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Developing, Piloting, and Factor Analysis of a Brief Survey Tool for Evaluating Food and Composting Behaviors: the Short Composting Survey

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DEVELOPING, PILOTING, AND FACTOR ANALYSIS OF A BRIEF SURVEY TOOL FOR EVALUATING FOOD AND COMPOSTING BEHAVIORS: THE SHORT COMPOSTING SURVEY

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ABSTRACT

DEVELOPING, PILOTING, AND FACTOR ANALYSIS OF A BRIEF SURVEY TOOL FOR EVALUATING FOOD AND COMPOSTING BEHAVIORS: THE SHORT COMPOSTING SURVEY

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Composting on a university campus may take a variety of forms. Sustainable approaches to waste management can be taught and supported through educational programs, peer-to-peer behavior modeling, and composting program interventions. Although peer-reviewed research on composting interventions is somewhat lacking, student interest in the topic is demonstrated by a range of exploratory senior projects and pilot interventions conducted at colleges across the United States and abroad.

The purpose of this study was twofold: conduct an educational compost intervention pilot study and develop a survey tool to measure participant attitudes surrounding food behaviors and composting. The Compost Project pilot study focused on determining the influence of a short composting intervention on fruit and vegetable consumption among university students. The Short Composting Survey was developed for use during the pilot study to measure the knowledge, values, barriers, and social norms surrounding composting.

Through development of the pre-intervention survey tool, analysis of the results from the pilot intervention and survey, and post-hoc factor analysis, the researchers found that student interest in home composting is considerable. Confirmatory factor analysis on the survey tool resulted in a three-factor solution with a cumulative loading of 71.2%, meaning that these identified factors contributed 71.2% of the variance in responses. These three factors were labeled “Values,” “Social Norms,” and “Barriers.”

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Sustainable behaviors such as composting can be taught and supported through a variety of methods. The university setting provides an excellent environment for teaching young adults hands-on techniques such as home composting, vermicomposting, aerobic pile rotation, and trench composting. Waste sorting skills can be taught through proper signage and peer-to-peer education in campus dormitory common areas and cafeteria dining rooms. Typical compost education initiators may be waste management contractors or facilities employees, but it is most compelling when undergraduate and graduate students explore student interest through surveys and pilot projects.

Published, peer reviewed journal articles on composting interventions are difficult to locate. Much of the published literature on composting takes the form of scientific articles on the biological processes involved in organic materials degradation along with lengthy explanations of waste management techniques. There are, however, many unpublished student research projects exploring the initiation of composting in campus cafeterias (Audi et al., 2014) and dormitories (Brown et al., 2010; University of Richmond, 2010; Hollerbach & Chan, 2016). Home composting interventions are reflected in both published (Sharp et al., 2009) and unpublished (City of Red Deer, 2014) literature.

In order to start a dialogue about campus composting at a university which does not have a structured program in place, it is important to review literature by approachable experts on home composting (Markham, 2013) and professionals who build and distribute industrial equipment which is appropriate for high volume, rapid degradation of organic materials (FOR Solutions, 2018). One of the wonderful aspects to the practice of composting is that it is a teachable system which can be adapted to any environment. The best approach to learning how to compost is to have an experienced composter teach the system to a group of students, who can then learn by doing.

CHAPTER II

LITERATURE REVIEW

Sustainability Initiatives

The United Nations Sustainable Development Goals provide guidance to member nations on a variety of initiatives aimed at eliminating poverty and inequality and combatting climate change (United Nations, 2018). Goal 12 is focused on "Responsible Consumption and Production," and it includes measures related to waste reduction and sustainability (United Nations, 2018). The two targets which directly pertain to composting are the following:

- "By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse."
- "Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle" (United Nations, 2018).

With regard to the first target listed above, composting provides an opportunity to recycle organic materials into rich soil, which can then be used to grow additional plants. Organic waste can be diverted from the landfill to composting solutions which range from simple aerobic piles to complex in-vessel container processing units. The second target can be applied to a university setting in which "sustainable practices" such as composting can be implemented, measured, and reported by students, campus faculty, and administrative staff. This paper will describe the implementation of composting programs in several university settings along with the development of a brief composting survey tool utilized during an educational pilot study conducted at Central Washington University (CWU) in Ellensburg, Washington.

Composting 101

Composting is a recycling method whereby biodegradable materials can be broken down into usable soil. In a 2013 book on composting, Brett Markham provides a comprehensive but reader-friendly overview of composting, along with instructions for establishing aerobic and anaerobic systems for breaking down organic materials (Markham, 2013). This farmer and author explains that the speed of decomposition will vary, but assures readers that “organic materials will all eventually turn into compost with or without your help” (Markham, 2013). Composting kitchen scraps and leaves contributes to a more fertile garden, thus higher crop yields, and decreases the risk and frequency of plant diseases (Markham, 2013). It also reduces the use of “fertilizers, insecticides, and fungicides” on garden crops, increases the availability of trace elements for plants and the people consuming the plants, and diverts kitchen waste away from landfill (Markham, 2013).

Achieving the correct mix of “greens” and “browns” in a composting system is an important consideration for the home composter (Markham, 2013). If an organic material has a carbon (C) to nitrogen (N) ratio smaller than 30:1, then it is called a “green;” if the ratio is larger than 30:1, it is called a “brown” (Markham, 2013). “Greens” include aged chicken manure, food, vegetable, and fruit scraps, coffee grounds, and seaweed (Markham, 2013). “Browns” include leaves, hay, sawdust, shredded newspaper, corn stalks, and peat moss (Markham 2013). Food scraps have a C:N ratio of 17:1, which means that there are seventeen parts carbon to one part nitrogen. Plants require both carbon and nitrogen to grow strong and healthy, and the gardener can adjust the C:N ratio to contribute to an aerobic or anaerobic environment (Markham, 2013). The ideal ratio for an aerobic compost pile is 25-30:1, while an anaerobic pile requires a slightly lower ratio of 25:1 (Markham, 2013). When starting a compost pile from scratch, “greens” and “browns” should be added in a 2:1 ratio by weight (Markham, 2013). If contributing to an existing compost pile, the “greens” and “browns” can be added to the pile in equal portions by weight (Markham, 2013).

Table 1: Greens and Browns (Markham, 2013)

Greens (Nitrogen)	**C:N Ratio**	**Browns (Carbon)**	**C:N Ratio**
Aged chicken manure	7:1	Leaves	60-80:1
Food scraps	17:1	Hay	90:1
Vegetable scraps	25:1	Sawdust	500:1
Coffee grounds	25:1	Wood chips, twigs	700:1
Grass clippings (fresh)	17:1	Shredded newspaper	175:1
Fruit scraps	25-40:1	Nut shells	35:1
Rotted manure	20:1	Pine needles	80:1
Soil	10:1	Corn stalks	60:1
Seaweed	19:1	Peat moss	58:1
Garden clippings	30:1		

Composting on the University Campus

Environmental sustainability on a university campus should be rigorously investigated and supported by students, faculty, and the administration. At CWU, campus sustainability has recently been examined by stakeholder groups during two “Sustainability Cafes” (Central Washington University, 2018). Both events encouraged collaboration among participants through the development of an extensive list of past successes along with current and future sustainability goals for the campus community. Participants listed composting under the waste management category as one of the future opportunities CWU should embrace (Central Washington University, 2018).

