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Cover Page Footnote

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Using Extension as a Vehicle to Reduce Elementary Student Food Waste

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Abstract. Extension can play a key role in providing food waste education nation-wide. This study is the first to evaluate the effects of environmentally focused lesson plans on elementary student knowledge and perceptions regarding food waste. Herein we provide suggestions on concepts to teach students for the greatest impact on food waste reduction. We also provide avenues to incorporate food waste education into existing Extension programming. We hope the study can inspire and inform further food waste program development, assessment, and implementation through Extension.

INTRODUCTION

Food waste, defined as "edible food that is thrown away or discarded," has been a growing issue of international significance (Buzby & Bentley, 2016). Approximately 30% of all food produced has been wasted globally each year (Food and Agricultural Organization of the United Nations, 2018). Environmental impacts include the use of 25% of all fresh water and 50% of all global land for growing food that has largely been wasted (Hall et al., 2009; Roser & Ritchie, 2018). Once in landfills, the food that people have wasted negatively affects water quality and wildlife and contributes to climate change (Natural Resources Defense Council, 2013; Osterback et al. 2015).

The United States remains one of the top contributors of global food waste, with consumers wasting 90 billion pounds of food annually (Buzby et al., 2014; Parfitt et al., 2010). Stakeholders at the 2015 U.S. Food Recovery Summit set a goal of reducing food waste by 50% in 2030 and identified education as a critical component to addressing the problem. The U.S. Department of Agriculture has taken the lead in consumer and retail food waste education (U.S. Department of Agriculture, 2021,). Extension has been "the community education outreach arm of the National Institute of Food and Agriculture, an agency of the U.S. Department of Agriculture" (McCoy, 2019, "Introduction," para. 2). Thus, it stands to reason that Extension educators should lead food waste education at the consumer level.

Until recently, U.S. schools have been among the least targeted yet most desirable venues for food waste education. School administrators spend approximately $1 billion on wasted food annually, or roughly 26% of the U.S. school food budget (Cohen et al., 2013). Indeed, food waste has made up the largest component of the school waste stream (Minnesota Pollution Control Agency, 2010). Despite this national problem of food waste in schools, very few resources have been made available to teach students about the environmental effects of wasting food, and no studies have been published on the effectiveness of this programming. However, at least two commentary articles have been published recently about Extension's role in the food waste conversation (McCoy, 2019; Snyder et al., 2018).

We intend to add to this conversation by providing the tools for Extension to address the need for environmental food waste programming. Herein, we deliver an Extension program using select lesson plans across second- and fifth-grade classrooms at two distinct elementary schools to assess the impact of Extension education on student knowledge, attitudes, and behaviors regarding food waste.

METHODS

The study described in this article was conducted in two elementary schools. School 1 was suburban, with a 48% rate of free/reduced lunch and a student-teacher ratio of 24:1. School 2 was rural, with a 39% rate of free/reduced lunch and a student-teacher ratio of 19:1. Two second- and two fifth-grade teachers in each school volunteered their classrooms to participate in the study ($n = 8$). We selected one classroom from each grade level (based on schedule availability) to

be the treatment classroom (n = 4), and the other to be the control classroom (n = 4).

The institutional review board approved the study protocol #1703019012A001. Students were given up to 3 weeks to return signed student assent and parent consent forms to participate in the study. There were 113 student participants across all eight classrooms.

EDUCATION INTERVENTION

We taught the treatment classrooms (n = 4) three 1-hr lesson plans over the span of 1 week. Students learned about the environmental effects of food waste, including climate change, in Lesson 1 (Koetz & Williams, 2019a). Students learned about food waste reduction strategies within their control in Lesson 2 (Koetz & Williams, 2019b). Students were given infographics after this lesson to share with their families. Students were encouraged to try new and "ugly" (blemished or oddly shaped, sized, or colored) foods to reduce food waste in Lesson 3 (Hullinger et al., 2018).

We delivered curricula identically across classrooms with some intentional exceptions. Second-graders were not required to perform the multiplication equations for one activity, and they were provided an introduction to climate change (fifth-graders already knew about climate change). All lessons were published through the Purdue Nature of Teaching website (https://ag.purdue.edu/extension/nature/Pages/default.aspx).

SURVEY

We designed an online survey in Qualtrics (Qualtrics; Provo, Utah) to measure the effects of the program. The survey consisted of 26 questions that either used a 7-point Likert scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*) with a 0 (*I don't know*) option or a 5-point Likert scale from 1 (*Never*) to 5 (*Almost Always*) with a 0 (*I don't know*) option for (self-reported) behavior questions.

