Food waste knowledge, attitudes, and behavioral intentions among university students

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Abstract

After policy change, educational programming has been cited as one of the most powerful tools for improving food systems and decreasing food waste. University students represent a population in which emerging habits, skills, and identity may be targeted easily and changed through on-campus educational programming. To understand how to best implement programming on impacts of food, food waste, and related issues, the factors that underlie students' behaviors related to food waste must be understood. We analyzed factors that influence food waste–related behaviors within a university student population to understand the potential for improving targeted, school-based food waste diversion programming. Four hundred and ninety-five students were surveyed to: (1) identify self-reported knowledge, attitudes, and behaviors

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related to food waste; (2) explore underlying factors driving food waste–related behaviors through exploratory factor analysis (EFA); and (3) understand the interactions between factors within a regression framework. Participants reported that they most often left food on their plate because it did not taste good or they had overestimated portion size. A majority of participants already performed many food waste reduction behaviors, and were both interested in taking action and aware that their efforts could make a difference. Food management skills, compost attitudes, sustainability attitudes, and reported household food waste were correlated, in various ways, with both intent to reduce and reported food waste reduction behaviors. Opportunities for improving university-related food waste programming through this data are explored.

Keywords
Food Waste, Sustainability, Behavior Change, Environmental Education, Behavioral Factors, Exploratory Factor Analysis

Introduction
Human need (biophysical) and want (preferences and habits) for food are arguably the primary way in which we shape our world. Food is also central to culture and community. The global food cycle—defined as the system encompassing all activities, interconnections, drivers, and outcomes related to the production, distribution, consumption, and waste of food worldwide (Neff, 2015)—drives environmental, social, and political change across time, culture, and geographic region. Agriculture and other land uses related to food production have one and a half times the greenhouse gas (GHG) footprint of the global transportation sector (Bajželj, Allwood, & Cullen, 2013; Olhoff, 2018). Additionally, agriculture is a leading cause of biodiversity loss and pollution (Feldstein, 2017) and contributes significantly to racial, gender, labor, and other social inequities (Patel, 2012; Penniman, 2018).

Not only does the food cycle have significant global impact, but it also remains highly inefficient. Up to 40% of the total edible food in the U.S. and 30% worldwide is wasted (Food and Agriculture

Organization of the United Nations [FAO], 2013). Loss of edible food occurs at each stage within the food cycle from production to consumption, but eaters (consumers of food) are responsible for the bulk (60%) of food waste along the food cycle in countries with more affluent economies (Lipinski et al., 2013). Factors that influence food waste–related behaviors are diverse and context-specific (Thomas & Sharp, 2013). Therefore, mobilizing change will rely on policy intervention, skill building, community mobilization, and grassroots education, among other things (Graham-Rowe, Jessop, & Sparks, 2014; ReFED, 2016).

As participation in higher education increases, marriage and childbearing are delayed, and technology transforms the way we interact, college age is emerging as a separate and essential period of life in which significant changes occur and defining lifestyle skills and habits emerge. Research indicates that college-aged adults tend to have an increased risk of becoming obese, decreased physical activity, increased leisure-time computer use, and decreased overall quality of diet and vegetable consumption (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). Additionally, marketers of sugary beverages and snacks heavily target adolescent and college-aged (and even younger) populations as important customers and to develop brand loyalty (Nestle, Bittman, & Baer, 2015). Young adulthood is also an important time for developing identity, self-efficacy, and life skills (Nelson et al., 2008). Therefore, this period is an essential and optimal time for behavioral interventions related to food intake and health. Furthermore, the university setting provides a microcosm that is excellent for developing and implementing specified and targeted behavioral interventions. Research shows that students targeted by food- and health-related programming on-campus, particularly with the support of mentors, demonstrate an increased intent to change health-related behavior after programming (McComb, Jones, Smith, Collins, & Pope, 2016). Therefore, more research on food-related interventions targeted to early adults and on college campuses may have the potential to affect both individual behavior and develop a more skilled community in relation to health and sustainable food.

Furthermore, community education, generally,

has been found to be a primary tool for addressing food waste. Rethink Food Waste through Economics and Data (ReFED) gathered available data and expert input, and performed an assessment of cost effectiveness and potential impacts of 27 solutions that could be used to address food waste in the U.S. (ReFED, 2016). Community education was ranked as the second most economically feasible solution to food waste (second only to standardizing food labeling) (ReFED, 2016). Educational programming was also reported as the solution with the second largest potential for GHG reductions, after centralized composting (ReFED, 2016). While the ReFED report was meant to inform policy, it did not assess policy change as a specific potential solution. Policy change, however, remains one of the most effective methods for addressing food waste, as is demonstrated in examples such as grocer donation requirement laws in Europe, implementation of fee-by–food weight systems in Asia, and implementation of composting infrastructure in many cities worldwide (Chrisafis, 2016; Chrobog, 2015; Evans, 2011). Additionally, educational programs in the U.K. and elsewhere have shown considerable success in addressing food waste behaviors, as well (Quested, Ingle, & Parry, 2013). For example, the *Love Food Hate Waste* campaign funded through the Waste and Resources Action Programme (WRAP) in the U.K. is unique in that both significant funding and research efforts are combined to engage eaters in food-waste diversion skills. A 1.1 million ton (13%) reduction in annual household food waste in the U.K. between 2007 and 2010 is partially attributed to this programming (Quested, Marsh, Stunell, & Parry, 2013).

