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ABSTRACT

Food safety education for children is important in developing a good foundation for food safety knowledge and behaviors. The goal of the Food Safety and School Garden Program (FSSGP) was to develop a curriculum that integrated food safety principles into school garden-related activities for elementary school students. Specific objectives of this study were to assess knowledge and evaluate the FSSGP through student activity ratings and student-to-parent/guardian interaction. The two-lesson intervention consisted of a didactic component and interactive activities for four major food safety principles: bacteria and washing hands, produce, and containers. Students' (n=194) knowledge, grades 1-5, was evaluated using a 10-question pre- and post-test. Number of correct responses increased from 5.6 ± 1.8 to 8.1 ± 1.9 ($P < .001$). Knowledge increased within each grade ($P <. 001$) and category ($P <. 05$). Additionally, the majority of students rated all activities as satisfactory or better. Finally, over 80% of students indicated they would tell their parents/guardians about what they learned and the majority of parents/guardians responding to a follow-up questionnaire, indicated that their child communicated with them about FSSGP topics. This study supports the importance of early education on proper food safety principles in school gardens for elementary school students.

INTRODUCTION

Incorporation of school garden programs in elementary and middle schools has successfully increased both nutrition knowledge and consumption of fruits and vegetables in children *(14, 15, 21, 25)*. However, food safety has not typically been a component of school garden curriculums. Children should be targeted for food safety education programs because they have little existing knowledge, fewer improper food safety behaviors to unlearn *(7, 8)*, and a desire to share what they learn with family and friends *(13, 17)*.

An estimated 48 million people, or 1 in 6 Americans, are affected by foodborne illness annually and approximately 128,000 hospitalizations and 3,000 deaths occur each year *(3)*. Children are particularly at high risk to foodborne illnesses due to their underdeveloped immune systems *(9, 26)*. Foodborne illness outbreaks, including those due to produce, have increased for the past four decades *(24, 32, 34)*. Moreover, all reported foodborne illness outbreak data display clear trends of increases in foodborne illnesses due to produce *(4, 11, 24)*.

Multiple factors could possibly be associated with the increase in produce-related foodborne illnesses such as, inadequate food safety knowledge resulting in unsafe food handling practices *(31)* and increases in both home produce-gardens *(23, 29)* and fresh produce consumption *(16, 19)*. A review of observational consumer food safety studies showed that consumers have relatively low levels of food safety knowledge and when observed, exhibit risky food handling behaviors *(31)*. While research has shown that home gardeners have inadequate food safety knowledge *(29, 30)*, 48% of home gardeners reported the reason they garden is to grow safer produce than they can purchase *(2)*. The number of home produce gardens increased more than 20% since 2008 *(23)* and reports of fruit consumption significantly increased in both children and adults from 2003 to 2010 *(16, 19)*. Produce grown anywhere, commercial farms and

home and school gardens, can be the source of pathogenic microorganisms, since similar food handling practices are needed to keep produce safe.

Commercial farmers are involved in multiple food production practices, such as growing, harvesting, processing, and distributing. All steps in production have the potential for microbial contamination. For example, improper personal hygiene practices, unsafe water and manure treatment, and improper sanitation of equipment are potential sources *(10)*. Home gardeners plant, harvest and handle post-harvest produce, and therefore are likely to have the same microbial contamination concerns *(30)*. Currently, 33% of schools are growing an edible garden, which translates into 2401 school gardens across the country *(37)*. With the recent rise in school gardens (Turner and others 2014) and the fact that microbial contamination can occur at the same steps in the gardening process in both home and school gardens, a plan should be put in place to minimize the risk of foodborne illness from school garden produce.

The impact of school garden-related food safety education programs for elementary school students has not been well studied. The overall goal of this study was to create a food safety program using school garden-related activities for first to fifth grade students in Rhode Island. Specific objectives were to: assess students' overall knowledge change of basic school garden food safety principles from pre- to post-intervention, evaluate the program via students' ratings of the activities, and assess reported student-to-parent/guardian interaction.

MATERIALS AND METHODS

Program design

The Food Safety and School Garden Program (FSSGP) was developed based primarily on the principles described in "Food Safety Tips in School Gardens" *(22)*. Additionally, Good

Agricultural Practices regarding produce safety for commercial growers *(10, 35)* were used and adapted for the FSSGP.

