Research Article

Influences of Constructivist-Oriented Nutrition Education on Urban Middle School Students' Nutrition Knowledge, Self-efficacy, and Behaviors

Nate McCaughtry, Mariane Fahlman, Jeffrey J. Martin, and Bo Shen

ABSTRACT

Background: *Health professionals are looking to nutrition-based youth health interventions in K-12 schools to combat the growing obesity crisis; however, none have explored the influences of interventions guided by constructivist learning theory.* ***Purpose:*** *This study examined the influences of a constructivist-oriented nutrition education program on urban middle school students' nutrition knowledge, self-efficacy and behaviors.* ***Methods:*** *A quasi-experimental design examined changes in middle schools students' (*N = *1,476) nutrition knowledge, self-efficacy and behaviors, relative to a control group (*N = *656), in response to a 6-lesson nutrition education intervention.* ***Results:*** *For dietary knowledge and self-efficacy, there were significant group and time main effects and group x time interactions. In addition, there were significant group and time main effects and a group x time interaction for the dietary behaviors related to consuming fruits, vegetables, meats and "other" food groups, but not dairy or grains.* ***Discussion:*** *The constructivist-oriented professional development, curriculum and instruction yielded significant changes in middle schools students' nutrition knowledge, self-efficacy and behaviors.* ***Translation to Health Education Practice:*** *Given the efficacy of the intervention curriculum and instruction, K-12 teachers are encouraged to implement similar high quality, theoretically grounded efforts. However, recommendations are made that additional focus be given to key items that proved resistant to change.*

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BACKGROUND

American youth, especially minority youth and those from economically disadvantaged urban communities, are facing an obesity epidemic.[1,2] This is troubling given the ongoing connections between obesity and a host of chronic diseases.[3] Unhealthy eating has been identified as a key contributor.[4] Efforts have now turned to identifying locations and strategies that might effectively address the problem. Some proclaim that K-12 schooling offers one venue because most children attend schools for a significant time and schools seek to educate the whole child, including health and wellness.[1,4,5]

In response, educators and public health professionals have developed school-based approaches to improving youth health. Many factors contribute to the effectiveness of school-based health initiatives, some of which include legislation (federal or state level), nutrition policies (e.g., state and school district wellness policies), and institutional support for nutrition education (e.g., providing necessary instructional resources or teacher professional development).[2,4] Some initiatives take a system-wide approach, for example, the Coordinated

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School Health Program[6] or Generation With Promise.[7] Others take a more targeted approach and concentrate on increasing physical activity;[8] improving children's food options;[9] or enhancing classroom-based nutrition education.[10] In summary, the World Health Organization concluded that nutrition variables seem among the most malleable to change through school-based interventions.[5] Studies have shown respectable improvements in children's nutrition through changes to school food and beverage offerings, nutrition policies, and formal educational curriculum.[10,12] For example, Contento, Koch, Lee, Sauberli and Calabrese-Barton found that following a nutrition education intervention, students increased fruit and vegetable intake; decreased consumption of sweetened beverages; packaged snacks and fast-food meals; ate and drank smaller portion sizes; and increased their nutrition-related outcome beliefs and self-efficacy.[12]

Several factors contribute to the success of school-based nutrition interventions. Curriculum materials and instructional delivery in successful interventions are based on sound theory, such as social cognitive theory, the theory of planned behavior and self-efficacy theory.[13,14] Second, teachers implementing interventions must have sufficient, up-to-date curriculum and receive effective professional development to increase their aptitude, comfort and efficacy.[15,16]

However, there are a couple of key issues that warrant further examination. First, most nutrition interventions in schools use social cognitive theory focusing on how youth interpret their social environment relative to competency, control, self-efficacy, outcome value, outcome expectations, social norms and the built environment. While social cognitive theory plays a role in interventions that promote positive feelings about changing nutrition habits, they could be further supplemented by cognitive learning theories like constructivism,[17] situation learning theory,[18] or cognitive schema theory[19] that focus more on how students acquire and use new information. Second, many classroom-based nutrition interventions examine a narrow range of nutrition-related variables such fruit and vegetable intake, consumption of sweetened beverages, or healthy eating efficacy. More researchers need to examine a wider range of nutrition variables that include behavioral, social cognition and knowledge outcomes in order to understand of how interventions lead to changes in children's nutrition.[20] Third, more interventions need to be conducted in urban, inner-city schools because of their many unique challenges,[21,22] the prevalence of overweight/obese,[23] lack of physical fitness,[24] insufficient physical activity[23,24] and unhealthy eating.[25]