So, why do eaters waste food? Food waste behaviors are influenced by many, often competing, factors (Benítez, Lozano-Olvera, Morelos, & Vega, 2008; Evans, 2012; Graham-Rowe et al., 2014). Cost and convenience, including accessible infrastructure like city composting, are strong determinants of food waste diversion behaviors (Pelletier, Dion, Tuson, & Green-Demers, 1999; Refsgaard & Magnussen, 2009). The role of cost and convenience, in general, to behavior determination is well established in many behavioral and motivational theories, including expectancy-value theory and the

energization theory of motivation (Eccles & Wigfield, 2002; Fiske, Gilbert, & Lindzey, 2010). Even minor environmental cues and conveniences such as smaller plate size, absence of cafeteria trays, displaying healthier options before less healthful ones, and precutting fruits instead of serving them whole, can encourage food waste diversion and healthier eating habits (Freedman & Brochado, 2010; Lehner, Mont, & Heiskanen, 2015; Moseley & Stoker, 2013).

Knowledge and skills specific to food management are also essential to food waste diversion (Graham-Rowe et al., 2014; Whitehair, Shanklin, & Brannon, 2013). Food management skills have been the focus of various food waste diversion campaigns and interventions (Oliver, 2010; Pollan, 2008; Quested et al., 2013). Presumably, having specific food-related knowledge and food management skills decreases the actual and perceived costs of food preparation and waste management. In fact, consumer perception of their ability to affect systems is also important in determining action (Eccles & Wigfield, 2002).

Both general sustainability beliefs and beliefs specific to food waste have been shown to influence plate waste (Whitehair et al., 2013). Emotions such as guilt are also important to food waste diversion (Graham-Rowe et al., 2014; Leigh Gibson, 2006). Nevertheless, even after acknowledging many factors important for food waste–related behavior change, ingrained consumption habits are difficult to change (Graham-Rowe et al., 2014).

Food use labeling is also a major driver of food waste, causing up to 20% of household waste (Leib, Ferro, et al., 2013; Neff, Spiker, & Truant, 2015; WRAP UK, 2017). The vagueness of food use labels and the lack of regulated standards lead to a considerable amount of consumer confusion about how date labels translate to food safety, thus resulting in significant food waste globally (Leib, Ferro, et al., 2013; WRAP UK, 2017).

Understanding the impacts of these factors on food-waste behaviors and determining how to influence them through targeted interventions are necessary to promote food waste diversion efforts. In this study, we analyzed factors that influence food waste–related behaviors within university stu-

dent populations to understand the potential for improving targeted, school-based food-waste diversion programming. Food waste diversion is defined here as all manners of diverting *edible* food from the landfill, including more efficient procurement and management of food.

We developed a simplified diagram (Figure 1) of the main factors on which we built our survey instrument. Although these are the factors on which our analysis relied, as discussed previously, food waste–related behaviors are complex. We also acknowledge that positive self-reports related to behavioral and affective factors do not directly lead to action. Therefore, we included both "action" and "intention to act" as separate outcomes in our analysis. They are represented in our simplified diagram as two factors loosely, but not directly, associated with one another (Figure 1).

We analyzed 495 surveys on food waste administered to university students using a three-step approach. First, we assessed average reported food waste attitudes, knowledge, intent, and behaviors compared to those reported nationally (Objective 1). Second, we determined the underlying factors that influence reported food waste diversion behaviors through an exploratory factor analysis (EFA) (Objective 2). Third, we considered relationships between emergent factors within a regression framework (Objective 3).

Method

Setting and Participants

Our study took place during the 2015 academic year at Portland State University (PSU), located in downtown Portland, Oregon, U.S. With an enrollment of 28,000 students, PSU is the largest university in Oregon. Demographically, 56.6% identify as White, 8.4% as Asian, 12.5% as Latino, 7.0% as international, 3.3% as African American, 1.1% as Native American, 6.0% as multi-ethnic, 0.06% as Native Hawaiian/Pacific Islander, and 4.6% as other (PSU University Communications, 2016). Full-time students represent 61%, and part-time represent 39%. A majority of students commute (approximately 80%), while 10% reside in university housing on campus (Housing and Residence Life, 2019; University Communications, 2017).