The FSSGP consisted of two, 40-60 minute interactive lessons that were divided into four categories: (1) bacteria, (2) hand washing, (3) produce washing, and (4) container washing. The categories, topics and interactive activities are outlined in Table 1. For example, the topics included within the bacteria category were “good” versus “bad” bacteria and keeping pets and animals out of the garden. The interactive activity for bacteria, Pass the Apple, was based on an activity used by the University of Rhode Island’s Supplemental Nutrition Assistance Outreach Education Program that uses stickers to represent the spread of bacteria *(36)*. Due to time constraints, a simulated hand washing activity was created to practice the proper method to wash hands. A large activity board with laminated pictures of fruits and vegetables was created to illustrate that all fruits and vegetables need to be washed. Finally, three review activities were created: What’s Wrong with this Picture, Food Safety Bingo and Food Safety Jeopardy.

Student assessment

A 10-question, multiple-choice assessment was used to test school garden-related food safety knowledge of elementary school students at pre- and post-intervention (Table 2). The question and/or answer formats were modeled from previously tested food safety knowledge assessments *(28, 29)*. The questions were divided into the four categories described above and all categories had three questions with the exception of container washing, which had only one question. All questions had three or four response options, one of which was “I do not know”. In an effort to reduce guessing, students were encouraged to circle “I do not know” if they did not know the answer. Knowledge-based questions were graded as right or wrong. For statistical assessment purposes, “I do not know” was considered and coded as incorrect, as it reflected a

lack of knowledge *(29)*. Students that scored 80% or better were considered proficient in the subject matter *(29)*.

The same 10 knowledge-based questions were randomized on the post-test. The post-test also included two program evaluation questions and one question on intent to disseminate, or tell their parents/guardians, about information learned in the FSSGP. Program evaluation questions asked students to circle the topic they felt was most important and to rate how much they liked each activity. A modified facial rating scale was used for program evaluation response options *(12, 28)*. Students had the option to circle a smiling face, neutral face, or frowning face if they liked the activity, thought it was okay or disliked it, respectively.

The pre- and post-tests were administered to all participating students and each question was read aloud to compensate for all reading and comprehension levels *(28)*. Students were assigned ID numbers corresponding to the pre- and post-tests and teachers kept the student ID rosters between lessons to maintain student anonymity. Only students who completed both pre- and post-tests were included in the statistical analyses. Two educational specialists reviewed the assessments for readability and clarity and revisions were made as suggested.

Parent/Guardian letter and follow-up

At the start of the first lesson, participating teachers sent home a letter to all parents/guardians regarding the FSSGP. At the completion of the program, students were given a follow-up questionnaire as well as a "Garden to Table – Five Steps to Food Safe Fruit and Vegetable Home Gardening Booklet" to take home for their parents *(27)*. A parent/guardian follow-up was used to determine the extent of child to parent/guardian interaction. The three questions on the questionnaire were: (1a) did your child communicate to you about the content of the program; (1b) did you learn anything from your child?; (2) do you have a home fruit or

vegetable garden?; and (3) what grade is your child in?. Parents/guardians were encouraged to complete the questionnaire and return it to their child's teacher within one week. Any responses indicated by parents/guardians that were unrelated to food safety or gardening were not included in the analysis.

Program implementation

The Institutional Review Board at the University of Rhode Island approved the study protocol, assessments, and educational materials.

The elementary school students who participated in the FSSGP were recruited through the existing Farm Fresh Rhode Island (Pawtucket, Rhode Island) Farm to School programs. The two lessons were conducted at least one week apart between September and December 2014. The first lesson began with the pre-test followed by instruction on the first three categories. The second lesson included a review of the first lesson, instruction on the fourth category, and review activities that incorporated all information presented to the students (Table 1). All students participated in the "What's Wrong with this Picture?" activity *(28)* and either Food Safety Bingo (grades 1-3) or Food Safety Jeopardy (grades 4-5). At the end of the second lesson, students completed the post-test. Students were given an educational handout that summarized sources of bacteria from the garden and how to prevent the spread of bacteria, a "Wash Fruits and Vegetables Before Eating" pencil, and small bar of soap that was used in the simulated hand washing activity.