The 7-point scale allowed students to report their level of agreement with the questions presented to them (Krosnick & Presser, 2010). The 5-point scale measured the frequency with which students demonstrated the behaviors.

I don't know was included because accuracy has been shown to decrease when youths must choose between yes and no answers (Groothuis & Whitehead, 2010; Koriat et al., 2001). Youths might answer *I don't know* to avoid answering what is perceived as an undesirable response (Cronbach, 1950). Groothuis and Whitehead (2010) found that *I don't know* responses were more similar to *no* responses in their study but recommended that researchers use their own judgment on how to interpret the results of *I don't know*. Studies have emphasized not excluding *I don't know* responses from analyses (Francis & Busch, 1975; Groothuis & Whitehead, 2010). During our study, we recommended that participants only answer *I don't know* when they did not understand the question (e.g., if they did not know what composting or climate change was). We predicted that *I don't know* responses would decrease in favor of more positive responses after introducing these topics. Therefore, we determined to analyze *I don't know* responses as 0, more similar to our negative response options, to be factored into the analyses.

Additionally, fifth-grade students were asked three free-response questions to define food waste and list ways to reduce food waste at home and school. Survey items were divided into four clusters: knowledge, attitude, behavior, and behavioral intention. Students reported their knowledge of food waste and its impact on the environment (e.g., *Food waste affects wildlife*). Students reported their attitudes toward reducing food waste (e.g., *Reducing food waste is easy*). Students reported the frequency with which they performed a behavior (e.g., *I finish my fruit*). Students reported the likelihood that they would perform a behavior (e.g., *I plan to reduce my food waste at school*).

All participating students completed surveys in their classroom or in a computer lab before and after the program, regardless of whether their class received the program. All students were given unique numeric identifiers to enter in the online survey to ensure the confidentiality of individual responses. Students were guided through the survey step by step to increase its validity (Cronbach, 1950).

INTERVIEWS

We conducted semiformal interviews to provide insight into variation in student survey responses. Questions were related to student knowledge of and perceived control over food waste. Students were selected to be interviewed pre- (n = 17) and posteducation (n = 18) using maximum variation sampling (Patton, 1990). We chose upper- and lower-scoring students from each classroom to be interviewed based on the total survey score. We calculated the total survey score by assigning a number to each survey response variable (with higher numbers being allocated to more positive or correct responses) and adding these numbers for each student.

Interview data could only be generalized in upper- and lower-score groupings and not to entire classrooms or grades due to maximum variation sampling. If multiple students scored the highest or lowest in one classroom, all of those students were interviewed. It was possible for students to be interviewed pre- and posteducation (n = 3).

SURVEY ANALYSES

We determined the survey question clusters based on an exploratory factor analysis conducted postdata collection and in context of research goals. Cronbach's alphas (α) for internal reliability in question clusters ranged from .657 to .693. We dropped all questions that lowered the Cronbach's

alpha from their cluster and analyzed those questions separately, as individual questions.

We analyzed survey responses using SPSS (version 24.0; Chicago, Illinois). *I don't know* answers were coded as 0. We performed independent sample *t*-tests to assess differences in mean change in survey scores (posteducation minus preeducation) between control and treatment groups (e.g., School 1 second-grade treatment vs. School 1 second-grade control). We conducted Pearson's correlations to determine correlations between changes in individual student survey scores and preprogram survey scores. We conducted these correlations with all students across all groups because the correlations were based on preexisting knowledge and perceptions. We also conducted correlations to determine relationships between changes in knowledge, attitudes, and behaviors in response to the treatment. Therefore, these correlations were conducted only with treatment-group students.

We conducted Mann-Whitney U tests to assess differences in change in percentage of students answering *I don't know* between control and treatment groups. We analyzed free-response questions from fifth-grade surveys by creating a codebook. We then used this codebook to quantify the number of accurate responses per individual preeducation and posteducation and compared mean change in number of accurate responses (posteducation minus preeducation scores) between treatment and control groups using independent-samples *t*-tests.

INTERVIEW ANALYSES

We audio-recorded and transcribed student interviews in Express Scribe and coded them in NVivo11Pro (NVivo qualitative data analysis Software; QSR International Pty Ltd. Version 11, 2017). We took notes during interviews and used them to determine initial coding nodes. We created a codebook to document accurate or positive responses to student interview questions. We performed two coding cycles to increase reliability (Saldana, 2009). We created frequency tables based on positive/accurate responses to compare frequencies between groups, as in Morgan (1993). We compared frequencies between control and treatment groups, between grades, and between preeducation and posteducation scores in upper- and lower-scoring groupings. We also compared upper- and lower-scoring student responses.

