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Implementation of a Food-Based Science Curriculum Improves Fourth-Grade Educators' Self-efficacy for Teaching Nutrition

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Abstract

Background—Teacher self-efficacy can positively impact student dietary behaviors; however, limited curricular resources and professional development can serve as barriers to the provision of nutrition education in the classroom. The purpose of this study was to assess the impact of a food-based, integrative science curriculum on 4th grade teachers' self-efficacy toward teaching nutrition.

Methods—Researchers used a quasi-experimental design to implement the FoodMASTER Intermediate (FMI) curriculum in 19 4th-grade classrooms across Ohio and North Carolina. The Nutrition Teaching Self-Efficacy Scale was used to assess baseline and post-test teacher self-efficacy using a 4-point Likert-scale (1=not confident at all; 4=very confident). ANCOVA and Wilcoxon-Signed Rank Test were used for statistical analysis.

Results—Teachers in the intervention group displayed significantly higher post-efficacy expectation scores (mean=3.52; sd=0.41) than comparison group teachers (mean=2.86; sd=0.55). Overall, the intervention group showed significant improvement in self-efficacy on 15 of the 18 items.

Discussion—The results suggest providing training and integrative resources to teachers can significantly improve self-efficacy toward teaching nutrition. Future research should focus on determining the amount of training needed to improve the quality of teacher-delivered nutrition education.

Translation to Health Education Practice—Health educators can use the findings to inform the development of teacher trainings in nutrition and health.

Background

An alarming number of youth in the United States are considered overweight or obese (32%).¹ This causes concern for educators due to the long-term effects overweight and obesity may have on school attendance and performance, and long-term chronic disease risk among children of all ages.^{2–4} When examining the factors that influence learning and health education and health promotion, teachers have the potential to greatly affect the

Purpose

As previously described, researchers have identified a positive relationship between teacher self-efficacy and teaching nutrition, and the factors that affect teacher self-efficacy. However, focus has not been placed on improving teacher self-efficacy in nutrition education using a hands-on, food-based education program. The purpose of this study was to examine the effect of Food, Mathematics, and Science Teaching Enhancement Resource (FoodMASTER) Intermediate (FMI), an integrative science, mathematics, and nutrition curriculum and professional development program, on teachers' confidence towards teaching nutrition education in the 4th-grade classroom.

Methods

The FoodMASTER Initiative is a compilation of projects aimed at using food as a tool to teach science and mathematics. The first food-based activities were developed through a partnership between a nutrition science faculty and an elementary school teacher; these initial lessons led to the creation of the FMI (Grades 3–5). After piloting 45 one hour, food-based science lessons in 10 third-grade classrooms in Southeast Ohio over the 2007–2008 academic year, formative feedback was collected from pilot teachers and content experts.²² This information informed the modification and completion of the final intermediate curriculum. Significant gains in nutrition, science, and mathematics knowledge have been observed among 4th grade students as a result of exposure to FMI.^{23–25}

Researchers used a quasi-experimental design to implement the FMI curriculum in 19, 4th-grade classrooms across Ohio (OH) and North Carolina (NC). Fifteen 4th-grade classrooms (OH=7; NC=8) served as comparison classrooms. This study utilized a baseline/post-test design to assess the impact of the FMI curriculum on self-efficacy toward teaching nutrition education among participating 4th-grade teachers. East Carolina University's Institutional Review Board reviewed and approved all study protocol and instruments.

Intervention

FMI is a hands-on science and mathematics curriculum that uses food and nutrition concepts as teaching tools for grades 3–5. FMI lessons provide students with an opportunity to engage in a hands-on, minds-on approach to learning science and crosscutting concepts in mathematics. FMI was implemented as a supplement to teachers' existing 4th-grade curriculum. Incorporating nutrition education into the existing science standards is one possibility for increasing nutrition teaching time during the school year.⁹ At the time of this study, participating 4th-grade teachers were aligning educational content to the National Science Education (NSE) content standards. As part of fulfilling the NSE *Science in Personal and Social Perspectives* standard, teachers were expected to educate 4th grade students to understand their personal health and teach skill sets to help students understand personal and social issues related to their health.²⁶