Two cafeterias serve students, along with various options throughout the urban area. Most of our surveying was conducted in the residence-hall cafeteria as part of a campuswide effort spearheaded by the Campus Sustainability Office (CSO) to begin to understand food waste behaviors. A full-scale composting program in residence halls was rolled out in 2013 (Siegrist, 2015), a couple years before our survey. Therefore, all residents have access to composting options in their dormitories. Furthermore, there are some compost re-

Figure 1. A Simplified Conceptual Figure of Various Underlying Factors that Influence Food Waste Diversion Behaviors
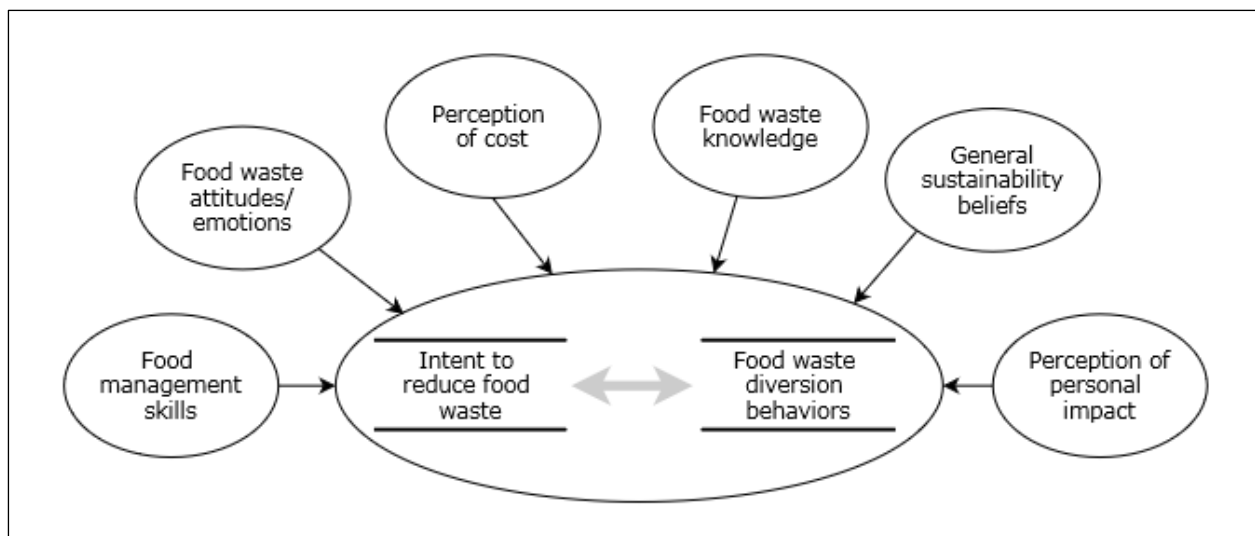
ceptacles throughout campus, although not in all mid-point receptacles (the divided containers that have subsections for landfill-bound trash, recyclable glass, and sometimes other materials). The residence hall cafeteria programming emphasizes local, sustainable food options year-round; for example, it composts all food scraps, highlights local sourcing, and encourages students to participate in Meatless Mondays. The cafeteria hosts an average of 175 people at breakfast, 400 people at lunch, and 500 to 600 people at dinner each day (C. Wapelhorst, personal communication, 2015).

Although the residence hall cafeteria avoids food waste specifically by composting all food waste that comes in through the tray returns (the only waste receptacle in the cafeteria), on the campus overall an average of 25% of landfill-bound waste is food scraps (and food scraps make up 36% of the landfill-bound compostable material in general) (Doherty, Brannon, & Crum, 2013). This includes more than 500 tons per year of valuable food scraps that could be diverted (Hair, 2013). As an institution, the university is working toward a 25% reduction in waste generation and 10% reduction in its landfill-bound waste by 2030 as part of its Climate Action Plan (CSO, 2010).

A total of 495 surveys were collected through convenience sampling in the school cafeteria, three freshman classes, and online throughout campus. At the cafeteria, students were approached while in line to pay for food or while eating, and returned their completed questionnaires after their meal. Students in some freshman courses were given questionnaires during a Campus Sustainability Office class presentation. The online survey was set up in Qualtrics (Qualtrics, Provo, Utah) and distributed by email to students in various departments throughout the university.

Data Collection
The survey instrument was designed to measure food-waste related attitudes, knowledge, intent, reported behaviors, and general sustainability beliefs (Graham-Rowe et al., 2014; Lipinski et al., 2013; Neff et al., 2015; Refsgaard & Magnussen, 2009). Questions (Table 1) were modeled from previous literature on food waste, but developed further based on knowledge of the specific population, as described below. Cognitive interviews were conducted and survey experts were consulted to establish the content validity of the instrument.

Respondents were asked 24 questions with Likert scales and three questions with written answers (Table 1). All Likert-type questions were given a five-point response scale that ranged from "Strongly agree" to "Strongly disagree," with "Neutral" as the middle anchor point. A 5-point scale allows for sufficient variation within the scale without risking participant reluctance to choose extreme answers on a wider scale (Boslaugh, 2013). Questions written in anti–food waste diversion form (for example, "I do not like composting") were reverse coded for analysis. Basic university-related demographic questions were also included.