Composting is conducted on a small scale at the CWU Campus Community Garden through the contributions of local gardeners, nearby residents who see the bringing of scraps to the garden as a responsible way to dispose of waste. Meanwhile, campus garden refuse also goes into the garden's composting systems. The compost "donors" and garden volunteers manage both anaerobic trench or "pit" composting and aerobic piles. Garden-based trimmings and green waste are added to the piles, whereas kitchen food waste is reserved for the trench in order to prevent rodent activity or odors from causing problems or lessening campus support for this aspect of the garden's success. Examples of organic materials which can be composted include fruit and vegetable scraps, egg shells, coffee grounds, and empty toilet paper rolls.

With sufficient support and funding from campus facilities along with appropriate infrastructure, campus composting can be scaled up to include the collection of green waste from cafeterias and residence halls. Cape Cod Community College (CCCC) (Wong, 2008), the University of Massachusetts Amherst (UMA) (Hollerbach & Chan 2016), Ohio University (Waliczek et al., 2016), and Texas State University (TSU) (Waliczek et al., 2016) have developed campus composting programs to recycle green waste into usable soil.

Cape Cod Community College

Sustainability efforts at CCCC include the development of a sustainability committee and a robust cafeteria waste composting program (Wong, 2008). Residence hall composting at UMA began in 2015 with a pilot study conducted at the North Apartment D, in which an educational program and signage informed North D residents of compostable materials which could be diverted from landfill (Hollerbach & Chan 2016). Student residents had access to sizeable (3.4 gallon) compost bins inside their apartments and a 32-gallon bin in the building's waste collection room (Hollerbach & Chan 2016). The pilot was conducted during the Fall quarter, and researchers collected 965 pounds of compost (33 pounds per week average) (Hollerbach & Chan 2016). In addition, the post-pilot survey found that 92% of participants (44 students) discarded their compost in the waste room at least once per week (Hollerbach & Chan 2016). Due to the success of the pilot study, the residential compost program was expanded to three more residence halls on campus during the Spring quarter of 2016 (Hollerbach & Chan 2016).

Ohio University

Ohio University at Athens has a large in-vessel composting system for processing food scraps (Waliczek et al., 2016). In-vessel composting consists of an enclosed structure such as a silo or rotating drum which processes the organic materials in a controlled environment (Zero Waste Scotland, 2018). Due to the strict regulation of the temperature and aeration inside the vessel, organic materials should break down within a matter of weeks, after which they age for several months before use (Zero Waste Scotland, 2018). Another in-vessel program is found at TSU San Marcos. Started in 2008, the system is so successful that the school sells bagged compost under the Bobcat Blend label (Waliczek et al., 2016). Food scraps are collected from five dining halls on campus, collecting 80 tons of food waste in 2012 alone (Waliczek et al., 2016).

Texas State University

Waliczek, McFarland, and Holmes compared composting knowledge and attitudes of students attending TSU (intervention) with those enrolled at Farmingdale State College (comparison) (Waliczek et al., 2016). TSU students sort their waste in the dining halls according to posted signage, and Bobcat Blend student employees regularly hold educational sessions on composting (Waliczek et al., 2016). After developing their own survey, the researchers administered it to 660 students (403 at TSU, 257 at Farmingdale) and found that mean compost knowledge scores were significantly higher for the intervention group when compared to the comparison group (Waliczek et al., 2016). This increase in compost knowledge was also "associated with an increase in positive compost and environmental attitudes and a more internal locus of control" (Waliczek et al., 2016). Student composting efforts were reinforced by newspaper updates on collected amounts (Waliczek et al., 2016).

Case Studies in Student Research

Throughout our investigation of the literature surrounding composting interventions in a university setting, we found a significant lack of published, peer-reviewed research on the topic. Many of the peer-reviewed articles on composting focus on the science of organic material degradation rather than intervention design and outcomes. When we widened our search to non-peer-reviewed and unpublished research articles from university settings, we found that students are conducting pilot interventions, designing composting programs for their dining halls, and evaluating their existing waste diversion programs for aesthetics and adherence. This student-driven approach indicates that there is a strong interest in sustainability at the student level, but it may not yet be fully present at the administrative level.

UROT at the University of Richmond

At the University of Richmond in Virginia, students Michael Rogers and Carly Vendegna started the UROT program for campus composting during the 2009/2010 academic year (University of Richmond, 2010). Rogers and Vendegna started small with ten composting units placed next to the University Forest Apartments (University of Richmond, 2010). They collaborated with Backyard Farmer, a Richmond team of contractors skilled in gardening and composting practices, who monitored the units and held workshops for interested students (University of Richmond, 2010). Food waste was collected in biodegradable bags, deposited in the composting units, and then rotated by Backyard Farmer contractors (University of Richmond, 2010). This small system was designed to process "8,000 pounds of waste every 90 days," and the resulting soil would be applied to gardens on campus (University of Richmond, 2010).

Rogers was interested in ease of reproducibility and scalability, stating that “It’s not just a pile, it’s a professional product that other people could replicate in their own businesses and backyards” (University of Richmond, 2010).

Portland Community College

Portland Community College (PCC) at the Rock Creek campus in Oregon has a robust composting program utilizing five different systems for breaking down organic materials for reuse in their Learning Garden (Portland Community College, 2018). Their compost needs exceed their production ability, so they purchase additional soil from Recology, a waste collection service which also composts residential and municipal organic waste for Portland residents (Portland Community College, 2018). PCC has a large worm bin which holds two tons of materials along with red wiggler worms, the ideal worm for vermicomposting (Portland Community College, 2018). Red wiggler worms are supplied by the worm nursery on campus, located in a raised garden bed in the Learning Garden (Portland Community College, 2018). Livestock are raised at the working farm on campus, and the animals produce manure which is properly aged and used for landscaping needs (Portland Community College, 2018).

Two additional composting systems are used on the Rock Creek campus as well: the Geobin and the EnviroWorld black compost bin (Portland Community College, 2018). Whereas the Geobin is a “flexible, expandable compost bin” that quickly and aerobically breaks down materials, the Enviroworld bin is an anaerobic, enclosed system with a smaller capacity which takes longer to degrade materials (Portland Community College, 2018). Students and maintenance employees collect pre-and-post consumer waste from campus cafeterias along with food waste from offices, which is then weighed and recorded (Portland Community College, 2018). Through the management of a variety of composting systems, students and employees can compare the quality and quantity of the various soils produced by these methods (Portland Community College, 2018). There are many opportunities for student education in the Learning Garden and at the composting facilities, and PCC provides an outstanding model of sustainability for other college campuses to emulate (Portland Community College, 2018).

Boston College

Boston College (BC) in Massachusetts attempted student-driven, post-consumer waste management in two on-campus dining halls from 2008 to 2010 (Audi et al., 2014). Due to a lack of student education regarding the proper sorting of biodegradable and landfill materials, the composting bins were contaminated and the program was pulled from the dining halls (Audi et al., 2014). During the 2014 academic year, Environmental Studies majors Lauren Audi, Peter Keating, Bryan Sterling, and Hillary Weber conducted a Senior Seminar project exploring the feasibility of re-establishing student-driven composting at the McElroy Dining Hall (Audi et al., 2014).

Employees at all of the BC dining halls collect pre-consumer organic waste during meal preparation, whereas post-consumer waste is collected by employees at the Corcoran Commons ("Lower") dining hall after food trays are returned by students (Audi et al., 2014). BC students do not sort their waste, nor do they see the sorting process that takes place behind the scenes in the dining hall facilities (Audi et al., 2014). Audi and associates decided to investigate current composting practices at their college to attain a better understanding of the program, survey undergraduate students to determine interest and awareness regarding a campus composting program, and research existing student-driven programs at other comparable universities (Audi et al., 2014).