RESULTS

SURVEY CHANGE

Changes in survey responses varied by school and by grade. While students in both second- and fifth-grade treatment groups showed an increase in knowledge gain, only students in the School 1 second-grade treatment group had significantly greater positive change in knowledge ($p = .041$) (Table 1). The students in the School 2 fifth-grade treatment group had significantly greater positive change in reported behaviors ($p = .039$) and attitudes ($p < .001$) than did the control group (Table 1). Students in the same group also showed significant increases in reporting that their *family composts* ($p = .024$), that they know that *food waste affects climate change* ($p = .002$), and that they *like trying new foods* ($p = .024$) far more often than did the control group (Table 1). Mann-Whitney U tests yielded no significant differences in change in percentage of students answering *I don't know* between control and treatment groups.

Table 2 reports that an increase in all individual students adopting behaviors to reduce food waste at school was significantly correlated with preexisting student attitudes ($r(111) = .374$; $p < .001$), including the attitude that reducing food waste is easy ($r(111) = .432$; $p < .001$), that they should reduce their food waste ($r(111) = .208$; $p = .029$), and that they care about the environment ($r(111) = .255$; $p = .007$). An increase in students knowing that school trash is made up mostly of food waste was significantly correlated with an increase in students reporting that they talk with their families about food waste ($r(111) = .258$; $p = .006$). An increase in students knowing that food waste affects climate change was significantly correlated with an increase in students reporting that their family composts ($r(111) = .249$; $p = .008$). These results are for all students, regardless of treatment.

Separately, Table 3 reports that an increase in knowledge was significantly correlated with an increase in treatment-group students saying that they talk with their families about food waste ($r(47) = .331$; $p = .023$) and an increase in behavioral intention ($r(47) = .333$; $p = .022$). Change in *I know food waste affects climate change* was significantly positively correlated with change in attitude ($r(47) = .392$; $p = .006$). Change in *I like trying new foods* was significantly positively correlated with change in behavior ($r(47) = .561$; $p < .001$). Change in *I throw away leftovers when I bring lunch from home* was significantly negatively correlated with change in behavioral intention ($r(47) = -.315$; $p = .031$).

FIFTH-GRADE FREE-RESPONSE QUESTIONS

Incorrect responses to the question *What is food waste?* were present in all groups preeducation and posteducation, but particularly in lower-scoring groups. Although not significant, students in treatment groups had a greater increase in the number of responses to *What are some ways to reduce food waste at home?* and *at school?* than control groups did across both schools and grades. Students in treatment groups, especially in School 2, were more likely to reference ways to reduce food waste from the curricula, such as communicating with cafeteria staff or the person who packs their lunch about what they like to eat and how large a portion that they would like.

Table 1. Differences in Mean Survey Changes between Control and Treatment Groups

Group	Survey question	2-tailed *p*-value	Direction of significance
School 1 second-grade treatment vs. control	Knowledge	.041 [a]	T (indicates treatment group shows more positive change)
	Attitude	.030 [a]	C (indicates control group shows more positive change)
	Behavior	.323	C
	Behavior intention	.683	C
	Change in *I get extra snacks and treats before finishing my lunch*	.194	T
	Change in *I throw away my leftovers when I bring a lunch from home*	.206	T
	Change in *school trash is made up mostly of food waste*	.442	C
	Change in *I know food waste affects climate change*	.976	C
	Change in *I care about the environment*	.360	T
	Change in *I like trying new foods*	.864	T
	Change in *my family talks about food waste*	.334	C
	Change in *I help pack my own lunch*	.833	T
	Change in *my family composts*	.550	C
Group	**Survey question**	**2-tailed *p*-value**	**Direction of significance**
School 1 fifth-grade treatment vs. control	Knowledge	.601	T
	Attitude	.562	C
	Behavior	.861	T
	Behavior intention	.489	C
	Change in *I get extra snacks and treats before finishing my lunch*	.151	C
	Change in *I throw away my leftovers when I bring a lunch from home*	1.000	0 (indicates no change)
	Change in *school trash is made up mostly of food waste*	.721	C
	Change in *I know food waste affects climate change*	.127	C
	Change in *I care about the environment*	.892	C
	Change in *I like trying new foods*	.068	C
	Change in *my family talks about food waste*	.451	T
	Change in *I help pack my own lunch*	.434	T
	Change in *my family composts*	.735	C
Group	**Survey question**	**2-tailed *p*-value**	**Direction of significance**
School 2 second-grade treatment vs. control	Knowledge	.123	T
	Attitude	.072	T
	Behavior	.832	T
	Behavior intention	.350	T
	Change in *I get extra snacks and treats before finishing my lunch*	.179	T
	Change in *I throw away my leftovers when I bring a lunch from home*	.372	C
	Change in *school trash is made up mostly of food waste*	.779	C
	Change in *I know food waste affects climate change*	.981	C
	Change in *I care about the environment*	.577	C