Food waste knowledge and knowledge of on-campus resources were measured through questions that have been used in other food-waste studies (Leib, Ferro, et al., 2013; Quested et al., 2013) and questions on specific PSU campus-related food waste diversion knowledge (Pelletier et al., 1999; Whitehair et al., 2013). For example, questions included "I understand food freshness labels" and "I know about the campus composting program." Respondents' knowledge was also probed by asking them to estimate the percent of food waste at various consumer levels: an average American household, the campus community, and the U.S. as a whole. Additionally, respondents were asked to pinpoint waste in the food cycle from production to consumption. Food waste estimate responses were compared to percent averages for "North American and Oceania" reported by Lipinski et al. (2013) to determine how accurately students perceived consumer waste generation compared to preconsumer waste generation. Household and national estimates were compared to those reported in Gunders (2012) and Parfitt, Barthel, and Macnaughton (2010) to determine if students generally over- or underestimated their personal food waste compared to other average Americans. Previous research has indicated that Americans underestimate their own household food waste by up to 47% (McDermott, Elliott, Moreno, Broderson, & Mulder, 2019).

Intent and interest in food waste reduction were measured with questions such as "I put effort

into reducing food waste" and "I am interested in taking action to prevent food waste" (Eilam & Trop, 2012; Hebrok & Boks, 2017; Neff et al., 2015). Food management skills have been cited as important in food waste generation (Graham-Rowe et al., 2014; Neff et al., 2015; Vidgen & Gallegos, 2014) and were measured using a series of questions: "I eat leftovers," "I check the refrigerator before shopping," and "I compost my food scraps." Students were also asked to estimate their own household waste and the percentage of food that is wasted from that which they purchase overall.

Attitudes towards food waste were measured with both cognitive and affective statements. Cognitive statements included items such as "Food waste does not bother me" and "My individual actions towards food waste do not make a difference" that are similar to questions posed in other studies (Brook Lyndhurst, 2007; McKenzie-Mohr et al., 1995; Neff et al., 2015). The affective component was measured with the additional items: "I dislike composting," "When I compost I feel like I'm contributing to the greater good," and "Composting stinks and is gross." "I don't think the food I throw away costs much money" measured the perceived cost of food waste. These items were generated by the authors.

Broader sustainability beliefs were probed indirectly with the following questions: "I believe that many materials can be reused or recycled into something new," "I believe proper waste disposal makes a positive environmental impact," "I would like to see more programs that help reduce food waste," and "I would enroll in a course with a sustainability theme." Participants were also directly asked about the amount of food they wasted, as a percentage of total food, and the reasons for that food waste with the question, "I generally leave food on my plate because?" with multiple potential answers. Basic, university-related demographic questions were also asked, including age, gender, academic level, and whether students lived on-campus.

General Frequency Analysis (Not Applicable to EFA)
General frequency analysis of the data allowed for initial insight into behavioral and dispositional re-

sponses and a comparison to previously published data, where appropriate (Objective 1). Specifically, for summary statistics (but not for the EFA), when participants "agreed"" with a statement, the results presented are a sum of "agree" and "strongly agree" responses. Similarly, if participants "disagreed," the "disagree" and "strongly disagree" responses were combined.

Factor Analysis
We conducted an exploratory factor analysis (EFA) to explore the underlying factor structure of the 24 Likert items (Objective 2) and generate response variables for the regression analysis. As opposed to a hypothesis-driven endeavor, an exploratory method explores which factors were present but maintains methodological flexibility to better understand and utilize potential unexpected correlations among items (Bartholomew, Steele, Galbraith, & Moustaki, 2008).

Following the data screening, the EFA was conducted using a multistep process and clear set of decision rules (Williams, Onsman, & Brown, 2010). First, a principal axis extraction method was used because it is robust against non-normally distributed variables (Fabrigar, Wegener, MacCallum, & Strahan, 1999). The analysis was performed on a polychoric correlation matrix, which is a modified version of Pearson's correlation that is more appropriate for ordinal data, using oblique rotation to allow for some correlation between factors (Browne, 2001; Lorenzo-Seva & Ferrando, 2015). Second, we examined the item-loadings and cross-loadings and retained only those with eigenvalues greater than one (Costello & Osborne, 2005). Finally, we retained factors if: (a) they contained at least three items with loadings greater than 0.32, and (b) no cross-loadings of 0.32 or above (Yong & Pearce, 2013). Multi-item indexes were generated for each factor by averaging the responses to questions within each factor. All indexes were evaluated for internal correlation using Cronbach's alpha (Boslaugh, 2013). Pairwise deletion, which leaves all available cases without removing all data from a given respondent (Schafer & Graham, 2002), was used for all steps in the analysis. This deletion method allows for the analysis of all available data,

avoiding the additional data loss that occurs when list-wise deletion is utilized.

Regression Analysis

The relationship of the measured factors and reported individual food waste to both "intent" and "food waste diversion behaviors" (Figure 1) were explored using linear regression (Objective 3). The factor indexes for these two concepts were used as the dependent variable in separate models. This was done to get a more complete understanding of the impact of factors on one another within the model (Figure 1). Models were reduced to include significant factor indexes.