Boston College contracts with Save That Stuff for food waste collection and processing, and in 2013 the company processed 297.32 tons of compost for the college (Audi et al., 2014). The increase in collections between 2011 and 2013 suggests that the Office of Sustainability at BC is invested in improving organic material collections on campus (Figure 1) (Audi et al., 2014; Boston College, 2009).

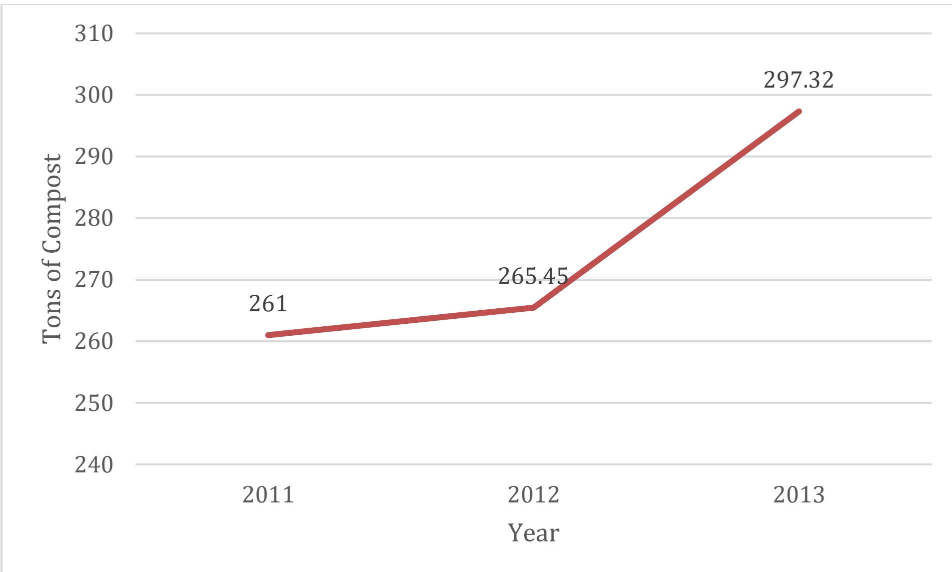

Figure 1: Annual Compost Collected from 2011-2013 (Audi et al., 2014)

When Audi and associates collected survey data from the student population, they had interesting results. When asked about their knowledge of composting, “53.6% of the participants stated that they understand what composting is and how to do it correctly,” with the remaining participants not understanding the term or quite unaware of the definition (n=221) (Audi et al., 2014). Most of the participants (88.2%) were “unsure or unaware” that composting occurs at Boston College, and 57.3% stated that composting “should be more prevalent,” with 39.4% indifferent (Audi et al., 2014). When students were asked about their interest in participating in a “student-run composting program,” 50.2% might be interested, 30.4% stated that they would be interested, and 19.4% would not be interested (Audi et al., 2014).

Audi and associates made favorable conclusions based on their survey responses. With 88.2% of the 221 students surveyed not being aware of BC composting, the researchers stated that "this statistic is problematic for promoting sustainability at BC because the composting that is being done is not appreciated or generating campus awareness" (Audi et al., 2014). With regard to composting prevalence on campus, 57.3% of the surveyed students expressed an interest in this possibility, which suggests that the majority of the student population would be receptive to a visible composting program in the campus dining halls (Audi et al., 2014). Half (50.2%) of the students surveyed may be interested and 30.4% are definitely interested in participating in a "student-run composting program," suggesting that a student-driven waste diversion program may be a desirable sustainability measure for the BC community (Audi et al., 2014).

Northeastern University

Northeastern University (Massachusetts), University of Massachusetts at Amherst (UMA), and University of California, Davis (UCD) have student-driven composting programs in place for their campus communities (Audi et al., 2014). In 2007, Northeastern started the "Be Green" composting program for employee-led sorting of pre and post-consumer waste in campus dining halls and catering facilities, with an annual collection of over 700 tons of compostable waste (Audi et al., 2014). The "Compost Here" program requires that students sort their own post-consumer waste into clearly-labeled bins in campus dining halls (Audi et al., 2014). "Peer Composters" volunteer to monitor the bins during peak business hours, answering questions and gently encouraging their peers to properly sort their waste (Audi et al., 2014).

University of Massachusetts at Amherst

As described above, the North Apartment D pilot study was conducted in 2015 at UMA, with the intent of developing and instituting a small scale composting program among residents at the apartment complex (Hollerbach & Chan, 2016). In 2012 a pilot study was conducted at Blue Wall Eatery to investigate the feasibility of adding student-driven waste management practices to UMA dining halls (Audi et al., 2014). Pre and post-consumer composting was instituted at UMA in 1996, but it was conducted behind the scenes by UMA employees (University of Massachusets, 2017; Audi et al., 2014).

During the pilot study, waste management staff added compost bins with signage to the Blue Wall Eatery and coordinated compost education events on campus (Audi et al., 2014). Recycling Works, a UMA subcontractor for compost collection, found trash contaminating the collected compostable materials during the pilot study (Audi et al., 2014). Subsequently, UMA provided bin monitors during peak business hours to assist students with proper waste diversion along with an educational “annual composting workshop” for students and faculty to attend (Audi et al., 2014).

University of California, Davis

Composting on the UCD campus is a collaboration between many campus community groups: “R4 Recycling, ASUCD [Associated Students of UCD] Project Compost, UC Davis Dept. of Grounds, Prairie Organics, and UDS [University Dining Services]” (Audi et al., 2014). Pre and post-consumer waste is diverted and composted on the campus farm, with a zero waste goal set for 2020 (Audi et al., 2014). Campus groups support this goal through tray-less dining, visible signage for post-consumer sorting at waste collection sites, two hours of waste diversion training per quarter for each cafeteria employee, UDS packaging that is “recyclable, reusable or compostable,” and biodegradable tableware (Audi et al., 2014). Neither students nor employees monitor waste collection bins in the cafeterias; rather, effective signage and the educational efforts of campus groups prevent contamination of the campus compost bins (Audi et al., 2014).

The ASUCD Project Compost is a collaborative effort of "student staff, interns, and volunteers" with the goal of teaching the UCD community how to vermicompost and conduct home and campus composting (Audi et al., 2014). They provide compost pickup service at multiple campus locations, collecting one ton of organic materials per week (ASUCD, 2018). If students seek further sustainability education, they can attend a two-credit class on "sustainable living" or a week-long seminar on "environmental and sustainability issues" (Audi et al., 2014).

Cornell University

In Ithaca, New York, Cornell University student Joanna Blaszczak conducted a study in which she analyzed student-driven waste diversion efforts in three campus dining halls (Blaszczak, 2011). Cornell had started collecting pre-consumer food preparation waste from their campus dining facilities in 1997 (Blaszczak, 2011). During the 2005-2006 academic year, students collaborated with Cornell Dining to establish post-consumer waste collection at the Manndibles Café, Trillium, and The Terrace (Blaszczak, 2011). In her study, Blaszczak explored the design aspects of the three campus dining locations in order to determine the features which were most supportive for successful composting among the student population (Blaszczak, 2011). She examined "environmental aesthetics… crowding, and the location of the composting bins" through in-person observations and survey responses (Blaszczak, 2011).

Manndibles Café is located inside the Mann Library and is operated independently from Cornell Dining (Blaszczak, 2011). This small café has a distinctive, environmentally-friendly aesthetic in which there are "more compost bins than trashcans" (Blaszczak, 2011). Most of the items sold in the café come in compostable packaging and the utensils are biodegradable

(Blaszczak, 2011). Trillium has a “relaxed” aesthetic, is the largest dining facility of the three, and has waste collection bins available on both floors of the facility (Blaszczak, 2011). The Terrace facility has a “business-like atmosphere” with “limited composting locations” (Blaszczak, 2011). One compost bin is placed near the main exit to the facility, one is located in a small niche at the rear of the café, and the remaining bins are trashcans (Blaszczak, 2011).