PURPOSE

We examined the influences of a constructivist-oriented nutrition education program on urban middle school students' nutrition knowledge, behaviors and self-efficacy.

METHODS

Participants

During the fall of 2008, middle school children (N = 2,132) and their health education teachers (N =32) from a large metropolitan area participated in the current study. Table one contains their demographic information (e.g., age, gender, ethnicity) categorized by intervention (N = 1,476) and control groups (N = 656). The intervention and control group schools were randomly selected in two different ways. First, the researchers had obtained a small grant to conduct the nutrition education study in one urban school district provided all schools were given the opportunity to participate if they met the criteria of having a specifically designated health education teacher and willing teacher and principal participants. Out of a pool of 32 schools in the district, 16 schools had clearly identified health education teachers and teachers and administrators who were willing to participate. To obtain control group schools, we contacted school districts that directly bordered the intervention school district. A total of 26 individual schools met the above criteria, and from this group we randomly selected 16 to match the number of intervention schools we had selected. The health education teachers at the control schools refrained from teaching any nutrition education during the curricular implementation phase of the study. The research was approved by the University's Institutional Review Board and written informed consent was obtained from administrators, teachers, students and their parents. A nearly equal percentage of students from the intervention and control schools were lost to post-intervention due to school transfers or illnesses. Overall, 92% of the students who completed the pre-intervention survey also participated in the curricular unit and completed the post-intervention survey.

Instruments

We adapted a survey instrument used in previous studies examining dietary knowledge, dietary behaviors and dietary self-efficacy in children.[20] It was reviewed for content and face validity by university professors and middle school health education teachers with expertise in nutrition education and then pilot tested it with students. No difficulties were encountered during the pilot study suggesting the scales were appropriate.

Demographic questions. Seven demographic questions were used such as the participants' ages, genders, ethnicities, etc. (see Table 1).

Dietary behaviors. Twenty-one questions asked children how often they ate food from the major food groups (i.e., grains, fruit, vegetables, diary, meats and other) yesterday. For instance, they were asked "Yesterday, how often did you eat diary?" Students were presented with pictures of foods representing the food groups. Answers ranged from none to three or more times and students indicated how often they ate foods from that food group "yesterday." Answers were recorded as the number of times students reported consuming items from that food group the day prior. The "other" category described foods at the top of the food pyramid such as donuts or candy.

Dietary knowledge. This scale was composed of 16 questions (see Table 3) address-

Table 1. Demographic Characteristics of Respondents

	Intervention N = 1476		Control N = 656	
Number of schools/Health Education teachers	16		16	
Mean Age (SD)	12.63 ± 0.87		12.82 ± 0.76	
Percent of students receiving free/reduced lunches	92%		57%	
Average Class Size	38		32	
	N	%	*N*	%
Gender				
Female	723	49	335	51
Male	753	51	321	49
Race				
Black	1358	92	118	18
Asian	14	1	33	5
White	89	6	492	75
Other	15	1	13	2
Ethnicity				
Hispanic	163	6	52	8
Non-Hispanic	1313	94	604	92

ing items taught in the nutrition curriculum. For example, one question read, "How many servings of fruits should you eat each day?" Possible scores ranged from 0 (no answers correct) to 16 (every answer correct).

Dietary self-efficacy. Five questions were used to examine dietary self-efficacy (see Table 4). An example was, "How confident are you that you could eat less fat?" Answers ranged from 1 (not at all confident) to 7 (very confident). Scores ranged from 5 to 35.