FMI is comprised of 10 chapters featuring 24, 45-minute hands-on science lessons that cover basic concepts relevant to food and nutrition education: Measurement; Food Safety; Vegetables; Fruits; Milk and Cheese; Meat, Poultry and Fish; Eggs; Fats; Grains; and Meal

Management. Each chapter contains at least one hands-on classroom experiment that illustrates a science standard or concept related to food and nutrition.²⁷ To ensure fidelity of curricular implementation, intervention teachers were provided with all materials needed to implement the curriculum in one classroom including a teacher's manual, student workbooks, online access to curricular materials, equipment (e.g. toaster ovens, hotplates), kitchen supplies, non-perishable food items, and gift cards for purchasing perishable foods needed for lessons throughout the academic year.

Participants

Researchers recruited 19 4th-grade classrooms (OH=10; NC=9) to implement the FMI curriculum (I = Intervention) and 15 4th-grade classrooms (OH=7; NC=8) to act as comparison classrooms (C = Comparison). Informal discussions with intermediate teachers and a review of national and state-level educational standards revealed the majority of concepts emphasized within FMI were taught at the 4th grade level. As a result, fourth-grade classrooms were selected for inclusion in the study. States were chosen based on the Principle Investigators' affiliation with Ohio University and East Carolina University. As part of participant recruitment, school administrators (e.g., principals, curriculum coordinators) recommended potential teachers willing to volunteer for the study. Researchers considered geographic location and community size (e.g. rural, urban) before contacting and entering each teacher into the sample in order to achieve a representative sample. Intervention classrooms were located in rural (n=10) and urban (n=7) areas within each state, with two classrooms being reported as located in an "other" area. After identification of each intervention teacher, comparison teachers in the same school, school district, or a nearby school district were asked to volunteer.

Intervention teachers took part in a one-day professional development session delivered by FoodMASTER Program Directors located within each state. Teachers were introduced to curricular materials, completed several hands-on food activities, and were given time to explore digital resources provided on computer disks. Teachers were provided a teacher manual and classroom set of student workbooks. Teachers were also provided with all supplies needed to implement the curriculum. Teachers in the intervention group were asked to implement 24 hands-on FoodMASTER activities over the academic year, and provide formative evaluation on curricular activities (evaluation will be reported elsewhere).

Comparison teachers did not incorporate the FMI curriculum into their lesson plans. Teachers verbally reported they did not use food as a tool to teach science and nutrition interactively in their classrooms. At the conclusion of the study, comparison teachers were provided with a FMI teacher's manual, student workbook, and online access to curricular materials.

Instrument

All participating teachers completed the previously validated Nutrition Teaching Self-Efficacy Scale (NTSES) at baseline and post testing.¹⁷ The NTSES was adapted from two existing teaching self-efficacy questionnaires: The Elementary Teacher's Science Teaching Efficacy Belief Instrument;²⁸ and the Elementary Health Teaching Self-Efficacy Scale.²⁹

The instrument's reliability and validity was assessed in a sample of 80 Maryland elementary school teachers (kindergarten through 5th grade). Benowitz & Tuttle's tool was found to be valid and reliable for assessing nutrition education teaching self-efficacy among elementary teachers. Cronbach- α scores for the tool; .90 for the efficacy subscale, .85 for the outcome subscale, and .90 for the overall scale. Validation was achieved through factor analysis. Significant differences in scores on the EE subscale were observed as the number of hours spent teaching nutrition content increased ($p<.05$). Further, teachers with higher scores on EE also reported spending more time teaching nutrition in their classrooms ($p<.03$). Finally, overall self-efficacy and subscale scores were higher among teachers who taught more than 11 hours of nutrition education versus those who taught less than 10 hours.¹⁷

The instrument used in this study included 18 of the original 20-items (Table 1) presented on a 4-point Likert scale (very confident to not confident at all) assessing EE (12 items) and OE (6 items) of teaching nutrition in the classroom.²⁶ Two questions from the originally developed 20-item instrument were not included in this study because: (1) the items did not align with the curriculum, (2) at the time of this study, the USDA Center for Nutrition Policy and Promotion (CNPP) developed FGP was outdated. These two questions were "you can do a good job teaching students what food groups make up the FGP" and "you can do a good job teaching students which nutrients come from each food group in the FGP" respectively.