Blaszczak collected 59 surveys through campus emailing lists and made 475 observations of students visiting the three campus dining facilities (Blaszczak, 2011). Most of the participants were undergraduates, and she assumed that they were able to understand the signage at each of the composting locations (Blaszczak, 2011). With regards to survey responses, “80% reported that they composted >50% of the last ten times they ate lunch on campus” (Blaszczak, 2011). Participants were surveyed regarding the factors which were the most important to them when they made their composting decisions while visiting the three dining facilities (Blaszczak 2011). As shown in Figure 2, survey respondents indicated that the convenience of the composting bin locations was the most important factor which influenced whether or not they composted.

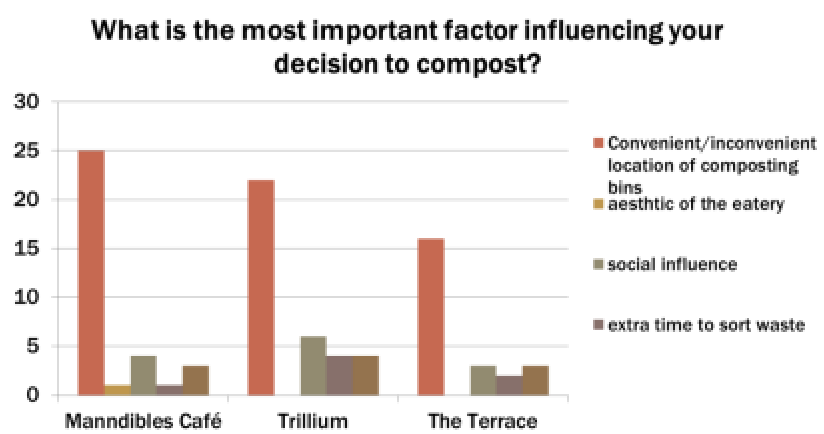

Figure 2: Important Factors in Survey Responses (Blaszczak, 2011)

With regard to participant observations, the Terrace and Manndibles dining facilities "had significantly higher composting than non-composting rates" (Blaszczak 2011). Crowding did not affect composting rates at Manndibles Café, but more people composted at Trillium café when it was crowded compared to when it was not crowded (Blaszczak, 2011). The researcher made this additional observation about Trilllium Café: "The staff members were the worst culprits. When a group of people [came] up to the garbage station, if the first person did not compost, the rest did not compost either" (Blaszczak, 2011).

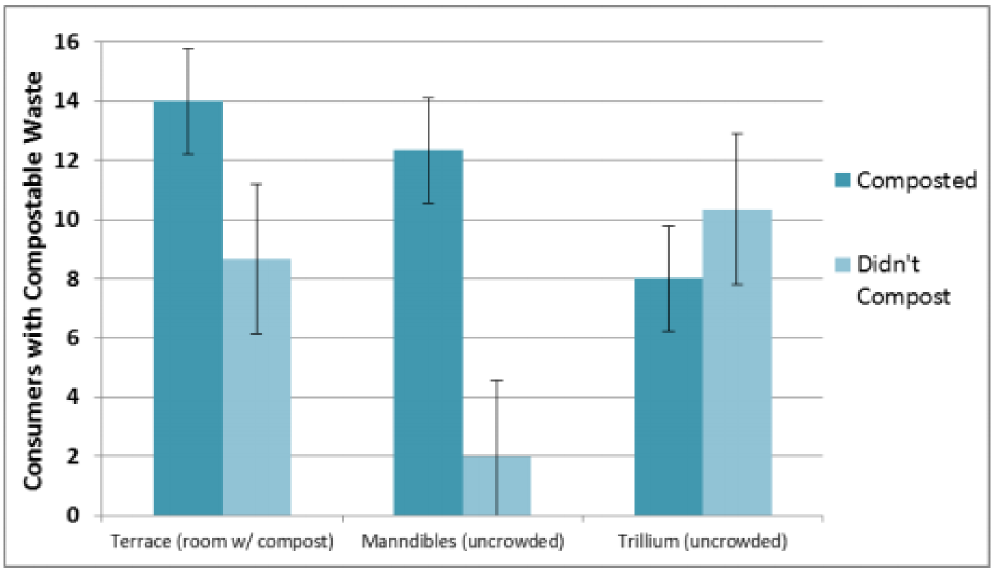

Figure 3: Average Composting Behavior Across Each Eatery (Blaszczak, 2011).

Blaszczak concluded that Manndibles Café was the "most composting-friendly location" of the three dining facilities, and that the volume of people using the café at any one time did not affect the composting rates of diners (Blaszczak, 2011). With regards to the group behavior observation (as stated above), if the first person in a group who approaches a waste container does not compost, then the remaining members of that group will also decide not to compost (Blaszczak, 2011). In other words, to a certain extent composting is a group behavior, and that the visible efforts of a composting initiator may have a positive impact on the remaining group members; in effect, the initiator is modeling the behavior for the other members of the group. This behavior can be further supported by the "Peer Composter" who monitors the waste containers at Northeastern University dining halls and guides students as they sort their waste into the correct bins.

Macalester College

Students at Macalester College in Saint Paul, Minnesota explored opportunities for initiating a composting system on their campus during the spring semester of 2010. Molly Brown, Davita Flowers-Shanklin, and Emily Merrill collaborated on a senior seminar project in which they discussed three on-campus composting options: industrial, in-vessel, and worm composting (Brown et al., 2010).

Industrial composting refers to the business arrangement in which the college contracts with a waste management company to pick up, transport, and process organic waste into compost (Brown et al., 2010). The cost for choosing this option would be $48 per ton of waste, and if industrial composting is chosen, then students would not have the opportunity to see composting in action on their college campus. In-vessel composting (described below) may be the most convenient solution for composting, but the prohibitive expense of purchasing a system encouraged Brown and associates to recommend vermicomposting as a reasonable alternative (Brown et al., 2010). They estimated the cost of purchasing and installing an in-vessel composting system to be between $60,000 and $300,000 (Brown et al., 2010).

In addition to their financial and practical analysis of these three composting solutions, Brown and associates provided a full budget for running a vermicomposting pilot project during the 2010-2011 academic year (Brown et al., 2010). Their budget included supplies and labor, along with recommended placements for small material collection bins in student dorms and worm bins in the Facilities Management office (Brown et al., 2010). Two part-time student workers would be needed for compost collection and program education, whereas two part-time facility employees would be required for worm and compost collection bin maintenance and transport (Brown et al., 2010).

Although the recommended pilot project did not take place at Macalester College, the school currently composts organic materials and has a Zero Waste by 2020 goal in place (Macalester, 2018). Labeled compost bins are located across the campus, Facilities Management employees service the bin, and a local waste service picks up the materials for processing at the Mulch Store in Rosemount, Minnesota (Macalester, 2018). It appears that for Macalester College, the best composting solution was to contract out for industrial composting with a local company.

In-Vessel Composting

Currently, many universities across the United States do not compost food scraps or plate waste. FOR Solutions, an in-vessel composting system manufacturer, has provided a step-by-step guide for universities who are considering implementing a composting system for their campus community (FOR Solutions, 2018). The first step in the process includes an organic waste recovery audit, which should include pre-consumer and post-consumer waste (FOR Solutions, 2018). The university may employ a professional food waste audit team or recruit students to assist with the project (FOR Solutions, 2018). If the university decides to have food waste processed off-campus, hauling and tipping fees will be charged for these associated services (FOR Solutions, 2018). Hauling fees refer to the charges for moving the food waste from the college campus to the processing location, whereas tipping fees are charged when the processor accepts the food waste for composting (FOR Solutions, 2018). The audit should include a comparison of the hauling and tipping fees with the cost of purchasing equipment for composting on campus (FOR Solutions, 2018).