Design and Procedures

We used a quasi-experimental design with intervention and control groups. The primary research goal was to improve youth's nutrition knowledge, behaviors and self-efficacy, to reflect a three-fold attempt to help them *know* how to eat healthier, actually *eat* healthier, and to *feel* efficacious in doing so. The intervention included two components: health education teacher professional development in a new constructivist-oriented nutrition education curriculum and its implementation in their health education classes. Both components were grounded in constructivist learning theory.[17,26,27] Constructivism includes three components.[17,26,28,29,30] First, constructivism emphasizes the importance of active learning and knowledge construction, over passive, rote memorization. Learners ask questions, generate hypotheses, and test their emerging ideas of new content. Individuals learn best when they encounter, interact with, use, and translate new knowledge. Second, constructivism emphasizes the interaction of new information with prior knowledge. Whether through Piaget's accommodation and assimilation,[31] Vygotsky's cognitive scaffolding,[32] or Rummelhart and Norman's accretion, tuning and restructuring,[33] new information must have some orientation with what has previously been learned. Third, learning is a socio-cultural activity with two parts. For one, learning occurs in groups as individuals negotiate, share, hash out and organize knowledge as a social function. In addition, new knowledge must transfer to the socio-cultural context where it will be used.

The three components of constructivism were embedded into eight hours of weekend professional development on the Michigan Model for Health Education: What's Food Got to Do With It? for grades seven and eight.[34] The health education teachers were given the curriculum and all supporting resources. Lesson by lesson, the nutrition workshop specialist and teachers talked

about differences between the new curriculum and their past knowledge and teaching. The health education teachers debated and discussed lessons in light of their difficult teaching contexts. They peer taught lessons to one another, and provided feedback afterward. They were active in the learning process, connecting the new knowledge and lessons with what they had already known and done in their classrooms, and they had ample opportunities to share and learn from one another while connecting the new curriculum with the challenges they believed they would face in their classrooms.

Next, the health education teachers implemented the constructivist-oriented curriculum. The curriculum is comprised of six one-hour lessons that cover: the content and benefits of food groups, eating based on food groups, analyzing influences that impact eating, selecting different foods, reading and interpreting food labels, deciphering health claims on labels, body image, and surviving fast food restaurants. Lessons position students as active learners, have them connect the new content with their prior knowledge, encourage students to work in groups and share their work, discuss, and debate with their peers, and connect new content with students' lives outside of schools. For example, lesson one included the following activities: reflection on students' eating patterns, group work where students assume different roles (e.g., reporter, presenter, group leaders) to discuss their prior knowledge about food groups, comparison of prior knowledge with the new food pyramid, food group presentations to the whole class, a small-group school advertising campaign assignment, a home eating analysis according to the food pyramid, and parent interviews about food groups. Experienced health educators on the research team who also had expertise in constructivism reviewed each lesson to ensure that students were actively learning during the majority of lessons, that new information connected with students' prior knowledge, that social interaction among students was maximized, and that lessons involved students' lives inside the school, at home and in the community.

After the workshops, the study followed three steps. First, research assistants conducted pre-intervention data collection with all students. Second, the intervention health education teachers implemented the six-lesson units with their classes over the next six weeks. Both the control and intervention health education teachers maintained a detailed teaching log with corresponding lessons plans to verify they either did not teach any nutrition education at all (control teachers) or implemented each intervention lesson according to the very detailed (nearly scripted) lessons in the curriculum (intervention teachers). Also, a research assistant conducted randomized school visits to observe each health education teacher's instruction to guarantee that the control teachers were not teaching nutrition content and that the intervention teachers were implementing the curriculum with fidelity (e.g., cover all lesson content and doing so following the constructivist-oriented approaches embedded in the written lessons). Last, after the six-week intervention, the research assistants conducted post-intervention data collection with the students at all schools.

The scores produced by each scale were tested for internal reliability using Cronbach's alpha. Dietary knowledge (α = .94) and dietary self- efficacy (α= .92) were found to be reliable, as they were all over .70. For test-retest reliability, the instrument was administered to 60 students two weeks apart. The stability reliability correlation coefficient was .92 for dietary knowledge and .91 for dietary self-efficacy, both were adequate.

