

The Effectiveness of a Dynamic Interdisciplinary Food Safety Curriculum Targeted on Middle School Students in Tennessee

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Abstract

The purpose of this study was to test the effectiveness of an interdisciplinary curriculum focused on food safety. A comparison of data collected from seventh grade students on food safety knowledge who had been through USDA's National Integrated Food Safety Initiative program with those seventh grade students who have had no formal school instruction on this topic was conducted. The food science and technology research team worked with two middle schools in Tennessee to implement the pilot curriculum and collected pre, post and follow-up tests from these two schools. In addition, information was collected from two other county schools that did not participate in the pilot program and used to compare the effectiveness of the curriculum. Students receiving the food safety curriculum gained and retained more knowledge related to food handling skills and behavior knowledge than students not receiving the curriculum. Overall, this research suggests that an interdisciplinary food safety curriculum has made a positive impact on students.

Introduction

For years, people have been reminded by communication outlets (physicians, university scientists, television commercials, and newspapers) to wash their hands before eating or preparing food (Whaley et al., 2005). In addition, parents and teachers have tried to reinforce this hygiene practice in children. However, in the United States it is estimated that there are still 76 million cases of food borne illnesses reported each year. This negligence comes at high price, causing 325,000 hospitalizations and 5,000 deaths, according to the Centers for Disease Control and Prevention (CDC) (Mead, et al., 1999). By developing good hygiene habits at an early age, the costs related to these hospitalizations and deaths, which reach \$19 to \$37 billion dollars per year, could be significantly reduced (Herringshaw and Largo as cited in Guion et al., 2004).

Youth are in the category labeled "high risk," by the Center for Disease Control (CDC) because they are more likely to acquire food borne illness and suffer more serious complications than adults. "Food borne illness affects millions of children each year,

but is almost 100 percent preventable" (Hammerschmidt et al, 1995). However, food safety is not taught in our public schools because of the priority given to state curriculum standards and high stakes accountability testing.

The key to reducing food borne illness is to educate children, especially the young, who are the food preparers of the future (Haapala and Probart, 2004). Patnod and Pivarnik (as cited in Eves et al., 2006) noted the importance of intervening early, before adulthood, as behaviors are more easily changed. Educating individuals of food borne illnesses during the ages of 11-14 may deter poor habits by providing direction as behaviors are learned for the first time, as well as providing an environment where young people can influence and be influenced by peers (as cited in Eves et al., 2006). To address this need, the Food Safety in the Classroom Curriculum was developed through the National Integrated Food Safety Initiative (NIFSI) Grant.

The Food Safety in the Classroom Curriculum was designed to deliver food safety education through hands-on activities with real world applications. These food safety lessons meet the Tennessee's performance standards in science, language arts, math and social studies.

The science lessons were designed so the students could demonstrate and explain the appropriate use and care of a compound light microscope; examine and describe plant and animal cells using a compound light microscope; watch a presentation on the introduction to bacteria; participate in a bacterial growth experiment; prepare and stain wet mount slides with their own germs and make a cell model using a tortilla. In language arts, students were educated on key concepts related to the safety of handling food. They were taught how to clean, cook, chill and separate foods properly; locate and analyze written information on Salmonella poisoning to prepare a press release educating the public on prevention of Salmonella poisoning; demonstrate mastery of writing process by composing, editing and revising multiple drafts of a press release; critique food handling and preparation scenarios for proper food safety skills; and predict possible outcomes of improper food handling.

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In math, students created and interpreted bar graphs using real world data; determined the mean, median, mode and range for data sets recorded in science class; constructed stem-and-leaf plots and scatter plots to analyze and understand data; described the difference between bacterial and human growth; and demonstrated the concept of generation times using examples of real life scenarios to decide if the food is safe to eat. In social studies the students were involved in watching a presentation on food borne illnesses related to risk and prevention; utilized the FDA webpage to investigate which the bacteria caused certain food borne illnesses; used geographic skills to create a map of Salmonella outbreaks; and used maps to locate and research different countries across the world to compare the life expectancy, gross domestic product per capita and infant mortality rate. This information was used to make predictions related to food safety.