Statistical analysis

The statistical software, SPSS (Version 21.0, 2012, Armonk, NY), was used for all statistical analyses. Means with standard deviations and descriptive statistics (frequencies and percentages) were reported for the knowledge-based pre- and post-tests and program evaluation

responses. Paired *t*-tests were used to determine mean score differences at 95% confidence interval for overall score and within grades. Differences between grades on pre- and post-tests were analyzed using analysis of variance with a Scheffe Post Hoc test. Analysis of covariance was used to determine if post-test knowledge score differences remained significant between grades when controlling for the differences in pre-test scores. Finally, Pearson's chi-square test was used to assess knowledge within each category on pre- and post-tests.

RESULTS

A total of 203 students from four Rhode Island elementary schools participated in the first lesson and completed the pre-test of the FSSGP. Two schools were located in Providence, one in Pawtucket, and one in Newport. Ninety-four-percent (183/194) of students completed the program during regular school hours: 34%, 27%, 9%, 20%, and 10% of the students were in first, second, third, fourth, and fifth grade, respectively (Table 3). The remaining 6% (11/194) were first and second grade students in an after school program.

Knowledge responses

Students had a mean knowledge score of 55.6 ± 18.8% on the pre-test and 80.6±18.6% on the post-test, which was a 25 percentage point increase in knowledge ($P < .001$) (Table 4). Significant knowledge increases also occurred from pre- to post-test within all grades ($P < .001$). Second grade students (n=56) had the highest increase (31.7%) and first graders (n=67) had the least (18.2%). Most students answered between 4 and 6 questions correctly (range: 1-10) on the pre-test; whereas the majority of students answered 9 or 10 questions correctly (range: 2-10) on the post-test (Fig. 1).

First grade pre- and post-test scores were significantly lower than all other grades ($P < .05$); mean post-test score for first grade, 64.1 ± 18.3%, versus 90.7 ± 11.3%, 85.2 ± 11.8%, 88.1

± 12.6%, and 90.6 ± 11.1% for second grade, third grade, fourth grade, and fifth grade students, respectively. Grades two through five did not significantly differ from each other. Analysis of covariance determined that statistical significance was independent of the initial knowledge score variations.

Pre- and post-test knowledge scores for each category are illustrated in Figure 2. Correct baseline knowledge for container washing was the highest and produce washing the lowest, 77.6% and 12.9%, respectively. The container washing category consisted of one question, whereas the other three categories consisted of three questions. Overall, knowledge within each category improved significantly ($P < .05$) following the intervention.

Program evaluation

The majority of the students rated each activity as okay or better on the post-test evaluation (Table 5). More than half of the students indicated that they liked the activities “very much”. Additionally, 84% (n=161) of the students indicated that they would tell their parents/guardians about what they learned in the FSSGP (data not shown).

Parent/Guardian follow-up

A total of 59 (30%) parent/guardian follow-up questionnaires were returned to the teachers. Of the 59 returned, 76% (n=45) of the parents/guardians indicated their child spoke with him/her about the FSSGP. Only two returned questionnaires were not used since topics mentioned were unrelated to those taught in the FSSGP. Fourth and fifth grade students had the highest return rate at 44% (16/36) and 55% (10/18), respectively. First graders had the lowest return rate at 13% (8/63) and second and third graders returned 39% and 36%, respectively.

Written responses were compiled and categorized into five categories: bacteria, hand washing, produce washing, animals, and other (Fig. 3). Any topic mentioned that did not fall into

one of the first four categories but was related to food safety or gardening, was included in the "other" category. The "other" topics were grouped into one category due to the low frequency and high variability of each topic. Examples of topics in the "other" category included any response about general food safety, gardening, planting, and containers. Of the 45 parents/guardians who indicated that their child spoke to them about the program, the majority wrote one or more school garden-related food safety topics.

DISCUSSION

The goal of this study was to create a food safety education program for elementary schools regarding food safety for school gardens. The students' overall knowledge of school garden-related food safety increased, from pre- to post-intervention, across all grades. Implementation of the FSSGP with first through fifth grade students could be used to increase overall garden-related food safety knowledge.