Data Analysis

Descriptive statistics were utilized to determine participant demographics including gender, location of employment, subjects taught, level of education, years of experience, and previous nutrition professional development as well as item means and standard deviations for baseline and post-test. Researchers utilized the Analysis of Covariance (ANCOVA) to explore differences between intervention and comparison groups on each of two subscales controlled for baseline scores: EE, and OE. Subscales were computed using the mean of the responses to the 12 items comprising EE and the 6 items comprising OE. Despite the ordinal scale of measurement for individual survey items, the aggregate subscale measures are treated in parametric fashion. While the ANCOVA addresses the main null hypothesis tests guiding this study, nonparametric Related-Samples Wilcoxon Signed Rank Tests are reported to compare individual survey item results for intervention and comparison groups. Means and standard deviation at pre and post, as well as percent change, were also determined for each survey item to support the results of the Wilcoxon tests. All statistical analyses were performed using IBM SPSS Statistics Version 22. Researchers considered all p -values $.05$ to be significant.

Results

Of the 34 teachers ($n=19$ intervention (I), $n=15$ comparison (C)), 91.2% ($I=89.5\%$; $C=93.3\%$) were female. The average age of participating teachers was 44.3 ± 10.8 ($I=44.0 \pm 12.8$; $C=44.6 \pm 7.7$) years. Ninety-one percent of all teachers reported themselves as White, 3% Samoan, 3% Hispanic and 3% other. Years of teaching ranged from 4 to 41 with a mean of 16.75 ± 10.24 ($I=17.84 \pm 12.31$; $C=15.29 \pm 6.67$). Sixty percent ($I=63\%$; $C=53\%$) of teachers

reported having at least a Master's Degree. None of the teachers reported having nutrition-related professional development in the past.

Cronbach- α scores for the tool were .95 (I=.90; C=.95) for the EE subscale at pre-test and .93 (I=.94; C=.91) at post-test; .87 (I=X; C=X) for the OE subscale at pre-test and .93 (I=.83; C=.91) at post-test; and .93 (I=.94; C=.91) for the overall scale at pre-test and .93 (I=.88; C=.87) at post-test. The ANCOVA indicated pre-scores on EE means were a significant covariate for respective post-scores ($F=4.97$; $df=1$; $p=0.03$). When controlling for baseline scores, a statistically significant difference was detected between intervention and comparison groups' post-EE mean scores ($F=17.50$; $df=1$; $p<0.001$). Teachers in the intervention group showed much higher post-EE scores (mean=3.52; $sd=0.41$) than teachers in the comparison group (mean=2.86; $sd=0.55$) (Figure 1)

Similar trends were revealed when comparing intervention and comparison teachers' OE scores. ANCOVA indicated pre-scores on OE were a significant covariate for respective post-scores ($F=20.92$; $df=1$; $p<0.001$). When controlling for baseline scores, a statistically significant difference was detected between intervention and comparison groups' post-OE scores ($F=5.88$; $df=1$; $p=0.02$). Teachers in the intervention group showed much higher post-OE scores (mean=3.32; $sd=0.51$) than teachers in the comparison group (mean=2.74; $sd=0.61$) (Figure 2).

Results indicated improvement in self-efficacy in the intervention group on all items, with 15 out of 18 items representing statistically significant median increases based on the Wilcoxon-Signed Rank Test (Table 1). The comparison group's median scores significantly improved in a statistically significant manner on only one item in the instrument, "if you do a good job teaching nutrition, your students will be interested in nutrition?", and demonstrated (non-significant) declines in self-efficacy on 3 items (2 EE and 1 OE) (Table 1).

Discussion

The purpose of this study was to examine the effect of FMI, an integrative science, mathematics, and nutrition curriculum, on teachers' confidence towards teaching nutrition in the 4th-grade classroom. Overall, researchers found teachers who participated in a one-day FMI related professional development session and implemented the food-based FMI curriculum significantly improved self-efficacy (overall EE and OE) for teaching nutrition education from baseline to post-test. Additionally, observed gains in efficacy were significantly greater than changes observed in the matched comparison group. Similarly, Norton, Falcigila, & Wagner⁹ found that teachers receiving nutrition curricular materials and professional development had higher self-efficacy toward teaching nutrition. Observed self-efficacy increases in the current study are likely attributable to educational supplemental materials supplied for intervention teachers, the one-day professional development session, provision of a food-based science and mathematics curriculum that enabled teachers to gain experience integrating nutrition content into their normal curricular practices.

