know if a carrot or a tomato is heavier. What do you do?	87%	81%	88%	86%
What do you measure using a thermometer?	85%	81%	89%	84%
Mean	87%	83%	88%	85%

Table 2

T-test comparison of mean scores and standard deviation for content areas and overall score

		Pre-test		p-Value	Post-test		p-Value
Content Area/Overall Score	**Total Score**	**Intervention**	**Control**		**Intervention**	**Control**	
Life Science	5	3.57±1.25	3.70±1.38	0.28	4.36±1.21	3.81±1.27	0.00*
Science in Personal & Social Perspectives	2	1.68±0.56	1.65±0.55	0.63	1.82±0.42	1.68±0.59	0.00*
Physical Science	3	1.61±1.00	1.67±1.02	0.49	2.32±1.14	1.78±1.07	0.00*
Science and Technology	3	2.60±0.65	2.50±0.67	0.07	2.64±0.60	2.54±0.73	0.05
Overall Score	13	8.43±2.06	8.53±2.22	0.57	9.95±2.00	8.84±2.37	0.00*

Significant at $p<.05$*