Although there are obvious limitations to using indexes based on self-reported behavior, it is appropriate due to the dispositional and behavioral data being collected and is common to this type of research (Barr, 2007). Predictor variables were tested for multicollinearity within the regression model using a variance inflation factor (VIF); no multicollinearity was detected below three. Data analysis was done in SPS) for Windows, version 24.0 (IBM, Armonk, NY) and R version 3.2.4 (R Core Team, Vienna, Austria).

Results and Discussion

Sample Characteristics and Demographics

A total of 495 surveys were collected, 332 from the residence hall cafeteria, 99 in freshman inquiry (required freshmen core) classes during class visits from the Campus Sustainability Office, and 64 online. The average age of respondents was 21, with a range of 18 to 58 years. Of participants, 54% were female and 42% male. A majority (n=490, 94% of respondents) were undergraduate students, and three (<1%) were postbachelor students. A majority (n=377, 76%) lived in residence halls on campus. On average, participants ate at the residence hall cafeteria eight times a week and at the general school cafeteria once a week. On average, the house or dorm room of participants had two members.

General Frequency Analysis

Participants reported wasting an average of 18% of the food they bought, but perceived that average

Americans were more wasteful (35% on average) (Figure 2). They estimated that 50% of food produced nationally was wasted (Figure 2). Thirty percent (n=150) of students reported that national food waste was in the 30-40% range.

This range is significant, because other studies show that an average of 30–40% of food produced in the U.S. is wasted (Figure 2; Buzby, Wells, & Aulakh, 2014; Gunders, 2012). In regard to household waste, research shows that Americans do indeed waste between 15% and 30% of the food they buy (Parfitt et al., 2010; Thyberg & Tonjes, 2015). Additionally, most Americans underestimate their own contribution to food waste compared to others (Quested et al., 2013). Although participants in our study reported an average household waste within this range, they also perceived themselves as less wasteful than others.

In addition to estimating their personal household waste, students estimated the amount of food waste along the food cycle that consumers were directly responsible for, that is, waste occurring after purchase of food. Students reported an average of 35% food waste by consumers along the food cycle, and 65% percent waste occurring upstream of the consumer (Figure 2).

The participants' perception of consumer waste is a significant underestimate; research shows that about 60% of food waste, in countries with higher income, occurs in the consumption phase (Figure 2; Lipinski et al., 2013). The participants' underestimate is consistent with previous research in which participants tend to downplay the contribution of consumers to food waste and exaggerate the percentage of waste that occurs upstream of the consumer (Neff et al., 2015; Thomas & Sharp, 2013). On the other hand, students perceived the U.S. as more wasteful of food than it is, estimating 50% food waste, whereas research indicates a true value between 30% and 40% (Gunders, 2012).

When asked for the single most common reason they left food on their plate, 55% of participants said because it "doesn't taste good," 31% because they "overestimated the portion size," 9% because they "don't have time to eat it," 6% because they are "being aware of their caloric intake," and 3% did not know or declined to answer. Four percent of respondents chose "Other" and dictated

Figure 2. Average Perception of How Much Food Is Wasted Along the Food Cycle in the U.S. and at Various Consumer Levels