If composting is conducted on campus, single or long pyramid-shaped piles (windrows) may be utilized for food waste processing, which takes several months and can be done aerobically or anaerobically (FOR Solutions, 2018). Pests may be attracted to the piles, and if they are not turned regularly they can produce methane gas (FOR Solutions, 2018). Two other on-campus solutions include biodigesters and dehydrators (FOR Solutions, 2018). Biodigesters use enzymes or bacteria to break down organic materials, which are then discarded through the campus waste removal system rather than used on-campus (FOR Solutions, 2018). Dehydrators remove water from food waste, and the dehydrated waste can then be used as compost (FOR Solutions, 2018). Another option is an in-vessel composting system, which uses a large sealed container to quickly degrade food scraps into useable compost (FOR Solutions, 2018). This system is pest and odor free, uses a small amount of energy, and degrades the organic materials quickly (FOR Solutions, 2018).

Once a campus chooses a composting system, kitchen staff can start collecting waste, typically in easily handled containers such as 10 gallon buckets (FOR Solutions, 2018). A school may require kitchen staff to scrape trays or may ask students to do so (FOR Solutions, 2018). Once the waste has been collected from dining facilities, trained composting personnel will consolidate and weigh buckets before processing (FOR Solutions, 2018).

If the university has chosen to use an in-vessel composting system, the waste must be mixed with a carbon source such as sawdust or wood chips so that it will properly degrade (FOR Solutions, 2018). This mixture is now placed into a hopper attached to the in-vessel container, where it will be shredded and moved through the system for degradation (FOR Solutions, 2018).

Beneficial bacteria break down the mixture within five days, with the temperature inside the vessel high enough to kill pathogenic bacteria (FOR Solutions, 2018). After processing, the compost can be used on campus or sold to local homeowners, as is the case with the Bobcat Blend label sold by student employees at TSU.

Household Composting

If conducted correctly, household composting can be an efficient system for disposing of organic kitchen waste, meaning environmental impact is reduced. The typical American produces 1,600 pounds of garbage each year, and an estimated 50% of this material could be composted (Buelin-Biesecker, 2014). When garbage is bagged and placed in landfills, it is compacted in an anaerobic state (no oxygen available for microbial activity). Organic materials slowly decompose in an anaerobic environment and methane gas is produced (Buelin-Biesecker, 2014). If organic materials are placed in an aerobic compost pile rather than the landfill, they can quickly break down into reusable garden soil and reduce methane gas emissions. Organic matter such as fruit and vegetable scraps, egg shells, and coffee grounds can be collected and composted for use in the home or community garden. Micro-organisms, specifically bacteria and fungi, break down organic materials into usable components which can fertilize plants and soil (Buelin-Biesecker, 2014).

In 2012 and 2013, 451 households in Red Deer, Alberta participated in two phases of a home composting pilot program (City of Red Deer, 2014). Participants attended a workshop, receiving a composter, kitchen waste bin, and mixing tool along with printed materials and training videos, and access to program support information (email and phone number) (City of Red Deer, 2014). Pre-pilot surveys collected information on composting “barriers and benefits,” whereas the exit surveys asked participants to comment on their experiences, share photos of their composting equipment, record the weight of all organic materials collected, and verify that they were still composting (City of Red Deer, 2014). Exit survey data found that 18.4 tons of organic waste were collected, and that 72% of the households were still composting one year later (City of Red Deer, 2014). Based on the success of this pilot study, the city planned to provide 200 composting units to Red Deer residents annually until 2018, as well as determine the feasibility of vermicomposting for households lacking backyards (City of Red Deer, 2014).

Home composting interventions in the United Kingdom (UK) have been initiated by non-governmental organizations (NGOs) with the intention of encouraging sustainable behaviors and reducing biodegradable waste in landfills (Sharp et al., 2010). Sharp, Giorgi, and Wilson conducted a review of the lessons learned from waste reduction interventions conducted in the UK from research published between 2006 and 2009 (Sharp et al., 2010). Their two main objectives were to analyze the methodologies of the various interventions and report the amounts of waste diverted from landfills (Sharp et al., 2010). The authors reviewed eight studies with a wide range in participation rates (fourteen to 3,602 individuals, households, or schools) (Sharp et al., 2010). Intervention periods were varied as well: the shortest campaign lasted one week whereas the longest program was conducted over three years (Sharp et al., 2010).

The researchers focused on describing multi-level interventions which included education, outreach events, and continual support from NGO employees (Sharp et al., 2010). An example is the *Love Food Champions* campaign conducted by the Waste and Resources Action Programme (WRAP), in which extensive support was provided to participants (Sharp et al., 2010). They received "workbooks, information, and kitchen caddies" for composting, along with training to become neighborhood champions of waste reduction (Sharp et al., 2010). During the four-month intervention they reduced their food waste by 50% to 2.5 kg per household per week (n=60) (Sharp et al., 2010). Since the time of the intervention, WRAP has provided 1.7 million compost containers to households and prevented 584,225 tons of organic waste from reaching the landfill (Sharp et al., 2010). Waste reduction campaigns can benefit from developing recognizable branding, and WRAP's *Love Food Hate Waste* logo is perhaps one of the most iconic sustainability-oriented brands (Sharp et al., 2010).

In their study, Sharp, Giorgi, and Wilson were not able to identify the driving forces contributing to sustainable behavior (Sharp et al., 2010). Rather, they stated that "behavior change has been supported by a number of integrated 'enabling' tools and 'engagement' promotions – measures which have made a collective rather than isolated difference" (Sharp et al., 2010). The food waste reduction campaigns conducted by WRAP are an excellent example of this "collective" effect (Sharp et al., 2010). In addition, though, the authors noted that "waste prevention behavior and options need to become more 'visible'" (Sharp et al., 2010). They refer to the "visibility" of recycling efforts in UK communities, which helped to normalize the behavior for residents (Sharp et al., 2010). When or if such "visibility" and attention is applied to food waste reduction and composting efforts in the United States, over time the behavior will become normalized within our communities (Sharp et al., 2010).

Composting Survey Tools

Sustainability and composting behaviors should be supported with robust research and education efforts by community stakeholders. Waliczek, McFarland, and Holmes developed a survey tool to assess the environmental and composting attitudes and knowledge of students at TSU and Farmingdale State College (Waliczek et al., 2016). In addition to looking at environmental attitudes and locus of control, the survey asked respondents to reflect on their composting knowledge and attitudes (Waliczek et al., 2016).

The survey included twenty compost knowledge true/false questions, which included such phrases as "the nutrients in food can be recycled" and "the product of a compost pile is similar to topsoil" (Waliczek et al., 2016). Students attending TSU were asked sixteen additional survey questions pertaining to compost attitudes, and the questions were specific to their campus composting program (Waliczek et al., 2016). The questions included such statements as "sorting meal waste is easy," and "when I sort my food waste in the cafeteria/dining hall, I understand what can be composted" (Waliczek et al., 2016).

A Likert scale was used with the options "never," "sometimes/usually," and "always" (Waliczek et al., 2016). If participants answered "never," they received one point, "sometimes/usually" earned them two points, and "always" granted them three points, with higher overall scores suggesting a more favorable attitude toward composting behaviors (Waliczek et al., 2016).