Table 1. (*continued*)

Group	Survey question	2-tailed *p*-value	Direction of significance
School 2 second-grade treatment vs. control	Change in *I like trying new foods*	.237	T
	Change in *my family talks about food waste*	.903	T
	Change in *I help pack my own lunch*	.474	C
	Change in *my family composts*	.707	C
Group	**Survey question**	**2-tailed *p*-value**	**Direction of significance**
School 2 fifth-grade treatment vs. control	Knowledge	.248	T
	Attitude	.001 [a]	T
	Behavior	.039 [a]	T
	Behavior intention	.068	T
	Change in *I get extra snacks and treats before finishing my lunch*	.375	T
	Change in *I throw away my leftovers when I bring a lunch from home*	.333	T
	Change in *school trash is made up mostly of food waste*	.326	T
	Change in *I know food waste affects climate change*	.002 [a]	T
	Change in *I care about the environment*	.605	C
	Change in *I like trying new foods*	.024 [a]	T
	Change in *my family talks about food waste*	.984	T
	Change in *I help pack my own lunch*	.255	C
	Change in *my family composts*	.024 [a]	T

[a] Significant *p*-value at 95% confidence level.

Table 2. Correlations between Survey Results, Regardless of Treatment of Control Group

Survey questions and question clusters	Change in behavior question cluster (*n* = 111)	Change in *school trash is made up mostly of food waste* (*n* = 111)	Change in *I know food waste affects climate change* (*n* = 111)
Preexisting *I care about the environment* (*n* = 111)	*r* = .255 *p* = .007		
Preexisting *I should reduce my food waste* (*n* = 111)	*r* = .208 *p* = .029		
Preexisting attitude question cluster (*n* = 111)	*r* = .374 *p* < .001		
Preexisting *reducing food waste is easy* (*n* = 111)	*r* = .432 *p* < .001		
Change in *my family talks about food waste* (*n* = 111)		*r* = .258 *p* =.006	
Change in *my family composts* (*n* = 111)			*r* = .249 *p* =.008

Note. Correlations between survey variables are depicted in the intersection between a column and a row.

Table 3. Correlations between Survey Results for Treatment Group Only

Survey questions and question clusters	Change in *my family talks about food waste*	Change in behavioral intention question cluster	Change in attitude question cluster	Change in behavior question cluster
Change in knowledge question cluster (n = 47)	r = .331 p = .023	r = .333 p = .022		
Change in *I know food waste affects climate change* (n = 47)			r = .392 p = .006	
Change in *I like trying new foods* (n = 47)				r = .561 p < .001
Change *in I throw away leftovers when I bring lunch from home* (n = 47)		r = –.315 p = .031		

Note. Correlations between survey variables are depicted in the intersection between a column and a row.

STUDENT INTERVIEWS

Student interview responses provided insight into variation in student survey responses. In general, students in upper-scoring fifth-grade treatment groups experienced increases in knowledge from preeducation to posteducation, whereas students in lower-scoring groups did not. Particularly, more upper-scoring students understood the concept of food waste posteducation. This corroborated the fifth-grade free-response survey results, in which lower-scoring students tended to define food waste incorrectly. Additionally, upper- and lower-scoring fifth-grade students experienced a greater increase in knowing the connections between food waste and the environment in response to treatment than did second-grade students. Perceived control was greater in fifth-graders than in second-graders in all groups, preeducation and posteducation. All treatment-group students were more likely to mention communication as a solution to food waste and knew more solutions to food waste at home and school than did control groups posteducation. The latter corroborated the fifth-grade free responses, which showed that treatment-group students knew more solutions to food waste posteducation. Major interview themes are presented in Table 4.

DISCUSSION

The study provides a foundational step for food waste Extension programming by creating curricula to combat the lack of knowledge of the environmental effects of food waste (Qi & Roe, 2016) and measuring the impact of that education. To our knowledge, this study is the first to quantify the effects of environmentally focused curricula on elementary-student knowledge and perceptions of food waste.

Knowledge change could be the first step toward behavioral change (Miller et al., 1990). Survey results reported that all treatment groups experienced greater increases in knowledge than did control groups, although they were significant only for School 1 second-grade students.