Within the intervention group, the largest single item increase was observed in the EE subscale. The question, “*you understand nutrition concepts well enough to teach them to your students*” increased by 0.85 from baseline on the ordinal 4-point scale (32%), more than any other individual question. This result suggests the FMI curricular resources and professional development provided as components of the FoodMASTER Initiative may have positively impacted teacher understanding of basic nutrition concepts, in addition to their self-efficacy. Other areas of improvement included possessing skills to teach nutrition; experiencing adequate professional development; ability to answer student questions; teaching food groups, dietary guidelines and food guide pyramid; and food safety. Only one of the EE items did not show a significant increase within the intervention group, “*you can do a good job teaching students about fat, sugar, and salt in fast foods and snack foods*” (10% increase). Lack of significant change may be attributed to limited discussion of the nutritional content of fast foods and snack foods in the curriculum. Prior research also suggests increasing self-efficacy for teaching subjects related to calorie-dense products like fast food is difficult.¹⁴

For the subscale OE, the largest change (25% increase) in the intervention group was for “*you can interest students in the subject of nutrition*”. Teachers with higher levels of self-efficacy are more likely to engage students in nutrition education, resulting in students who are more prepared to learn and apply nutrition concepts.²¹ By implementing the curriculum, teachers likely gained confidence in their abilities and were able to observe student interest levels rising. Two OE items showed improvement in OE, however, the changes were not significant: “*if you do a good job teaching nutrition, your students will increase their nutrition knowledge*” (5% increase), and “*if you do a good job teaching nutrition, your students will change their nutrition-related attitudes*” (7% increase). Overall, it appeared intervention teachers’ self-efficacy for increasing their students’ nutrition knowledge was unchanged, which could be a result of positive baseline scores. Interestingly, student nutrition knowledge outcomes within the same intervention study found that students exposed to the FoodMASTER curriculum demonstrated significant gains in nutrition knowledge compared to matched comparison classrooms over the academic year.²³

Within the comparison group, self-efficacy increased significantly for only one OE question “*if you do a good job teaching nutrition, your students will be interested in nutrition*” (13.8%). One of the six OE items actually declined in the comparison group, “*if you teach more hours of nutrition, you will have a greater impact on your students’ nutrition related knowledge, attitudes, and behaviors*.” Based on prior research, teachers may have lost confidence in their ability to impact student knowledge, attitudes, and behaviors as the academic year progressed due to decreased time spent teaching nutrition in the classroom.⁸ Similarly, eight of the 12 EE items showed decreases in self-efficacy for teaching nutrition among comparison teacher over the course of the school year. These findings imply, as the academic year progressed comparison teacher self-efficacy to impact student nutrition knowledge and behaviors progressively declined without the added benefit of supplemental nutrition education materials (supplies and integrative curricula) and professional development. Observed decreases may be related to commonly cited barriers to nutrition education in the K-12 classroom, including limited time, inadequate professional development, and lack of access to/awareness of nutrition education materials.^{6–7,9–11}

Strengths & Limitations

There were five primary limitations in this study. First, to improve teacher nutrition self-efficacy, past research indicates teachers need to receive formal education on the topic, be provided access to teaching materials, and be encouraged to teach the topic.^{15,21} While FMI teachers received all of the recommended components, findings suggest in order to impact self-efficacy for increasing student knowledge about fat, sugar, and salt in fast foods and snack foods teachers may need more focused professional development or additional teaching materials related to these topics. Future research may explore the level of professional development needed to improve teachers' self-efficacy related to these factors. Second, the process evaluation methods used in this study were limited to teacher journals. Due to the large geographical span of the study, researchers were not able to observe each classroom to ensure the fidelity of curricular implementation. This type of formative feedback does, however, address the fidelity of the curriculum since it just required teachers to recall lesson implementation soon after completion.³⁰ Researchers supplied teachers with all materials needed to fully implement the curriculum to reduce potential implementation barriers throughout the academic year.