Survey tool development provides researchers with an opportunity to focus questions on a particular subject matter which will support their research efforts. Lavelle and associates created two survey instruments, separately measuring cooking skills and food skills (Lavelle et al., 2017). The cooking skills tool contained fourteen questions pertaining to cooking methods and common food preparation abilities, whereas the food skills survey included nineteen items measuring such abilities as shopping, meal planning, using a budget, kitchen resourcefulness, and reading labels (Lavelle et al., 2017). The researchers applied a Likert scale to the survey questions, with a range of one ("very poor") to seven ("very good)" (Lavelle et al., 2017).

While validating their new survey tools, the authors conducted forty pilot studies with convenience samples of contacts working and studying at universities in Ireland (where the study took place) (Lavelle et al., 2017). In addition, they hired a data collection company to perform fourteen pilot studies to further refine the survey instruments (Lavelle et al., 2017). The researchers applied an exploratory factor analysis to the results of the fourteen pilot studies in order to clarify the categorization of the survey questions (ie cooking vs food skills) (Lavelle et al., 2017). They used a scree plot to identify two factors (cooking skills and food skills) as being the two main categories for their survey questions (Lavelle et al., 2017). While developing and testing new survey tools, researchers can use such additional statistical processes as the Index of Item-Objective Congruence and confirmatory factor analysis to determine if the survey questions accurately measure the intended concepts.

Conclusion and Study Objectives

Research regarding composting interventions and their associated survey tools is limited. Therefore, it is the intent of this study to develop, pilot, and analyze the results from a short composting survey for use in future studies. The initial versions of the survey tool will be adjusted based upon participant feedback, and the results from the pilot study will guide the researchers in developing future composting interventions in the university setting.

CHAPTER III

JOURNAL ARTICLE

DEVELOPING, PILOTING, AND FACTOR ANALYSIS OF A BRIEF SURVEY TOOL FOR EVALUATING FOOD AND COMPOSTING BEHAVIORS: THE SHORT COMPOSTING SURVEY

Developing, Piloting, and Factor Analysis of a Brief Survey Tool for Evaluating Food and Composting Behaviors: The Short Composting Survey

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ABSTRACT

Household composting is a practical sustainable behavior which should be further investigated. The Short Composting Survey was developed for use during the Compost Project pilot study to measure the knowledge, values, barriers, and social norms surrounding composting (n=25). The purpose of this research was to describe the testing and refining of the survey tool for the pilot study. Statistical analyses included calculating the Index of Item-Objective Congruence (IIOC) values and conducting a confirmatory factor analysis following administration of the survey. Nine respondents assisted with survey tool development by completing the IIOC, and values ranged from 0.29 to 0.66 which indicated that all of the survey questions matched more than one construct. The factor analysis resulted in a three-factor solution with a cumulative loading of 71.2%, meaning that these identified factors contributed 71.2% of the variance in responses. Factor 1 ("Values") proved to be the strongest factor, explaining 36.6% of the variance, whereas Factor 2 ("Social Norms") explained 20.04%, and Factor 3 ("Barriers") had 14.6%. This survey may be useful for future food composting and

sustainability-related research efforts.

KEYWORDS

Composting; survey; food sustainability; confirmatory factor analysis

INTRODUCTION

Efforts to address reducing food waste are needed in all community settings, including schools and workplaces. Household approaches include freezing leftovers, donating unopened packages to food banks, using vegetable scraps for soup stocks, and minimizing fresh produce purchases to what can reasonably be consumed within a certain time frame (EPA, 2017). Even if community members attempt to minimize their food waste by following these recommendations, a certain amount of waste is inevitable.

In 2010, food waste was 31 percent of the food supply, which was equivalent to 133 billion pounds (an average of 218.9 pounds of food waste per person was sent to a landfill) (EPA, 2017). Thus, in September 2015, the United States Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) announced the U.S. 2030 Food Loss and Waste Reduction Goal (EPA, 2017). The federal government is aiming to reduce food waste by 50% to 66 billion pounds by 2030 (EPA, 2017). If successful, the benefits of this reduction would include reduced methane emissions, a potent greenhouse gas, from organic materials decomposing at landfill sites and less money spent on wasted food (EPA, 2017). If an individual can't reduce food waste by following the recommendations outlined above, then composting is a reasonable method for redirecting the waste from landfills (EPA, 2017).

Composting effectively recycles organic food scraps into usable soil, and it can be done under aerobic or anaerobic conditions. At the household level, food scraps can be collected in a small container and then added to an outdoor bin or pile, fed to red wiggler worms living in a worm bin, or placed into a shallow trench and buried under soil. Community efforts to live sustainably through such approaches as composting and reducing food waste can be aided by the development of survey tools assessing the knowledge, attitudes, and perceived barriers surrounding the practice of composting.

Research regarding composting interventions and their associated survey tools is limited. Therefore, it is the intent of this study to develop, pilot, and analyze the results from a short composting survey for use in future studies. As researchers develop new survey tools, a process such as the Index of Item-Objective Congruence (IIOC) may prove useful. The IIOC helps researchers determine if an item (survey question) can be matched to a particular concept, as described by Crocker and Algina (1986).

After piloting a new survey, confirmatory factor analysis may assist researchers in evaluating how well the survey tool measures the constructs of interest. Initial versions of the survey tool can be adjusted based upon participant feedback, and the next iteration of the tool can be applied to a different group of participants. If a survey question does not adequately match the construct, it can be discarded in favor of a more appropriate choice. The survey validation process assists researchers in developing tools which accurately measure their constructs of interest.

Factor analysis may be applied to a new survey tool as a method of exploring response patterns and looking for “common components among multiple dependent items” (Crocker & Algina, 1986). Gorsuch explains the goal of factor analysis as follows: “to summarize the interrelationships among the items in a concise but accurate manner as an aid in conceptualization” (1983). A tool’s intended constructs are considered factors contributing to an understanding of the tool’s object of interest. For example, a tool designed to assess participants’ attitudes surrounding physical activity behaviors might include such factors as perceived benefits and barriers, interest in various physical activities, and time spent outdoors.

Factor analysis helps a researcher determine how well a given set of items addresses the intended construct or constructs. When conducting a factor analysis, the researcher loads factors in the model to look for the "degree of generalizability" between factors (Gorsuch, 1983). Factor loadings can vary in value from -1 to 1, with values which approach -1 and 1 indicating the item has a strong relationship with the construct, and values approaching zero indicating the item appears unrelated to the construct (Deviant, 2017).

Communalities are also reported for the items, which refers to the "proportion of [their] variance that can be accounted for by the common factors" (Crocker & Algina, 1986). These values range from 0 (no correlation) to 1 (perfect correlation) (Crocker & Algina, 1986). Items with communalities below 0.20 should be removed from the factor analysis because their posited items (as addressed) have less in common with the other factors, meaning that these items are less useful for the tool's purpose (Yong & Pearce, 2013).

Participant responses are used to analyze the tool's function via either exploratory or confirmatory factor analysis. Researchers should choose an exploratory factor analysis (EFA) when they have not yet determined the structure of the data or the number of dimensions to the items (Gorsuch, 1983). In the case of a CFA, the researchers already have an idea about the data structure and the number of dimensions to the items (Gorsuch, 1983).