The overall purpose of this study was to assess the effectiveness of the Food Safety in the Classroom Curriculum with regard to its ability to increase seventh grade students' knowledge in science, language arts, math and social studies core courses, as well as their knowledge of proper food handling skills and behaviors. To facilitate the purpose, the following objectives were developed:

1. Describe the differences in pre-test and post-test scores on all six dependent variables studied for the treatment group (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

2. Describe the difference in post-test scores for the treatment and comparison groups on all six dependent variables (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

3. Describe the difference in post-test scores and follow-up test scores on all six dependent variables for the treatment group (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

4. Describe the difference in pre-test scores for the treatment group and post-test scores for the comparison group on all six dependent variables (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

Methods

A descriptive research design was employed using ex post facto research (Ary et al, 1996). Pre-post tests were used as well as post-test comparison. The study was conducted in the individual school classrooms, as to not disturb their learning environment. The population consisted of seventh grade students

at Burchfield, Huntsville, Fairview and Oneida Middle Schools. Each student was given equal opportunity to voluntarily participate in the study. The population consisted of 239 students; 145 for the treatment schools and 94 for the comparison schools. The comparison group consisted of every seventh grade student registered at Burchfield and Huntsville Middle Schools. The treatment group consisted of seventh grade students at Fairview and Oneida Middle Schools. Convenience sampling was employed by the researchers so the closest persons or intact groups could be utilized. In addition, non-probability sampling was employed as the intended purpose was not to generalize to the entire United States population, but to use the findings to compare schools of the actual sample group being studied.

The survey instrument was developed by Jennifer Richards, Education Coordinator of the USDA NIFSI Food Safety Project. The survey instrument consisted of 64 questions divided into three sections. The first section focused on science knowledge, language arts knowledge, math knowledge, and social studies knowledge. The second section focused on food handling skills knowledge and the third section consisted of questions to identify respondents' knowledge of food handling behaviors. Survey questions were multiple-choice, true/false and Likert-type questions with a 4-pt. Likert-type scale (Ary et al., 1996). The pre-test, post-test and follow-up all used the same survey instrument.

Subject area experts from the University of Tennessee evaluated the instrument for test construct, readability and grade level appropriateness. The survey instrument was tested for instrument reliability, consistency and instrument validity utilizing 51 seventh grade students from a middle school in a local county nearby (Ary et al., 1996). A total score was generated for each field test and an item analysis was performed on each question. If students scored less than 40% on the end of exam questions, these questions were flagged and reexamined for level of difficulty and misleading answer choices. The internal consistency coefficient for attitudinal scales was calculated and found field test Form A had a Chronbach Alpha of 0.87 and Form B had a Chronbach Alpha of 0.83. Also a test, re-test was administered August 18, 2006 and August 28, 2006 (Ary et al, 1996). The analysis was computed and found Form A: $p=0.127$ and Form B: $p=0.075$. Therefore, no significant difference was found between the pre and post-test survey instruments

Only those who had completed a letter of consent and had it signed by their parents received a survey. The school name was the only identification on the survey and no personal identification was shared. The treatment group consisted of 145 seventh grade students registered at Fairview and Oneida Middle Schools and these students were given a pre-test, post-test and follow-up survey by Jennifer Richards,

Education Coordinator, USDA NIFSI Food Safety Project at the University of Tennessee. Each student was given the first ten to fifteen minutes of class to complete the survey. A total of 109 pre-test surveys, 110 post-test surveys and 102 follow-up surveys were collected for a pre-test response rate of 75%; post-test response rate of 76%; and follow-up response rate of 70%. The post-test questionnaire was administered by the researcher to each seventh grade class from Burchfield and Huntsville school during the first ten to fifteen minutes of class as to not disrupt their teaching period. A total of 54 post-test surveys were collected for a response rate of 58% and the data collected was analyzed by the researcher.

Results and Discussion

Objective 1. Describe the differences in pre-test and post-test scores on all six dependent variables studied for the treatment group (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

The first objective sought to describe the differences in pre-test and post-test scores on all six dependent variables studied for the treatment group (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge). As reported in Table 1, the mean scores for the four knowledge areas (science, language arts, math and social studies) had an increase in scoring from pre-test to post-test. There was a mean increase of 1.94 per knowledge area, which caused an overall mean score increase of 7.77 within these four knowledge areas comparing pre-test (M= 21.90) to post-test scores (M= 29.67). In comparing the food handling skills pre-test and post-test, there was a (1.85) difference in mean scores. In comparing the pre-test and post-test mean scores for food handling behaviors, the mean score increased by 2.93. The overall mean score for the pre-test totaled 60.01 and 72.56 for the post-test. Overall, the treatment group's mean score improved from pre to post-test (12.55).

Objective 2. Describe the difference in post-test scores for the treatment and comparison groups on

Table 1. Comparison of pre-test and post test scores on all six dependent variables studied for the treatment group

Dependent Variables	Pre-test Treatment Group N	Pre-test Treatment Group M	Pre-test Treatment Group S.D.	Post-test Treatment Group N	Post-test Treatment Group M	Post-test Treatment Group S.D.
^a Science Knowledge	109	5.14	1.44	108 ^d	7.63	1.40
^a Language Arts Knowledge	109	4.76	1.61	108 ^d	7.23	2.07
^a Math Knowledge	109	5.86	1.56	108 ^d	7.14	1.80
^a Social Studies Knowledge	109	6.14	2.10	108 ^d	7.67	2.04
Mean Score for Knowledge areas		21.90			29.67	
^b Food handling Skills	28 ^c	10.61	1.50	28 ^c	12.46	1.57
^c Food Handling Behaviors	28 ^c	27.50	4.03	28 ^c	30.43	3.52
Mean Score for Food Handling		38.11			42.89	
Overall Mean Score		60.01			72.56	