Construct validity was established using a principal components factor analysis with varimax rotation. Based on an eigenvalue of 1 and a factor loading criteria of .45 or better, two distinct scales were formed with all items loading on their respective factors. For concurrent validity, registered dieticians assisted a subsample (N = 161) of students with 24 hour recalls. The recalls were coded for times students consumed foods following food groups: grains, fruits, vegetables, dairy, meats, or "other" food. These food groups were totaled in the "dietary behaviors" subset on the questionnaire. Spearman's rank order coefficient was used to compare the results with the dietary behavior items. Concurrent validity was acceptable for grains (.46), fruit (.88), vegetables (.79), dairy (.79), meats (.90), and "other" (.86).

Data Analysis

The reliability and validity of the scores produced by the scales were calculated. Then, descriptive statistics were determined and used to summarize demographic data. The effects of the intervention were assessed with a 2 (pre vs. post) by 2 (intervention vs. control) repeated measures analysis of variance. When significant time, group, or interactions were found, Tukey's Post Hoc analyses were run to determine the location of the differences. Statistical significance was set at $P \leq 0.05$. All aspects of this study were approved by the Wayne State University Human Investigations Committee (HIC).

RESULTS

Dietary Knowledge. There were significant group $F(1, 2131) = 14.213$, $P < 0.001$ and time $F(1, 2131) = 9.621$, $P < 0.001$ main effects and a group x time interaction $F(1, 2131) = 12.732$, $P < 0.001$; Cohen's $f^2 = .39$ for dietary knowledge (Table 2). Subsequent post-hoc analysis revealed that the intervention group had higher post scores than pre scores, and also higher scores than the control group at post. The intervention group significantly increased their knowledge in 13 out of 16 questions, and 11 out of 16 relative to their control group peers (Table 3).

Dietary Self-Efficacy. There were significant group $F(1, 2130) = 4.921$, $P < 0.001$ and time $F(1, 2130) = 7.219$, $P < 0.001$ main effects and a group x time interaction $F(1, 2130) = 6.814$, $P < 0.001$; Cohen's $f^2 = .66$ for dietary self-efficacy (Table 2). Subsequent post-hoc analysis revealed that the intervention group had higher post scores than pre scores and also scored higher than the control group at post. Students in the intervention group significantly increased their self-efficacy in four out of five areas

Table 2. Nutrition Knowledge and Dietary Self-Efficacy Total Scores

Subscale	Pre-Intervention		Post-Intervention		*P*
	Intervention Mean ± SD	Control Mean ± SD	Intervention Mean ± SD	Control Mean ± SD	
Knowledge (number correct 0[low] – 16 [high])	6 ± 2[a]	6 ± 3	11 ± 4[a,b]	6 ± 4[b]	<0.001
Self Efficacy (scale = 5[low] – 35[high]	17 ± 3[a]	18 ± 3	28 ± 3[a,b]	18 ±5[b]	<0.001

Note: Scores = Mean ± SD. Superscript (a) indicates a significant difference in the intervention group pre - post. Superscript (b) indicates a significant difference between the intervention group and the control group at post as determined by Tukey's Post Hoc analyses. *P* values represent overall F test.

(Table 4). There was a large effect size for fruits and vegetables (Cohen's $f^2 = 1.03$) to more modest, but still moderate to large, effect sizes for a nutrition plan (Cohen's $f^2 = .69$), eating less fat (Cohen's $f^2 = .86$) and eating healthy at a fast food restaurant (Cohen's $f^2 = .30$.