Black diamonds (♦) represent the estimated "true" values of food waste for each level as reported in the literature (Doherty et al., 2013; Gunders, 2012a; Lipinski et al., 2013; Parfitt et al., 2010). Percent average household can be compared to the food waste of an average American, to its right, but no true value is given as the true value differs for each individual. Standard deviation of responses are represented with error bars.
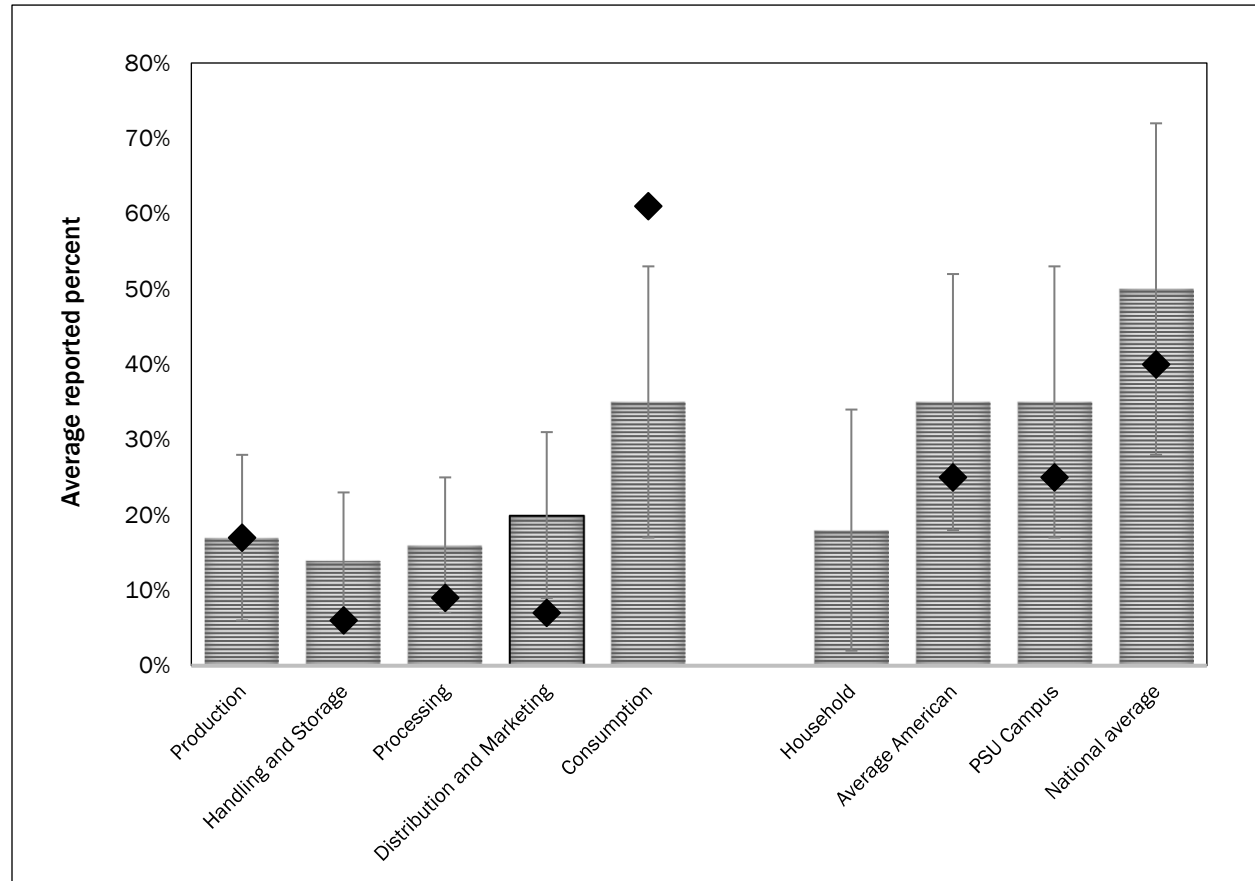
their top reason for wasting food; these included (each less than 1% of total respondents) that they were sick or felt sick, did not or usually did not leave food waste, were not hungry, realized that dietary restrictions were not met, various responses related to portion size, and various responses related to the quality of the food. One respondent noted an eating disorder and another said "I don't care."

In comparison, European food studies of meals eaten outside the home cited portion size or ordering too much as the main reason for plate waste. Being full, dislike of the taste, smell, or preparation of the food, and social influence were also cited as reasons for plate waste (Betz, Buchli,

Göbel, & Müller, 2015). Plate waste was also perceived by the respondents in these studies as not the customer's responsibility or out of their control (Oliveira, Pinto de Moura, & Cunha, 2016).

In regards to food waste diversion thoughts and behaviors in our study, 71% of participants agreed that they thought about the food waste they generated; 70% put effort into reducing food waste; 65% were interested in taking action; and only 23% talked to others about food waste. Thirty-six percent composted their own food scraps. Eighty-two percent ate leftovers; 77% checked the refrigerator before shopping; and 62% made shopping lists. It should be noted that only 38% prepared or cooked some of their own meals.

With respect to attitudes, only 5% reported that "food waste doesn't bother them"; 4% "dislike compost and composting"; 7% of participants agreed that if the compost, they "don't need to worry about source reduction (buying/preparing less food to avoid waste)"; and 4% agreed that food waste does not bother them because it breaks down in the landfill. Forty-four percent of participants felt like composting "contributed to the greater good." Only 10% agreed that "composting stinks and is gross" and only 11% agreed that their "actions towards food waste do not make much of a difference."

This data was relatively consistent with previously published research, in which only 9% of participants said that food waste did not bother them at all, approximately 75% of respondents used leftovers in future meals (sometimes or often), approximately 90% checked their refrigerator and cupboards before shopping (sometimes or always), and approximately 85% made shopping lists (sometimes or always) (Neff et al., 2015).

In terms of general sustainability beliefs, 84% agreed that "materials can be reused or recycled into something new," 89% agreed that "proper waste disposal makes a positive environmental impact," and 64% agreed that they "would like to see more programs on campus that help reduce food waste." Comparable research at another university campus also indicated high levels of agreement with sustainability-related items, even before waste reduction programming (Whitehair et al., 2013).

Factor Analysis and Regression Models
The EFA resulted in five factors based on our selection criteria. The items factored into categories (Table 1) similar to those that we attempted to measure (Figure 1), including clear factors for "Intent to decrease food waste" and "Food waste diversion behaviors." Factors represented about 55% of the variance in survey responses. The questions in each factor were averaged to produce factor indexes for the regression model. The factor indexes for intent and food waste–related behaviors were used as dependent variables to determine how the other factors and reported household food waste interacted with these constructs.