Students' adoption of food waste reducing behaviors was significantly correlated with preexisting attitudes toward reducing food waste, including the attitude that reducing food waste is easy, that they should reduce their food waste, and that they care about the environment. This pattern reflects the model of proenvironmental behavior (Kollmuss & Agyeman, 2002) in which preexisting attitudes are highly influential in emotional connection, knowledge gain, and behavior adoption. We believe that this correlation suggests that creating an emotional connection between students and their environment is necessary to facilitate effective knowledge gain and food waste reduction.

We found that students in all treatment groups were more likely to mention communication as a solution to food waste. This is consistent with a study by Williams (2011) that reported that students were more likely to teach others about recycling after participating in a program. Ballantyne et al. (1998) reported that students frequently communicate environmental information to adults. This could mean that teaching students about food waste is an effective means to transfer knowledge beyond the classroom. To this end, it may be beneficial to facilitate peer teaching and to provide resources, such as infographics, to take home to families.

Perceived control is integral to behavioral intention and behavioral change (Fishbein & Ajzen, 2010; Hungerford

Table 3. Major Themes used for Coding Student Interviews and Fifth-Grade Free-Response Survey Questions

Question	Statements coded as correct or *positive*
Knowledge about what food waste is when asked *What is food waste to you?*	Included "food you throw away/put in the trash," "food you waste," "food you don't finish," "food that's not eaten," "food you don't eat"
Knowledge about where food waste goes when asked *Where do you think food waste goes when it is thrown away?*	Included "dump," "landfill," "junkyard," "garbage place," "place with lots of trash," "where other trash is"
Knowledge about the connection between food waste and the environment when asked *Do you think food waste is an important issue?* and prompted with *Do you think food waste affects the environment?*	Mentioned the effects of food waste on "wildlife," "animals," "plants," "water," "climate change," "nature," "land," "trees," "ground/soil," "leachate," "pollution"; pertaining to overuse of natural resources
Attitude that food waste is important when asked *Do you think food waste is an important issue?*	Included "yes," "probably," "I think so"
Perception that kids can control food waste when asked *Do you think food waste is something kids can control?*	Included "yes," "probably," "I think so"
Knowledge of ways kids can reduce food waste when asked *If you were to talk to another kid about food waste, what would you say?* and prompted with *How would you teach other kids not to waste food?*	Included "eat fast," "eat it," "get foods they like," "get less food," "pack a lunch," "share," "talk to others (about food waste)," "try new foods," "donate (food)," "don't talk (during lunch)," "give untouched food back (share table)," "save for later," "take less," "take what they like," "talk with lunch ladies," "talk with people packing lunches," "talk with teachers," "take small portion," "don't rush (to get to recess)," "compost," "eat smaller breakfast," "slow down (in the lunch line)," "pack food you like"

& Volk, 1990). The perception of control over food waste in our study was a possible source of variation between grades. Interview results showed that upper- and lower-scoring fifth-grade students had greater perceived control over food waste than did second-grade students. Because students experienced little change in perceived control from preeducation to posteducation, it is likely that in some cases, it was a preexisting condition. Having a foundation of perceived control may increase the likelihood of students adopting food waste reduction behaviors. Therefore, we recommend empowering students with the skills needed to reduce waste as an important part of food waste education.

Herein, we show that Extension curricula can increase food waste knowledge in youths. Extension can use additional programming beyond the Nature of Teaching to address the need for food waste education nationwide. Potential avenues for food waste education through Extension include the National Farm to School program (U.S. Department of Agriculture Office of Communication, 2014), the Expanded Food and Nutrition Education Program, and Supplemental Nutrition Assistance Program Education. Educators can also partner with food councils to educate consumers and retailers about donating to food rescue groups and work with Extension Master Gardeners to teach about composting (McCoy, 2019). McCoy (2019) provided further information on the problem of food waste and ways that Extension could be involved with food waste education. Snyder et al. (2018) provided information on the intersection between food waste reducing behaviors and food safety, which leads to additional ideas for programming.

CONCLUSION

Extension can use existing programming to deliver food waste education nationwide. The use of environmentally focused curricula can increase student knowledge about the environmental effects of food waste and solutions to food waste. Students with preexisting attitudes in favor of reducing food waste and those with greater perceived control over food waste respond more strongly to food waste programming. Successful food waste Extension programming should facilitate an emotional connection between youths and the environment and empower students with the skill sets that they need to reduce food waste. Programming should facilitate peer teaching and provide resources for youths to take home to share with their families.

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