While first grade students' knowledge increased significantly, they scored significantly lower than the other four grades on both the pre- and post-test. The lower scores could be due to lower reading levels *(5)* or the complexity of the program information. Many of the first grade students were unable to read and despite reading both assessments aloud, misunderstanding and/or misinterpretation of questions could have occurred. The FSSGP may be less suitable for first graders as compared to second through fifth. However, there was still a significant impact on knowledge of first graders though it was lower than the other four grades.

Overall, the students became proficient (>80%) *(29)* in the school garden food safety material after the intervention. More specifically, prior to the intervention, more than half of students indicated that it was acceptable to eat directly out of the garden without washing. Following the intervention, 80% of the students answered the question correctly indicating that

eating directly from the garden without washing was unsafe. The consequence of eating directly from the garden without washing is an increased risk for foodborne illness. Since children have a heightened susceptibility to foodborne illness, food safety education prior to engaging in school garden activities would be desirable.

While all categories reflected a significant increase in knowledge, the container category appeared to have the highest pre- and post-knowledge scores. However, the interpretation of this result may be unclear since this category had only one question whereas the other three categories had three questions each. Results may have been different had more questions been asked in this category. The constraints of a 10-question assessment resulted in an unequal distribution of category questions. However, based on previous food safety knowledge assessments for elementary-aged students, a short assessment was regarded as optimal *(6, 28)*.

It has been well established that students enjoy learning and retain information better if practically or experientially applied *(6, 8, 38)*. In previous studies, students who participated in experiential-based food safety programs rated activities highly *(8, 17, 28)*. This study produced similar results: the majority of the students rated all activities as satisfactory (okay) or better while simultaneously and significantly increasing their knowledge. Faccio, E., N. Costa *(8)* found the students in the experiential group of their study learned and retained significantly more complex and detailed food safety information compared to the students in the didactic, theoretical approach group. Similarly, students participating in nutrition education and school garden activities retained more nutrition knowledge post-intervention than those exposed only to nutrition education and those in the control group *(18, 21, 25)*. Therefore, the knowledge increases across all grades could be attributed to the practical application of knowledge through the interactive activities and concluding games.

Food safety education programs for students are primary prevention for foodborne illnesses *(17)* and are often conducted in school settings. Few food safety education programs have been conducted with students in after school programs. The after-school class of students that participated in the FSSGP was used as a pilot test to determine whether or not the currciculum would be suitable in this type of learning environment. Though several students appeared distracted and restless during the instruction, there were no significant knowledge differences between the first and second graders in the after-school program compared with students in the in-school classes (data not shown).

Upon completion of the program, 161 students indicated they would tell their parents/guardians about the FSSGP and what they learned. Thirty percent (59/194) of all parent/guardian follow-up questionnaires were returned. Based on the number and variety of topics written by parents/guardians, the children were able to reiterate and explain a variety of the garden-related food safety topics upon returning home. Parents/guardians described multiple topics, for example, wash your hands for 20 seconds; keep animals out of the garden; and wash your fruits and veggies before eating them. The approach and effect of children's intent to disseminate information to their families has been elucidated by the Theory of Planned Behavior *(1)*. This behavioral theory describes that intention is the strongest predictor of actual behavior. Thus, children who intended to tell their parents/guardians what they learned may be more likely to engage in proper food safety behaviors and teach what they learned to their family. Parent/guardian responses on the follow-up reflected a strong indication that students understood the information and taught their family what they learned. Additionally, students who spoke to their parents/guardians may be retaining more of the information *(17)*.

Parents/guardians are often targeted for food safety education programs, as they are typically the primary food preparer in the home *(20, 33)*. However, findings from this study support existing research that children are able to gain knowledge of correct food safety principals, start to develop proper food safety behaviors, and continue to build the fundamental foundation of food safety knowledge and behaviors *(6, 8)*. The results of this study show that educating children on – food safety principles related to school gardening also allows the family to be a secondary target audience that will receive proper food safety information.

CONCLUSION

The FSSGP was successful at increasing elementary school student's knowledge of school garden-related food safety principles, as evidenced by the significant increase in overall knowledge within each grade. This curriculum was appropriate for multiple grade levels (grades 1-5) Secondly, the FSSGP impacted a secondary target audience, the parents/guardians, via the elementary school students, as evidenced by the 23% response rate from the follow-up questionnaire indicating that the students were transferring the information and new knolwedge that they learned in the classroom. Finally, the interactive activities, rated as satisfactory or better by the majority of students, may have helped to reinforce the information taught in the program. The curriculum was part of a Master's thesis project and can be found at http://digitalcommons.uri.edu/cgi/viewcontent.cgi?article=1599&context=theses.