The food waste diversion behavior model

(n=495) indicated that three variables were most significantly ($p<0.01$) related to the food waste–related behavior index factor variable (after model reduction): intent to decrease food waste ($p<0.01$), composting ($p<0.001$), and waste attitudes ($p<0.001$) (Table 2, column 1). The model was highly significant as assessed by an analysis of variance (ANOVA) ($p<0.001$, R^2=0.242). Interestingly, the composting index was negatively correlated with food waste diversion intent, but attitudes toward composting were still positively correlated. This may indicate that those who divert food waste have to worry less about composting. It is also consistent with research showing that those who compost report worrying less about source reduction (Brook Lyndhurst, 2007; Neff et al., 2015; Refsgaard & Magnussen, 2009). Due to the complexity of factors that influence human psychology and behavior, models explaining 20% to 30% of variance are considered beneficial and useful (Bartholomew et al., 2008).

The model for intent to decrease food waste (n=495) showed significant relationship to all six input variables: sustainability intent and communication ($p<0.001$), food waste diversion actions ($p<0.001$), attitudes about composting ($p<0.001$), composting ($p<0.001$), reported household food waste ($p<0.001$), and waste attitudes ($p<0.01$) (Table 2; column 2). The model was highly significant as assessed by an ANOVA (p<0.001, R^2=0.368). Interestingly, respondents' reported personal household waste amounts were positively correlated with their intent to decrease waste; that is, the more food a student perceived they wasted, the higher their intent to decrease food waste. Fifty percent of respondents indicated that they only wasted 0% to 10% of their food.

It should be noted that asking students to report their household food waste percentages can be very challenging and represents a complex construct. A number of studies have shown that people consistently underestimate their own food waste. In fact, in multiple studies, between 45% and 70% of respondents indicate that they waste "very little," "hardly any," "no food," or "0-10% of food" (Neff et al., 2015; Quested et al., 2013; Thyberg & Tonjes, 2015). On the other hand, research suggests that participants reporting higher food

Table 1. Summary of Likert Items and Factor Indexes

Item (nested within factor)	Item loading	Cronbach's alpha	% Agree	% Neutral	% Disagree
Food waste diversion behaviors		0.648			
I eat leftovers	0.476		82.4	10.7	5.7
I check the refrigerator before shopping	0.77		77	13.3	8.7
I don't make lists or plan meals before shopping	0.655		18.2	19.6	61.2
I think about the portions of food that I take or cook	0.44		75.6	17.2	6.1
I prepare/cook some of my meals	0.21*		69.1	17.1	12.3
Intent to decrease food waste		0.752			
I think about the food waste I generate	0.944		70.7	20.2	8.3
I put effort into reducing food waste	0.711		70.1	21.2	7.9
I am interested in taking action to prevent food waste	0.545		64.8	28.1	6.7
Composting		0.813			
I know about the residence hall compost program	0.747		36.8	20.7	39.5
When I compost, I feel like I'm contributing to the greater good	0.881		81.8	13	1.9
Composting stinks and is gross	0.881		18.6	31.6	46.5
Sustainability intent and communication		0.621			
I would be interested in attending a workshop on portioning or cooking for one person	0.709		33.5	36	29.3
I talk to other people about food waste	0.322		23.2	31.1	41.8
I would enroll in a course with a sustainability theme	0.523		44.6	30.7	21.6
Waste attitudes		0.709			
I understand food freshness labels (sell by, best by, use by, expiration date, etc.)	0.542		71.1	18	7.3
I believe that many materials can be reused or recycling into something new	0.731		84	10.7	2.2
I believe that proper waste disposal makes a positive environmental impact	0.736		88.5	6.7	1.8
Attitudes about compost		0.638			
I compost my food scraps	0.324		35.8	22	39.4
If I compost, I don't need to worry about source reduction (buying/preparing less food to avoid waste)	0.592		6.5	29.1	62
I dislike compost and composting	0.666		4.2	24.4	68.7
Food breaks down in the landfill, so it doesn't bother me	0.946		3.8	21.6	71.5

* Item was removed from its original factor without significantly affecting its Cronbach's alpha and improving both the logical and correlational strength of factor "Food waste diversion actions."

waste percentages may actually be more informed and motivated to change their behaviors. Guilt has been shown to influence attitudes and intents toward food waste (Graham-Rowe et al., 2014). Our results are consistent: most respondents reported low amounts of food waste, but those reporting

higher amounts of food waste also reported a higher intent to make change.

Implications and Limitations
Results of this research are promising. Students surveyed are thinking about food waste, interested

Table 2. Linear Regression Models Indicating Relationships Between Measured Factors and Both "Intent To Decrease Food Waste" and "Reported Food Diversion Behaviors"

Factor index/item	Food waste diversion behaviors model	Intent to decrease food waste model
y-intercept	0.889	0.288
Food waste diversion actions index	*Dependent*	0.224***
Intent to decrease food waste index	0.296***	*Dependent*
Composting index	0.324***	- 0.174***
Sustainability intent and communication index		0.312***
Waste attitudes index	0.115**	0.104**
Attitudes about compost index		0.184***
Your household waste (%)		0.159***
(*n*=495)	*R²= 0.242*	*R² = 0.368*

in taking action, and aware that they can make a difference. Respondents also demonstrate similar attitudes and perceived food waste–related behaviors as adults nationally (Neff et al., 2015). Food management skills, compost attitudes, sustainability attitudes, and reported household food waste are correlated with intent to reduce and with actual food-waste reduction behaviors. Therefore, these constructs are potential target areas for university food-waste diversion programming.