Third, professional development time constraints (i.e. only a one-day workshop) may have limited observed nutrition education teaching self-efficacy gains among intervention teachers. Norton, Falcigila, and & Wagner⁹ have reported professional development increases self-efficacy. Unfortunately, the current literature does not identify the amount of professional development considered optimal for improving teacher self-efficacy for teaching nutrition. Future research is needed to explore the level of professional development needed to improve the teacher self-efficacy and therefore, quality of teacher delivered nutrition education. Fourth, the current study used a quasi-experimental design (versus random selection), and only matched teachers based on school size and location (rural, urban). Data on additional variables such as age, years of teaching experience, teacher training background, ethnicity, and gender were collected, but not used to include or exclude participants. Further, the final sample sizes for each group (intervention and comparison) were small; a larger study may have revealed different outcomes with regards to teaching efficacy. Finally, the comparison group was aware of the intervention group. This may have impacted post-test self-efficacy and the ultimate decline in scores for this group; however, authors believes that provision of equal benefits (e.g. curricular resources) to the comparison at post-test was adequate to prevent this effect.³¹

Three primary strengths in this study were the design, teacher diversity, and integrative nature of the curriculum. The quasi-experimental design provided the opportunity for comparing intervention outcomes against a control. This allows for a better evaluation of data to show gains in knowledge were a result of the intervention and not the typical environment. Teacher diversity in regards to background, experience, and location was another strength of this study. Classrooms from two states were located in various settings including rural and urban, which provided researchers with a robust sample. Researchers were able to address the time constraint issue for teachers by creating an integrative science curriculum that addressed mathematics, nutrition, and health concepts.⁹ Therefore, teachers

did not have to take away time from required subjects to include nutrition and health in their curriculum.

Translation to Health Education Practice

The concept of self-efficacy is an important construct for understanding behaviors³³ from the teaching practices of teachers to the diet and physical activity behaviors of K-12 students.³³ Self-efficacy is a key component in various health behavior theories with the idea that the “self” may impact specific behavioral outcomes, including the types of behaviors individuals attempt, perseverance in achieving goals, and level of persistence when faced with setbacks.^{18–2} Teachers can greatly affect the health behaviors of their students.^{5–11} Past research indicates self-efficacy may serve to increase teacher willingness to implement new instructional concepts like health.³² Increased support and opportunities to seek professional development would likely result in increased teacher confidence and knowledge.^{14,15} More research is needed to determine the specific components of professional development programs that are the most important for increasing teacher self-efficacy, while also providing teachers with the optimum knowledge about nutrition or health practices. Further, additional research is needed to determine the level of teaching self-efficacy necessary for teachers to impact student health behaviors. The current study focused on teacher self-efficacy for teaching nutrition education; however, what remains unclear is the relationship between the teachers’ self-efficacy and student health behaviors. Prior research has indicated high rates of overweight and obesity among children and adolescents may impact school performance and long-term chronic disease risk.^{2–4} Health educators can begin to address this area of need through: (1) further examination of self-efficacy as a influential factor towards learning and behavior change in the existing K-12 programs; (2) and the development and delivery of new educational interventions that will address and evaluate the relationship between teaching self-efficacy and student health behavior outcomes.³⁴

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Figure 1.

Comparison of Nutrition Teaching Efficacy EE Between and Within Groups at Baseline and Post-test.

There was a significant increase in teaching efficacy EE for the intervention group $p=.000$.

*1 = not confident at all; 2 = somewhat confident; 3 = confident; 4 = very confident.

Figure 2.

Comparison of Nutrition Teaching Efficacy OE Between and Within Groups at Baseline and Post-test.

There was a significant increase in teaching efficacy OE for the intervention group $p=.005$.

*1 = not confident at all; 2 = somewhat confident; 3 = confident; 4 = very confident.