For future research, the FSSGP could be tested in after-school programs on a larger scale and in summer camps that incorporate gardening activities. Perhaps incorporating additional hands-on garden activities into the program may further the development of proper food safety behaviors. The FSSGP was conducted in a primarily urban population and could be tested in first to fifth grade classes in other rural or suburban schools.

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413 *Table 1. Categories, topics and interactive activities included in the food safety and school*

414 *garden program*

Category	Topics	Activities
Bacteria	Good vs. bad bacteria	Pass the Apple
	3 ways bacteria can spread	
	Keep animals out of garden	
Washing Hands	Proper wash method	Simulated hand washing activity
	When/why to wash	
Washing Produce	Proper wash method	Produce washing activity board
	Bruised produce	
	Do not eat produce from garden	
Washing Containers	Proper wash method	
	When/why to wash	
All Categories: Review	**All Topics: Review**	What's Wrong with this Picture?
		Bingo (grades 1-3) Jeopardy (grades 4-5)

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Table 2. Pre- and post-test knowledge questions for the participants in the food safety and school garden program

Questions	Responses*
1. Jason has been playing in the garden. He comes into the kitchen to eat some blueberries. Jason looks at his hands. There is no dirt on them and they look clean. Does he need to wash his hands?	***a.*** **Yes** *b.* No *c.* I do not know
2. Do you think all bacteria in food will make you sick?	*a.* Yes ***b.*** **No** *c.* I do not know
3. You are harvesting the fruits and vegetables that are in the school garden. After you have picked them, they look great to eat. You want to see how they taste so you take a bite. What do you think?	*a.* This is okay to do ***b.*** **This is not okay to do** *c.* I do not know
4. Joe has found some bird poop on a cucumber in the garden. He knows that he should not eat poop, so he washes the cucumber and eats it. What do you think?	*a.* This is okay to do ***b.*** **This is not okay to do** *c.* I do not know
5. John found a cracked peach within the batch of peaches he picked from the garden. What should he do with the peach?	***a.*** **Throw the whole peach in the trash** *b.* Ask an adult to cut off the bad part *c.* Eat the whole peach anyway *d.* I do not know
6. You can always tell if a fruit or vegetable might make you sick.	*a.* Yes ***b.*** **No** *c.* I do not know

7. Mary's mother asked her to go and pick a few peppers from the garden. Mary washed her hands before she went into the garden even though she might get dirt on them while picking peppers. Did she need to wash her hands before going into the garden?	***a.*** **Yes** *b.* No *c.* I do not know
8. Sarah's pet dog, Barky, followed Sarah into the garden when she was going to pick some spinach for lunch. Is it okay for Barky to play in the garden too?	*a.* Yes ***b.*** **No** *c.* I do not know
9. Susan decided to pick carrots from the garden and she found a container in the garage. What should she do first?	a. Use it if it looks clean b. Shake out the dirt **c. Wash the container** d. I do not know
10. Carrie's hands were very dirty from helping her dad pick tomatoes in the garden. How long should she wash her hands with warm soapy water?	a. 5 seconds b. 10 seconds **c. 20 seconds** d. I do not know

*correct responses are bolded

Table 3. Description of student population participating in the food safety and school garden program

	Grade Level	# of Students	# of Classes
School 1 [a]	1	63	3
	4	36	2
	5	18	1
School 2 [a]	3	17	1
School 3 [a]	2	49	2
School 4 [b]	1	4	1
	2	7	
Total	--	194	10

[a] in-school classes (n=183); [b] after-school classes (n=11)

Table 4. Knowledge scores of students in all grades that participated in the food safety and school garden program

	Pre-test (% correct±SD)	Post-test (% correct±SD)	Absolute change (%)
All Grades (n=194)	55.6 ± 18.8[a]	80.6 ± 18.6[b]	25.0
Grade 1 (n=67)	45.9 ± 17.0[a1]	64.1 ± 18.3[b1]	18.2
Grade 2 (n=56)	59.0 ± 18.6[a2]	90.7 ± 11.3[b2]	31.7
Grade 3 (n=17)	63.5 ± 19.3[a2]	85.2 ± 11.8[b2]	21.7
Grade 4 (n=36)	58.6 ± 15.0[a2]	88.1 ± 12.6[b2]	29.5
Grade 5 (n=18)	67.2 ± 17.7[a2]	90.6 ± 11.1[b2]	23.4