Two outputs from factor analysis include the Eigenvalue and the Kaiser-Meyer-Olkin (KMO) test values. The Eigenvalue represents "the number of original values [concepts] that are associated with that factor," and they are grouped into related factors (Crocker & Algina, 1986). This value assists the researcher in determining how many factors should be retained (Yong & Pearce, 2013). If the researcher decides to follow "Kaiser's criterion," all factors above an Eigenvalue of one are retained (Yong & Pearce, 2013). The KMO test measures how suitable the data is for factor analysis (Deviant, 2017). Values range from zero to one: values between 0.8

and 1.0 indicate the data is adequate for a factor analysis (Deviant, 2017). Values less than or equal to 0.6 mean a factor analysis should not be conducted, although some researchers allow for values greater than or equal to 0.5 (Deviant, 2017). If the KMO value is near zero, then widespread correlations exist and a factor analysis should not be conducted (Deviant, 2017). In such cases, participant responses indicate that a tool's items are each addressing more than one construct (i.e. split loadings). The purpose of this research is to describe the testing and refining of the short composting survey tool used as part of a brief, supportive compost education intervention on a college campus.

METHODS

Pilot Study

The Compost Project was a brief pilot study conducted during the Fall 2017 quarter at Central Washington University (CWU) (results not published). This pilot study was designed to evaluate the effect of supported home composting on fruit and vegetable intake. The researchers developed the Short Composting Survey for use during the project in order to measure attitudes and behaviors around food and composting. Twenty-five participants were initially enrolled in the study. Participants ranged in age from 18 to 33 years old, 24 were students, and one participant was a recent graduate from CWU; nutrition students and faculty members were excluded from the study. This article relates the testing and refining of the tool during the pilot, with potential implications for future food and sustainability-related research efforts.

Short Composting Survey

At the initial study orientation meeting, participants were asked to complete the Short Composting Survey. The Short Composting Survey, a brief, researcher-developed tool, was designed to measure the aforementioned targets by asking about composting and food preparation behaviors. The results described within this article are based on the responses of participants to this initial application of the tool.

The researchers developed the Short Composting Survey for this study due to the lack of a validated survey tool pertaining to eating habits and composting. After writing the initial items, nine college-educated individuals completed the IIOC Rating Form for Composting. Following data collection, confirmatory factor analysis (CFA) was conducted to determine if the survey tool appropriately measured the concepts of values, barriers, and social norms as they related to composting and food.

Statistical Analysis

The confirmatory factor analysis was conducted with a computer with SPSS software (version 24).

RESULTS

The IIOC was calculated for each item on the IIOC Rating Form discussed above and using the following formula:

$$I_{ik} = \frac{N}{2N - 2}(\mu_k - \mu)$$

To solve for the formula above, *N* is the number of constructs, u_k refers to the respondents' mean rating of item *i* on a particular construct (*k*), and μ is the respondents' mean rating of item *i* on all of the constructs (Crocker & Algina, 1986).

Table 2: IIOC Results

Item	Construct	Index of Congruence
Thinking about what's typical for you, how often do you compost your kitchen scraps?	Behavior	0.66
Thinking about what's typical for you, how often do you prepare meals in your kitchen?	Behavior	0.65
Thinking about what's typical for you, how often do you visit a garden that grows food?	Behavior	0.44
Rate your level of agreement for this statement: I don't have time to compost.	Barriers	0.58
Rate your level of agreement for this statement: I don't have room to compost.	Barriers	0.53
Rate your level of agreement for this statement: compost smells bad.	Barriers	0.29
Paper towel rolls can be composted.	Knowledge	0.54
Plastic bags can be composted.	Knowledge	0.53
Onion skins can be composted.	Knowledge	0.59
Rate how important it is to you that composting reduces the environmental impact of garbage.	Values	0.62
Rate how important it is to you that composting recycles kitchen scraps into garden soil.	Values	0.62
Rate how important it is to you that if people composted, we could keep about half of our garbage out of landfills.	Values	0.53
Rate your level of agreement for this statement: My friends think composting is a good idea.	Social Norms	0.54
Rate your level of agreement for this statement: Many people I know like to compost.	Social Norms	0.56
Rate your level of agreement for this statement: Many people I know visit a community garden.	Social Norms	0.43

Before the confirmatory factor analysis, a KMO test was applied to the data to determine if such analysis was appropriate. The KMO test value was 0.503, indicating its suitability for factor analysis (based on a value greater than 0.5). Bartlett's test of sphericity ($p<0.0001$) produced significant results, which suggests that the data has "patterned relationships" (Yong & Pearce, 2013). If Bartlett's test results are non-significant, then the items are not sufficiently related to each other for a factor analysis to be applied to the data set (IBM, 2018).

A CFA was conducted on the data using a Varimax rotation with a Kaiser Normalization. According to Yong and Pearce, "factors are rotated [around an axis] for better interpretation since unrotated factors are ambiguous" (Yong & Pearce, 2013). The Varimax rotation is an orthogonal approach which decreases the presence of high loadings and minimizes small loadings, in effect reducing the likelihood that a researcher will report an erroneous factor structure (Yong & Pearce, 2013). Kaiser Normalization suggests retaining all factors with an Eigenvalue above one (Yong & Pearce, 2013).

This analysis resulted in a three-factor solution with a cumulative loading of 71.2%, meaning that these identified factors contributed 71.2% of the variance in responses. The individual Eigenvalues for the three factors were each greater than one, above the Kaiser's Normalization threshold for determining meaningful contribution. The scree plot contained three points above an Eigenvalue of one, which supported the conclusion that the tool addresses three factors.

Factor 1 ("Values") proved to be the strongest factor, explaining 36.6% of the variance, whereas Factor 2 ("Social") explained 20.04%, and Factor 3 ("Barriers") had 14.6% (Table 3). To determine which results are significant (i.e. which factors appear to be meaningful), the researchers conducting a factor analysis must set a cut-off value for factor loadings (Yong & Pearce, 2013). Using a cut-off value of 0.60, four out of nine items (addressed by items 1 through 4) loaded moderately or highly on Factor 1. Factor 2 was represented in two moderately loaded items (6 and 7), and Factor 3 in only one item (Table 3). Two items, as addressed by items 5 and 8, loaded below the cut-off value of 0.60.

If the cut-off value is moved to 0.50, Factor 1 is linked to seven out of nine items (1 through 6 and 8), Factor 2 to four (items 2, 6, 7, and 8), and Factor 3 to two (items 4 and 9).

There are a number of split loadings in the data, in which items load at “0.32 or higher on two or more factors” (Yong & Pearce, 2013). Using the lower cut-off value of 0.50, items 1, 2, 4, 6, 7, 8, and 9 all have split loadings. This finding indicates that the factors themselves are interrelated and factor identification may be more difficult, meaning that further refinement may improve the tool’s usefulness.

Table 3: Confirmatory Factor Analysis Results

Item	**Description**	**F1: Values**	**F2: Social**	**F3: Barriers**	**Communalities**
1	Composting keeps half of garbage out of landfills.	0.777	0.379	-0.283	0.827
2	Many people I know like to compost.	-0.721	0.510	0.185	0.814
3	Composting recycles kitchen scraps into garden soil.	0.708	0.233	-0.128	0.572
4	I don’t have room to compost.	0.681	0.026	0.532	0.747
5	Compost smells bad.	0.538	-0.260	-0.065	0.361
6	Composting reduces the environmental impact of garbage.	0.554	0.617	-0.446	0.887
7	My friends think composting is a good idea.	-0.327	0.604	0.398	0.630
8	Many people I know are involved with a community garden.	-0.550	0.573	-0.402	0.792
9	I don’t have time to compost.	0.444	0.451	0.614	0.778
Eigenvalue		3.292	1.804	1.314	
Variance explained (%)		36.577	20.046	14.603	
Cumulative percentage (%)		36.577	56.623	71.226	

Item 6 has the highest communality at 0.887, followed by items 1 at 0.827 and 2 at 0.814, respectively. Gorsuch refers to communality as the "proportion of its variance that can be accounted for by the common factors" (Gorsuch, 1983). Applying this definition to the results listed above, 88.7% of the variance for item 6 is due to the "common factors" and the remaining variance is unique (11.3%) (Gorsuch, 1983). Therefore, 11.3% of the unique variance of item 6 cannot be attributed to the common factors; rather, it is attributed to factors outside this model. In addition, 82.7% of the variance for item 1 and 81.4% of the variance for item 2 are due to the "common factors," with the remaining 17.3% and 18.6%, respectively, being unique (Gorsuch, 1983).