Dietary Behaviors. Each food group was analyzed separately. There was a significant group main effect $F(1, 2128) = 5.143$, $P < 0.001$ and a significant interaction for the grains food group $F(1, 2128) = 7.156$, $P < 0.001$; Cohen's $f^2 = .08$. However, the main effect of time failed to reach significance $F(1, 2128) = 2.426$, $P = 0.060$. There were significant group $F(1, 2130) = 4.102$, $P < 0.001$ and time $F(1, 2130) = 3.111$, $P < 0.001$ main effects and a group x time interaction $F(1, 2130) = 6.254$, $P = 0.027$; Cohen's $f^2 = .24$ for the fruits food group. There were significant group $F(1, 2130) = 6.212$, $P < 0.001$ and time $F(1, 2130) = 5.157$, $P < 0.001$ main effects and a group x time interaction $F(1, 2130) = 5.435$, $P = 0.018$; Cohen's $f^2 = .16$ for the vegetable food group. There were no significant group $F(1, 2130) = 1.017$, $P = 0.062$ or time $F(1, 2130) = 1.017$, $P = 0.801$ main effects or a group x time interaction $F(1, 2130) = 1.625$, $P = 0.260$ for the dairy food group. There were significant group $F(1, 2130) = 5.621$, $P < 0.001$ and time $F(1, 2130) = 4.517$, $P < 0.001$ main effects and a group x time interaction $F(1, 2130) = 5.435$, $P < 0.001$; Cohen's $f^2 = .32$ for the meats food group. There were significant group $F(1, 2129) = 6.144$, $P < 0.001$ and time $F(1, 2129) = 5.215$, $P < 0.001$ main effects and a group x time interaction $F(1, 2130) = 5.245$, $P = 0.025$; Cohen's $f^2 = .01$ for the "other" food group.

DISCUSSION

The best school-based nutrition interventions are multi-faceted and include nutrition policy, school meals, vending, use of food as rewards/punishment and nutrition education.[35,36] This study examined the influences that constructivist-oriented nutrition education in mandatory health education classes had on urban middle school students' nutrition knowledge, efficacy and behaviors. In particular, this study used a two-component intervention that first engaged teachers in constructivist-oriented nutrition education professional development and second had those teachers implement a constructivist-oriented nutrition education curriculum in their classes. Both components included: active learning, social learning, and connecting prior knowledge to new learning and socio-cultural environments.[17,26,28,29,30]

Constructivism is primarily a theory explaining how individuals learn new knowledge, hence it was expected the theory would have the greatest influence in the area of nutrition knowledge. The large effect size (i.e., .39) associated with the intervention group's increase in nutrition knowledge indicates a substantial gain after just six lessons. This finding confirmed the power of our intervention in influencing student learning as students significantly improved their nutrition knowledge as a global construct and specifically for 13 of the 16 items. Intervention students also knew more about recommended servings of fruits, vegetables, and grains, but not meats, suggesting meats may be a bit more confusing for middle school students and require greater attention during instruction. Additionally, the effect size (i.e., .39) associated with dietary knowledge was large, indicating very meaningful gains in knowledge. Intervention students also accurately understood the vernacular of marketing on food packaging and the nutritional content of various food groups. However, intervention students did not experience significant increases in their knowledge about the preventive qualities of proper nutrition such as heart disease, cancer, and overweight/obesity. This was likely attributed to their prior knowledge as both students in the intervention and control groups scored high during the pre-intervention testing in all three areas. This might suggest that teachers reinforce these topics quickly

Table 3. Dietary Knowledge Results by Question

Question	Pre-Intervention		Post- Intervention		*P*
	Intervention *N* = 1476	Control *N* = 656	Intervention *N* = 1476	Control *N* = 656	
	Percent Correct	Percent Correct	Percent Correct	Percent Correct	
From which food group should you eat the most servings every day?	14[a]	15	44[a,b]	14[b]	<0.001
From which food group should you eat the fewest servings every day?	57[a]	59	72[a]	57	0.027
How many servings of fruits should you eat each day?	11[a]	10	75 [a,b]	7[b]	0.018
How many servings of vegetables should you eat each day?	15[a]	13	78 [a,b]	17[b]	0.026
How many servings of meats should you eat each day?	21[a]	24	74a	24[b]	<0.001
How many servings of grains should you eat each day?	7[a]	6	62 a,b	8[b]	0.024
Which food group is a good source of vitamin C?	32[a]	33	64 [a,b]	36[b]	0.026
Which food group is a good source of energy?	5a	2	42 [a,b]	3[b]	<0.001
Which food group is a good source of calcium?	37[a]	49	63 [a,b]	50[b]	0.042
Which food group provides protein for muscles?	22[a]	25	69 [a,b]	26[b]	0.019
What you eat can make a difference in your chances of getting heart disease.	82	86	82	86	0.213
What you eat can make a difference in your chances of getting cancer.	60	62	59	60	0.206
People who are overweight are more likely to have health problems than those that are normal weight.	86	86	84	85	0.253
French fries are a "nutrient dense" food	24[a]	28	79 [a,b]	29[b]	0.020
The word "lite" on a food package means low fat	30[a]	28	52 [a,b]	29[b]	0.034
The word "lean" on a food package means the food is fat free	55[a]	54	70 [a,b]	53[b]	0.029