[a,b]indicate significant differences between pre-test and post-test at $P < .001$;

[1,2]indicate significant differences between grades for the pre-test or post-test at $P < .05$

452 *Table 5. Food safety and school garden program evaluation: Student's ratings of each activity*

	Student Responses (# of Students)			
Activity	**Very much** ☺	**OK** 😐	**Not at all** ☹	**No Response**
Pass the apple	121	50	21	2
How to wash produce	124	58	6	6
Hand washing	133	37	18	6
What's Wrong with this Picture?[a]	102	52	29	11
Food Safety Bingo [a]	116	12	8	4
Food Safety Jeopardy [a]	38	12	4	0

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454 [a]Review games: Bingo (grades 1-3), Jeopardy (grades 4-5)

455

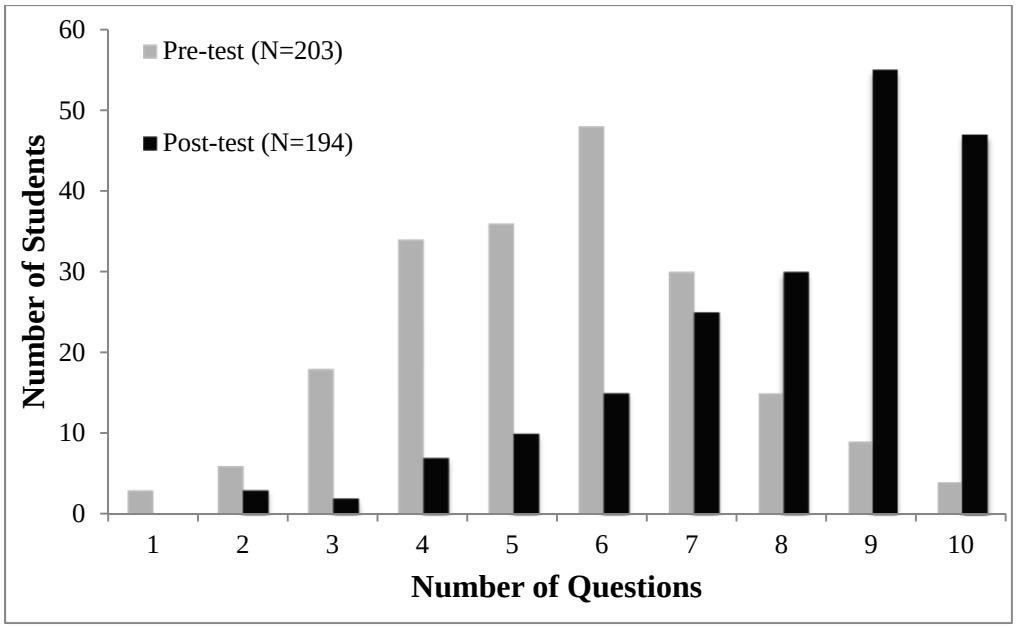


Figure 1 – Distribution of students who answered the knowledge questions correctly on the pre- and post-test