Note. ^a Knowledge Areas (Science, language arts, math and social studies) mean scores could have ranged from 0 to 10. ^b Food Handling Skills mean scores could have ranged from 0 to 15. ^c Food Handling Behaviors mean scores could have ranged from 1 to 36. ^d Although there were 110 post-test, 2 were dropped because this was a paired analysis. ^e The Food Handling Skills and Behavior survey questions were only completed by one school, the students forgot to complete the back portion of the survey.

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Table 2. Comparison of post-test scores for the treatment and comparison groups on all six dependent variables

Dependent Variables	Treatment Group	Treatment Group	Treatment Group	Comparison Group	Comparison Group	Comparison Group
	N	M	S.D.	N	M	S.D.
^a Science Knowledge	110	7.65	1.39	54	5.37	1.89
^a Language Arts Knowledge	110	7.22	2.05	54	4.22	1.56
^a Math Knowledge	110	7.15	1.79	54	4.11	1.59
^a Social Studies Knowledge	110	7.65	2.05	54	4.69	1.88
Mean Score Knowledge areas		29.67			18.39	
^b Food handling Skills	110	11.47	2.72	54	9.22	1.93
^c Food Handling Behaviors	100 ^d	28.65	4.71	54	24.94	5.60
Mean Score for Food Handling		40.12	34.16			
Overall Mean Score		69.79	52.55			

Note. ^a Knowledge Areas (Science, language arts, math and social studies) scores could have ranged from 0 to 10. ^b Food Handling Skills scores could have ranged from 0 to 15. ^c Food Handling Behaviors scores could have ranged from 1 to 36. ^d Some students chose not to answer the Food Handling Behavior survey questions.

all six dependent variables (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

Table 2 displays the observed difference between treatment and comparison groups for each knowledge area as it relates to food safety. The overall mean post-test score in the four knowledge areas (science, language arts, math, social studies) of the treatment group was higher (11.28) than the overall mean post-test score of the comparison group. However, there was only a difference of 2.25 in the food handling skills post-test score of the treatment group compared to the comparison group score. In addition, only a 3.71 difference was observed between the mean food handling behavior post-test score of the treatment group and the comparison group. The overall mean score for the post-test of the treatment group totaled 69.80 compared to 52.52 for the comparison group, an increase of 17.28. Overall, the treatment group scored higher than the comparison group on all components tested.

Objective 3. Describe the difference in post-test scores and follow-up test scores on all six dependent variables for the treatment group (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

As reported in Table 3, the mean scores for science, language arts, social studies, food handling skills and food handling behaviors had an increase in scoring from post-test to follow-up surveys. However, the math mean score decreased from 7.09 in the post-test treatment group to 6.89 in the follow-up treatment group. Furthermore, there was an increase in food handling skills and food handling behaviors. Food handling skills post-test mean score totaled 11.45 compared to the follow-up score of 12.18, an increase of 0.73. Food handling behavior mean scores increased from 28.77 on the post-test to 29.19 on the follow-up survey, an increase of 0.42.

Objective 4. Describe the difference in pre-test scores for the treatment group and post-test scores for the comparison group on all six dependent

variables (science knowledge, language arts knowledge, math knowledge, social studies knowledge, food handling skills knowledge and food handling behaviors knowledge).

Table 4 displays mean scores and standard deviation totals for the treatment group pre-test and comparison group post-test. In language arts, math and social studies knowledge areas, the treatment group scored higher. However, the mean science post-test score for the comparison group was higher (0.24) than the pre-test score of the treatment group. With regard to the food handling skills score, there was a difference of 1.30. The mean pre-test score for the treatment group was higher totaling 10.52 and the mean post-test score for the comparison group totaled 9.22. The pre-test mean score for the treatment group (27.41) was higher than the post-test comparison group score (24.94). The overall mean score for the treatment group pre-test totaled 59.76 and the comparison group post-test totaled 52.52.

Overall, the treatment group pre-test scores were higher (7.24) than the post-test scores of the comparison group.

Summary

Positive patterns emerged in the comparison of pre-test and post-test scores of the treatment group. In the four knowledge areas, science, language arts, math and social studies, all mean scores increased from pre to post-test. Science had the greatest increase followed by language arts, social studies and lastly math. The overall mean score for food handling skills also increased slightly as well as the food handling behaviors. The overall mean score increased from 60.01 to 72.56, a small increase for this treatment group. Although the total possible points equal 91, the post-test scores of the treatment group show that this interdisciplinary food safety curriculum increased the seventh grade students' knowledge, skills and behaviors related to food safety.