Table 1
Comparison of Nutrition Teaching Self-efficacy Scale (NTSES) Items Within Groups at Baseline- and Post-test

Item How confident are you that ...	Intervention						Comparison				
	Baseline Mean±SD	Post-test Mean±SD	Percent Change	t (df=18)	p- value		Baseline Mean±SD	Post-test Mean±SD	Percent Change	t (df=14)	p- value
Efficacy Expectations (EE) you have adequate training to teach nutrition?	2.68±0.82	3.42±0.61	27.61	-3.44	.003*		2.53±0.64	2.63±0.62	3.95	-.619	.546
you understand nutrition concepts well enough to teach them to your students?	2.68±0.82	3.53±0.51	31.72	-.474	.000*		2.73±0.46	2.69±0.60	-1.47	.000	1.00
you have the skills necessary to teach nutrition concepts effectively?	2.79±0.86	3.58±0.51	28.32	-.319	.002*		2.73±0.46	2.69±0.70	-1.47	.000	1.00
you can answer students' nutrition-related questions?	2.63±0.68	3.37±0.68	28.14	-.383	.000*		2.73±0.46	2.56±0.73	-6.23	.899	.384
you can do a good job teaching students what the Food Guide Pyramid (FGP) is?	2.79±0.86	3.58±0.61	28.32	-.377	.001*		3.00±0.66	2.94±0.77	-2.00	.000	1.00
you can do a good job teaching students about eating a balanced diet?	3.21±0.86	3.58±0.61	11.53	-2.35	.031*		3.00±0.54	3.06±0.57	2.00	-.435	0.670
you can do a good job teaching students which foods belong to each food group in the FGP?	2.89±0.81	3.58±0.61	23.88	-3.98	.001*		3.07±0.59	3.00±0.63	-2.28	.000	1.00
you can do a good job teaching students about fat, sugar, and salt in fast foods and snack foods?	3.05±0.78	3.37±0.68	10.49	-1.56	.137		2.60±0.63	2.88±0.72	10.77	-1.293	.217
you can do a good job teaching students what the Dietary Guidelines are?	2.47±0.84	3.11±0.74	25.91	-3.62	.002*		2.60±0.83	2.56±0.94	-1.54	.000	1.00
you can do a good job teaching students about reducing fat and salt in their diets?	3.00±0.82	3.63±0.60	21.00	-2.72	.014*		2.67±0.82	2.88±0.72	7.87	-1.00	.334
you can do a good job teaching students about increasing fruits, vegetables, and grains in their diets?	3.11±0.66	3.79±0.42	21.86	-4.44	.000*		3.07±0.59	3.06±0.44	-0.33	.000	1.00

Item How confident are you that ...	Intervention					Comparison				
	Baseline Mean±SD	Post-test Mean±SD	Percent Change	t (df=18)	p- value	Baseline Mean±SD	Post-test Mean±SD	Percent Change	t (df=14)	p- value
Efficacy Expectations (EE) you can do a good job teaching students about ways to keep foods safe?	2.94±0.73	3.68±0.48	25.17	-4.08 [†]	.001*	3.13±0.52	3.00±0.52	-4.15	.367	.719
Outcome Expectations (OE)										
you can interest students in the subject of nutrition?	2.89±0.81	3.58±0.51	23.88	-3.37	.003*	2.80±0.86	2.88±0.81	2.86	-.250	.806
if you do a good job teaching nutrition, your students will be interested in nutrition?	2.89±0.66	3.53±0.51	22.15	-4.61	.000*	2.60±0.91	2.94±0.85	13.08	-3.055	.009*
if you do a good job teaching nutrition, your students will increase their nutrition knowledge?	3.32±0.58	3.47±0.61	4.52	-1.00	.331	2.87±0.64	3.13±0.72	9.06	-1.74	.104
if you do a good job teaching nutrition, your students will change their nutrition-related attitudes?	2.84±0.77	3.05±0.85	7.39	-.889	.385	2.27±0.80	2.56±0.81	12.78	-1.74	.104
if you do a good job teaching nutrition, your students will change their nutrition-related behaviors?	2.53±0.91	2.89±0.74	14.23	-2.35	.031*	2.20±0.86	2.44±0.89	10.91	-1.146	.271
if you teach more hours of nutrition, you will have a greater impact on your students' nutrition related knowledge, attitudes, and behaviors?	3.00±0.67	3.42±0.61	14.00	-2.39	.028*	2.60±0.83	2.50±0.89	-3.85	.323	.751

[†] =not confident at all 4= very confident; Intervention (n=19) and comparison (n=14)

* indicates significant at p< 0.05.

[‡] indicates this question had a df=17 due to a missing response from a participant.