Note: Scores = Mean ± SD. Superscript (a) indicates a significant difference in the intervention group pre - post. Superscript (b) indicates a significant difference between the intervention group and the control group at post as determined by Tukey's Post Hoc analyses. *P* values represent overall F test.

Table 4. Dietary Self-efficacy Results by Question

Question	Pre-Intervention		Post- Intervention		
	Intervention *N* = 1476	Control *N* = 656	Intervention *N* = 1476	Control *N* = 656	
How confident are you that you could…	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	*P*
design a plan for better nutrition if you wanted to?	3.77[a] ± 2.1	3.79 ± 1.7	6.95[a,b] ± 2.0	3.72[b] ± 1.9	<0.001
eat more fruits and vegetables?	3.48[a] ± 1.8	3.62 ± 1.5	6.25[a,b] ± 0.7	3.41[b] ± 1.0	0.027
eat less fat?	3.31[a] ± 1.1	3.38 ± 1.4	6.83[a,b] ±1.2	3.32[b] ± 2.4	0.018
drink less pop?	2.72 ± 1.6	3.99 ± 1.6	2.95 ± 1.7	2.92 ± 1.7	0.260
eat healthy at a fast food restaurant?	3.98[a] ± 1.7	4.11 ± 1.9	6.12[a,b] ± 1.7	4.16[b] ± 1.9	<0.001

Note: 1 = not at all confident to 7 = very confident
Scores = Mean ± SD. Superscript (a) indicates a significant difference in the intervention group pre - post. Superscript (b) indicates a significant difference between the intervention group and the control group at post as determined by Tukey's Post Hoc analyses. *P* values represent overall F test.

during their instruction, but not focus on them in depth given that many students may already have a firm understanding of the long-term health consequences associated with healthy eating. Perhaps a better guide for teachers' instruction would be to focus more instructional time and effort on items that showed positive growth in learning, but where students still scored relatively low during the post-intervention testing such as, the food group that should be eaten most often (44% and 14% correct at post-test), which food group is a good source of energy (42% and 3% correct at post-test), and the correct meaning of the word "lite" on food packaging (52% and 29% correct at post-test).

Most successful school-based nutrition education interventions are guided by social cognitive theories (e.g., self-efficacy theory). However, despite not being principally focused on social cognitive variables, this intervention proved effective in enhancing students' overall self-efficacy for healthy eating. In fact, the large effect size (i.e., .66 and 1.03) we found among our global results was associated with student's gains in self-efficacy. After the intervention, the intervention students were much more confident than their control group counterparts that they could: plan better nutrition, each more fruits and vegetables, eat less fat, and eat healthy at fast food restaurants. In particular, based on the effect sizes, students gained the most efficacy in their confidence to eat more fruits and vegetables. Given the health benefits associated with eating adequate fruits and vegetables this finding is particularly valuable. Conversely, students were not more confident in their ability to drink less soda/pop. Others have noted that efficacy influences dietary practices and is malleable to nutrition education interventions in schools.[20] The constructivist-oriented intervention produced significant improvements in students' nutrition self-efficacy. The focus placed on connecting new nutrition knowledge to prior knowledge, the pro-social learning environment, and most of all the linkages between new content and students' socio-cultural lives likely contributed to the success of the intervention. Teachers led effective instruction on dietary planning, eating fruits and vegetables, eating less fat, and eating healthy at fast food restaurants in ways that helped students increase their confidence in those areas. The finding that constructivism, a knowledge acquisition theory, might also have success in promoting increases in healthy eating self-efficacy should be dually noted and explored further.