Although students have some knowledge around food waste and its drivers, many still underestimate their own food waste and that of consumers generally, indicating a potential knowledge gap that can be addressed by programming. Although knowledge does not always lead to action, the college period represents a time of significant change, identity progression, and habit development (Nelson et al., 2008). The fact that only 23% of students reported talking to others about food waste suggests an opportunity for opening up dialogue within university community spaces about improving local and global food systems.

Results also indicate a moderate level of composting (about 1 in 3 students) by participants. This suggests that the convenient availability of compost infrastructure (as is available in PSU residence halls) increases participation in composting programs. Implemented in 2011, Portland also has citywide composting for single-unit and some multi-unit dwellings. More composting participation should be encouraged through continued programming and infrastructure development.

This study also provides insights into factors that play a role in food waste diversion behavior of university students. The EFA and regression modeling show that our survey instrument was well suited for predicting the food waste diversion in this population. It would be beneficial to consider more items on barriers to food waste reduction and social influence, as both are central to the university setting. A confirmatory factor analysis on a survey instrument based on these results could strengthen the survey instrument for assessing intervention success. This model could be further applied to and assessed in other settings, such as event settings, households, and communities, in which programming could be implemented. Additionally, the use of random sampling over convenience sampling could improve future studies.

The strength of survey data is in understanding perceptions rather than actual behavior. Further research should compare self-perception from surveys to actual food waste behaviors measured through waste audits and observation, such as detailed daily journaling. Although linked food waste data is challenging to collect, some successful models exist, such as tagging or barcoding students' cafeteria trays individually during waste audits to identify their food waste in relation to survey responses

(Whitehair et al., 2013). Furthermore, although the university setting provides opportunity for food-related behavior change (McComb et al., 2016; Nelson et al., 2008), common lingering questions include whether and how such change can be integrated into a student's long-term lifestyle. Since socialization, infrastructure for change, and campus culture play directly into student food-related behavior, positive attitudes may only lead to positive behaviors in such settings where those behaviors are most accessible and encouraged. Further research establishing the likelihood of positive food waste–related behavioral outcomes and how to ingrain those behaviors into long-term practice is necessary.

This study offers insight into the similarities of college-aged adults' food waste perceptions compared to data collected nationally (Neff et al., 2015). Our relatively large sample size and sampling at a university with a relatively diverse student body allow for some generalizations of results to other universities and colleges. On the other hand, the high proportion of residence hall students and freshman respondents in our sample should be acknowledged. Although limited by the restrictions of the residence halls, students in our study still cooked meals sometimes (69%), engaged in meal prep and planning before shopping (77%–81%), and portioned when cooking (76%). Also, our city and university are actively focused on environmental sustainability and climate change. Therefore, some of the positive attitudes may be related to that context.

Individual behavior cannot be separated from its context. Today's food system contributes greatly to making waste a convenient, and even necessary, behavior. Therefore, we must also address the core issues that contribute to food waste at the community and policy levels. Our communities face many food-related challenges, including policies that encourage overproduction of commodity crops, food dumping in poor communities of that excess, junk food culture (also due in part to excess food), food apartheids (as opposed to the term food deserts; Penniman, 2018), confusing food freshness labels, standards that deem nutritious but oddly shaped food unsuitable for sale, inefficient or no composting infrastructure, and externalized costs that build cheap food on a foundation of worker injustice, just to name a few. Although educational programming can support and facilitate some change, deep work must be done at the policy and community levels to promote a more just, nutritious, and efficient food system overall.

Conclusion

As food waste per household continues to increase worldwide (Thyberg & Tonjes, 2015), food waste programming in educational settings is becoming an important tool to help address this trend (Al-Domi et al., 2011; Buzby & Guthrie, 2002; Merrow, Penzien, & Dubats, 2012; Sarjahani, Serrano, & Johnson, 2009; University of California, Davis Dining Services, 2015; Whitehair et al., 2013; Wilkie, Graunke, & Cornejo, 2015). Improving food-waste related programming at universities provides a unique opportunity for change. Universities provide the structure (students eat many meals on campus) and community (campus culture can be influenced and influence students) for implementing food-related programming, and students are at a prime life stage for change. Research on food waste–related behavior within these settings specifically will ensure that programming is based on a context-specific understanding of the factors that underlie food waste–related behaviors. Addressing specific food waste behavioral factors in programming is important to improving and continuing this work and to developing university and community cultures that are aware and mindful of reducing food waste.

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