Table 3. Comparison of post-test scores and follow-up test scores on all six dependent variables for the treatment group

Dependent Variables	Post-test Treatment Group	Post-test Treatment Group	Post-test Treatment Group	Follow-up Treatment Group	Follow-up Treatment Group	Follow-up Treatment Group
	N	M	S.D.	N	M	S.D.
^a Science Knowledge	102 ^d	7.71	1.37	102	8.04	1.54
^a Language Arts Knowledge	102 ^d	7.17	2.05	102	7.19	1.82
^a Math Knowledge	102 ^d	7.09	1.82	102	6.89	1.85
^a Social Studies Knowledge	102 ^d	7.66	2.06	102	7.70	1.97
^b Food handling Skills	102 ^d	11.45	2.75	102	12.18	1.85
^c Food Handling Behaviors	93 ^c	28.77	4.70	93 ^c	29.19	4.53
Overall Mean Score		69.84			71.18	

Note. ^a Knowledge Areas (Science, language arts, math and social studies) scores could have ranged from 0 to 10. ^b Food Handling Skills scores could have ranged from 0 to 15. ^c Food Handling Behaviors scores could have ranged from 1 to 36. ^d Although there were 110 post-test, 8 were dropped because this was a paired analysis. ^e Some students chose not to answer the Food Handling Behavior survey questions.

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Table 4. Comparison of pre-test scores for the treatment group and post-test scores for the comparison group on all six dependent variables

Dependent Variables	Pre-test Treatment Group N	Pre-test Treatment Group M	Pre-test Treatment Group S.D.	Post-test Comparison Group N	Post-test Comparison Group M	Post-test Comparison Group S.D.
^a Science Knowledge	109	5.13	1.43	54	5.37	1.89
^a Language Arts Knowledge	109	4.77	1.60	54	4.22	1.56
^a Math Knowledge	109	5.83	1.59	54	4.11	1.59
^a Social Studies Knowledge	109	6.10	2.13	54	4.65	1.88
^b Food handling Skills	29****	10.52	1.55	54	9.22	1.93
^c Food Handling Behaviors	29****	27.41	3.99	54	24.94	5.60
Overall Mean Score		59.76			52.52	

Note. ^a Knowledge Areas (Science, language arts, math and social studies) scores could have ranged from 0 to 10. ^b Food Handling Skills scores could have ranged from 0 to 15. ^c Food Handling Behaviors scores could have ranged from 1 to 36. ^d The Food Handling Skills and Behavior survey questions were only completed by one school, the students forgot to complete the back portion of the survey.

Therefore, the researcher concluded that educating students about food safety issues in academic programs, in fact, increase students' knowledge, skills and behaviors.

The results also revealed that post-test scores for the treatment group were higher in all testing areas than the post-test scores of the comparison group. In addition, post-test scores were higher for the treatment group as compared to the comparison group for the food handling skills and behaviors. Therefore, the researcher concluded that by teaching the food safety curriculum there can be a positive impact on students. Also, by students knowledge of food safety demonstrates that students may not have a strong background related to food safety practices. Therefore, introducing a food safety curriculum like the one in this study becomes imperative for our youth.

The study revealed some minor increases among the treatment group follow-up test as compared to their post-test. The overall mean score increased slightly by 1.34. In all areas scores increased slightly,

except math, when the score decreased slightly. Data showed the treatment group had retained the knowledge, skills and behaviors six weeks after the treatment was administered. Actually with a slight increase in follow-up test scores, seventh grade students revealed they can maintain the longevity of knowledge related to food safety issues.

Overall, the food safety curriculum proved to be beneficial to seventh grade students. Important to note is that students retained the information six weeks after the curriculum was taught. Therefore, this research could be useful to school systems. Since food borne illnesses are 100 percent preventable (Centers for Disease Control, as cited in Hammerschmidt et al., 1995), teachers could educate youth about proper hygiene and food safety issues in their core academic subjects. To incorporate the curriculum, teachers could use food examples in science, language arts, math and social studies. By doing this, educators could assist in decreasing the 325,000 and 5,000 deaths per year (Mead, et al., 1999). Moreover, this study has opened some avenues

for the education system to become proactive in reducing food borne illnesses while still meeting state academic standards.

Based on the findings of this study, future research would be needed to compare this interdisciplinary food safety curriculum to with another food safety curriculum. In addition, a similar study educating students related to one single subject instead of several subject areas would be useful. The findings would further support whether students learn and retain more information if it is taught across all disciplines or in just one subject area.

Furthermore, studies researching specific characteristics such as, ethnicity, age, gender, and parent education level should be conducted to identify if these characteristics influence the child's knowledge, skills, and behaviors related to food safety issues. Overall, data obtained from this study will be useful in designing food safety curriculum and reaching various populations with these distinct qualities.

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