The changes in nutrition behaviors in response to the intervention were equally promising. Intervention students reported significantly increasing their dietary intake of fruits and vegetables, and decreased their intake of meats and "other" non-nutritious foods. However, no changes were found in their consumption of grains and dairy over that time. The lack of behavior change in the grains food group was surprising given students' increased knowledge of the recommended number of servings. For fruits and vegetables, there was a trend that when students learned more about the recommended number of servings, their reported behaviors aligned. The most puzzling finding was that students' consumption of meats significantly decreased, but no significant difference in their knowledge of the recommended number of servings was reported.

Table 5. Dietary Behaviors by Food Group

Food Group	Pre-Intervention		Post- Intervention		Significance
	Intervention N = 1476 Mean ± SD	Control N = 656 Mean ± SD	Intervention N = 1476 Mean ± SD	Control N = 656 Mean ± SD	
Grains	2.86[a]± 2.1	2.89 ± 1.7	3.65[a,b] ± 2.0	2.52[b] ± 1.9	G, GxT
Fruit	2.48[a] ± 1.8	2.52 ± 1.5	3.25[a,b] ± 0.7	2.41[b] ± 1.0	G, T, GxT
Vegetables	1.31[a] ± 1.1	1.38 ± 1.4	2.83[a,b] ±1.2	1.32[b] ± 2.4	G, T, GxT
Dairy	2.72 ± 1.6	2.99 ± 1.6	2.95 ± 1.7	2.92 ± 1.7	NSD
Meats	2.08[a] ± 1.7	2.11 ± 1.9	1.12[a,b] ± 1.7	3.16[b] ± 1.9	G, T, GxT
Other	5.9[a] ± 2.8	5.2 ± 3.3	4.3[a,b] ± 2.7	5.0[b] ± 3.0	G, T, GxT

Note: G = Group Main Effect at Post; T = Time Main Effect from Pre to Post; GxT = Interaction. NSD = no significant difference.
Note: Scores = Mean ± SD. Superscript (a) indicates a significant difference in the intervention group pre - post. Superscript (b) indicates a significant difference between the intervention group and the control group at post as determined by Tukey's Post Hoc analyses. *P* values represent overall F test.

Students may have understood generally that they ought to eat less meat, without knowing exactly how many servings were recommended. Either way, similar to the increases in students' nutrition self-efficacy, the fact that a constructivist-oriented curriculum that was geared primarily toward enhancing cognitive knowledge acquisition might also lead to positive and substantial changes in students' nutrition behaviors adds further weight to its usage in future school-based education nutrition interventions. Changes in students' behaviors may have stemmed from the constructivist curricula's focus on connecting the new knowledge with students' lives outside school. In a sense, the knowledge of healthy eating moved from an abstraction to something very concrete as students analyzed their lives, consulted their parents and developed healthy eating plans as part of the curricular unit.

The success of this intervention is likely at least somewhat attributable to the constructivist focus in the teachers' professional development. Teachers often have little if any pre-service training in teaching nutrition, lack updated resources and are given woefully little professional development to update their nutrition education skills.[37, 38] This study provided teachers with the resources they needed and then went one step further by aligning all professional development (workshops, mentoring, resources) with the three principles of constructivism. This suggests that it may be as important to base interventions aimed at teacher learning on sound theory as it is student learning. Future studies of constructivist-oriented nutrition education projects should include analyses of teachers' perspectives on effective professional development programs. Other educational subject areas (e.g., math, reading, science, physical education) have fairly extensive literature on teachers' professional development, teacher change, and program reform, while health education lacks such a well-developed literature base.[39] After all, it is important to determine the student outcomes that result from health-related educational interventions, but of equal importance is understanding how to craft optimal professional development for teachers that maximizes their learning, provides them the resources they need to succeed and sparks excitement to improve their practices.