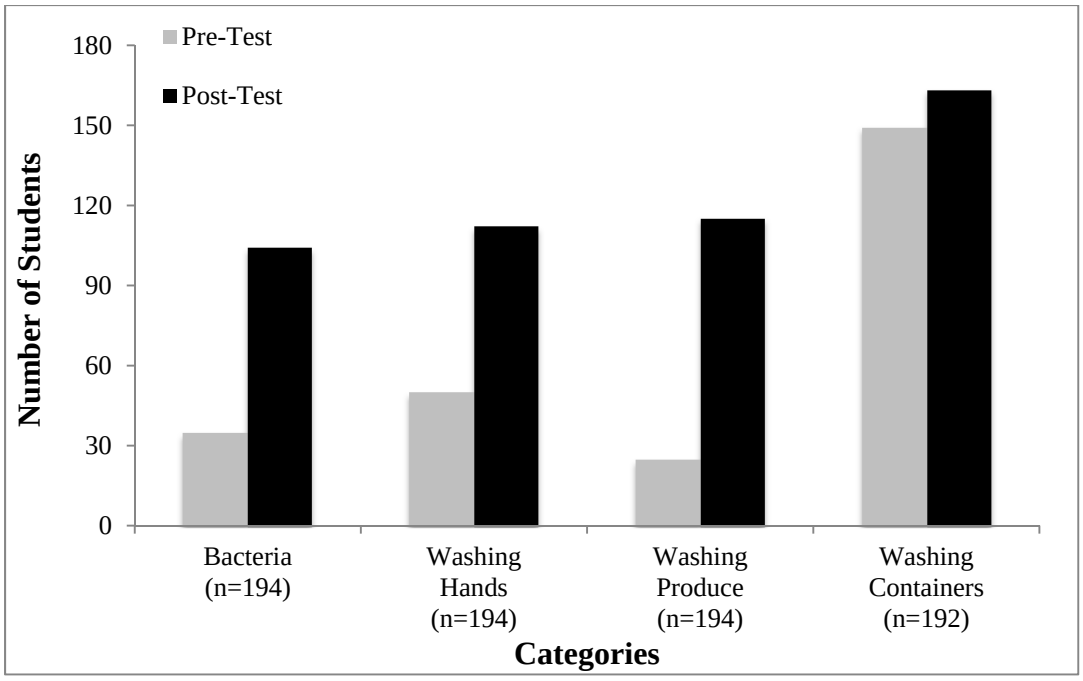
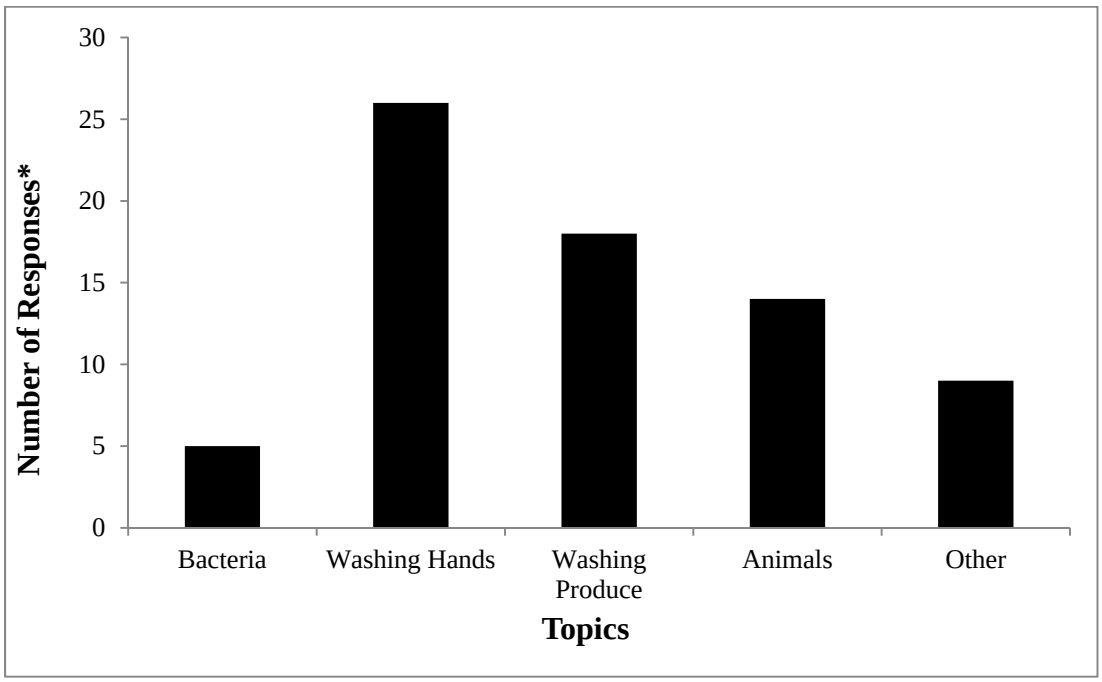


Figure 2 – Number of students who answered the questions correctly in each category on the pre- and post-test



** Majority of responding parents indicated ≥ 1 category/topic.*

Figure 3 – Categories and topics represented on the parent/guardian follow-up questionnaire (n=45)