Readers must nevertheless interpret the results of this study cautiously and take into account several limitations. First, the study relied on students' self-reporting their efficacy and nutrition-related behaviors, which may have involved some degree of inaccurate reporting by students. Second, although the teachers were trained in the curriculum, claimed they did or did not follow the lesson plans (depending on their intervention or control group status), and were observed during their teaching at least once, there is a chance that teachers may not have implemented the curriculum with the fullest fidelity. However, given the strong outcomes of the research, this was unlikely. Third, this research aimed to report the outcomes of constructivist-oriented curriculum and instruction using an intervention group and a control group. A better design that may have added veracity to the claims about the efficacy of the constructivist component of the curriculum might have included comparing a constructivist-oriented intervention group to a social cognitive-oriented intervention group, to a no-intervention control group. That way claims could have been made about the effectiveness of different theory-driven approaches to nutrition education. Fourth, the intervention and control groups were not randomly selected from the same large

pool of potential participants. The intervention schools were selected because they met two criteria, but the grant that funded the study required that any interested school be allowed to join the intervention group. On the upside, the control schools were chosen from a randomized sample and were located in school districts that literally bordered the intervention district. Nevertheless, some differences existed between the intervention and controls schools, most significantly their socio-economic status and racial compositions. Last, the risk of Type 1 error was increased with the number of statistical tests that were used to analyze the data. However, the very low *P* values lend credibility to the significant differences that were found.

TRANSLATION TO HEALTH EDUCATION PRACTICE

Findings from this study have a great deal of relevance for school district health education supervisors and teachers. Foremost, this intervention yielded powerful results regarding improvements in middle school students' nutrition knowledge, self-efficacy and eating behaviors stemming from a constructivist-oriented nutrition education curricular unit. The constructivist-oriented components of the intervention included students actively engaged in the learning process, social learning among peers, and connections of new content with students' prior knowledge and socio-cultural lives outside their schools. These instructional techniques may prove useful to future health educators seeking similar nutrition education results. Findings from this study that might also prove useful for future educators include spending additional instructional time on knowledge, self-efficacy and behavior items that proved resistant to improvements or items where students still scored low at post-test despite statistically significant improvements. For example, both intervention and control group students scored less than 70% at post-test on several nutrition knowledge items, teachers are therefore encouraged to focus more instruction on: which food groups should be eaten most often; how many grains should be eaten each day; which food groups are good sources of Vitamin C, energy, calcium and protein; that good nutrition lowers the risk of cancer; and the meaning of "lite" on food packaging. Similarly, with respect to building nutrition self-efficacy, teachers should be encouraged to spend much more time educating students on the negative health consequences associated with soda/pop consumption and more healthy alternatives that would fit into their lifestyles. Not only did this study find that the intervention students did not increase their self-efficacy to drink less soda/pop compared to their control group counterparts, but they reported almost no additional efficacy in this area after the unit compared to before it. Future teachers would do well to focus on soda/pop consumption in very detailed ways that directly address the consumption of these beverages throughout their students' life circumstances. Last, future educators using this constructivist-oriented curriculum and instructional approach should be aware that dairy consumption may be a cause for concern, as students' consumption of dairy in this study remained unchanged. Teachers might focus both on helping students understand the need for adequate dairy consumption, but also on healthy dairy choices (e.g., skim milk over whole milk). Strategies that teachers might implement to improve all of these troublesome items could include: ensuring that similar education and messaging is occurring throughout the school environment (e.g., vending, cafeterias, PE classes), enlisting the support of other teachers in cross-curricular efforts, implementing more take-home assignments where students work with parents/caregivers on worksheets or plans for lifestyle behavior changes, or integrating additional curricular supports that reinforce and extend learning in these areas beyond the existing curriculum. In the end, this study was about changes in students' nutrition knowledge, self-efficacy and behaviors in response to a constructivist-oriented nutrition education curricular unit. For the most part, students reported strong and positive increases in many areas, which should lead school districts and teachers to feel confident that this curriculum and instructional approach can lead to successful improvements in their students' nutrition, provided, of course, that they address some of the areas where little changes occurred or where even after changes students still scored low.

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