DISCUSSION

Survey tool development is a complex, intentional, and iterative process, and it may be aided by sought feedback as well as focused analyses including IIOC and CFA. During development of the Short Composting Survey, the researchers decided to focus on the following constructs: perceived benefits and barriers, value and importance, subjective norms, and knowledge about composting. The IIOC results indicated that all of the questions written for the survey measured more than one construct, meaning they should be revised before administration. With regards to the factor analysis, the low factor loadings on items 5 and 8 indicated that these items should be removed from the next version of the survey, whereas items 1, 2, and 6 should be retained due to their high communalities.

In the results from the IIOC, the low index of congruence for the item, "Rate your level of agreement for this statement: compost smells bad," was particularly compelling. The calculated index of congruence of 0.29, meaning that this item was not congruent with the barrier category, indicated that the nine pre-pilot respondents did not think that the concept of "compost smelling bad" was actually a barrier to composting. The nine respondents may have been better informed than the anticipated study participants, or their views may be in agreement with most peoples, thus making odor a less salient barrier to composting.

During evaluation of the CFA factor loadings, the researchers found it helpful to choose a higher cut-off value of 0.60 rather than a lower value of 0.50 in order to assign significance to results above the higher value. There are fewer split-loadings at the higher value, and two items (5 and 8) are below the cut-off value. Item 5 ("Compost smells bad") does not appear to address a true barrier to composting for the participants. During the initial IIOC analysis, Item 5 was assigned to the barrier category due to the assumption that the smell of decomposing organic materials inside the house would be a deterrent for most people. The factor loading of Item 5 within the barrier factor was quite low (-0.065), indicating that the smell of compost was not a deterrent for our participants. The next version of the Short Composting Survey should omit this item, as it doesn't appear to be a barrier to composting (at least to the current study's participants).

Item 8 is also below the cut-off value ("Many people I know are involved with a community garden"). This item has moderate-value split loadings across all three factors, indicating that it appears to measure several concepts. Due to the ambiguous nature of this item, it would be appropriate to remove it from the next version of the survey. Items 1, 2, and 6 have the highest communalities among all nine items (0.827, 0.814, and 0.887 respectively). These high values indicate that most of the variance for all three constructs can be attributed to the common factors (ie values, social, and barriers). These three items should be retained for the next version of the survey, as they have the most relevance to the constructs of interest.

CONCLUSIONS

Due to the limitations of the Compost Project and the potential value of a useful tool in filling a gap in the literature, this paper focused on the IIOC and CFA conducted during development and analysis of the Short Composting Survey. The main strength of this study was the focused nature of the analysis. Future versions of this tool should be tested with participants from non-university populations (i.e. community gardeners, schoolchildren, homeowners, etc.). Researchers may add new questions to the Short Composting Survey, request qualitative responses to specific questions, and retain the most clearly useful questions from the existing survey. Sustainability measurement tools can be administered in many different settings and populations, and they may help researchers develop educational and other programs targeting specific behaviors of interest.

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APPENDIXES

Appendix A: Index of Item-Objective Congruence Rating Form for Composting

The following items are included on a scale designed to measure _barriers, knowledge, behaviors, values, and social norms related to composting. All items reflect a 5-point Likert scale.

Score each item ***as you feel it represents each construct.*** Enter **1** if the item likely measures the construct, **0** if the item may somewhat measure the construct or it is unclear whether it measures the construct, and **-1** if the item likely does not measure the construct.

Example – Constructs: A) Hatred of math, B) Math anxiety, and C) Quality of math teachers

Item	A	B	C
I do not enjoy any type of math.	1	0	-1

In the example above, the rater determined the item most likely measures hatred of math, most likely does **not** measure quality of math teachers, and may or may not measure math anxiety.

Constructs: A) __Knowledge__, B) __Behavior___, C) ___Barriers____

#	*Item*	*A*	*B*	*C*
1	Thinking about what's typical for you, how often do you compost your kitchen scraps?			
2	Thinking about what's typical for you, how often do you prepare meals in your kitchen?			
3	Thinking about what's typical for you, how often do you visit a garden that grows food?			
4	Rate your level of agreement for this statement: I don't have time to compost.			
5	Rate your level of agreement for this statement: I don't have room to compost.			
6	Rate your level of agreement for this statement: compost smells bad.			
7	Paper towel rolls can be composted.			
8	Plastic bags can be composted.			
9	Onion skins can be composted.			

Constructs: A) ___Behavior____, B) ___Values_____, C) ___Social Norms_________

#	*Item*	*A*	*B*	*C*
1	Rate how important it is to you that composting reduces the environmental impact of garbage.			
2	Rate how important it is to you that composting recycles kitchen scraps into garden soil.			

3	Rate how important it is to you that if people composted, we could keep about half of our garbage out of landfills.			
4	Rate your level of agreement for this statement: My friends think composting is a good idea.			
5	Rate your level of agreement for this statement: Many people I know like to compost.			
6	Rate your level of agreement for this statement: Many people I know visit a community garden.			

Appendix B: Index of Item-Objective Congruence Data and Calculations

Constructs: A) __Knowledge__, B) __Behavior___, C) ___Barriers____

Item #	Item	Number of Responses Matching the Construct	μ_k
1	Thinking about what's typical for you, how often do you compost your kitchen scraps?	10	1
2	Thinking about what's typical for you, how often do you prepare meals in your kitchen?	10	1
3	Thinking about what's typical for you, how often do you visit a garden that grows food?	7	0.7
4	Rate your level of agreement for this statement: I don't have time to compost.	9	0.9
5	Rate your level of agreement for this statement: I don't have room to compost.	8	0.8
6	Rate your level of agreement for this statement: compost smells bad.	5	0.5
7	Paper towel rolls can be composted.	8	0.8
8	Plastic bags can be composted.	8	0.8
9	Onion skins can be composted.	9	0.9

Item #	Item	Number of Responses for ALL Constructs	μ
1	Thinking about what's typical for you, how often do you compost your kitchen scraps?	14	0.12
2	Thinking about what's typical for you, how often do you prepare meals in your kitchen?	17	0.14
3	Thinking about what's typical for you, how often do you visit a garden that grows food?	17	0.12
4	Rate your level of agreement for this statement: I don't have time to compost.	16	0.13
5	Rate your level of agreement for this statement: I don't have room to compost.	11	0.09
6	Rate your level of agreement for this statement: compost smells bad.	13	0.12
7	Paper towel rolls can be composted.	10	0.08
8	Plastic bags can be composted.	11	0.09
9	Onion skins can be composted.	15	.12

Constructs: A) ___Behavior____, B) ___Values_____, C) ___Social Norms_________

Item #	Item	Number of Responses Matching the Construct	μ_k
1	Rate how important it is to you that composting reduces the environmental impact of garbage.	10	1
2	Rate how important it is to you that composting recycles kitchen scraps into garden soil.	10	1
3	Rate how important it is to you that if people composted, we could keep about half of our garbage out of landfills.	9	0.9
4	Rate your level of agreement for this statement: My friends think composting is a good idea.	9	0.9
5	Rate your level of agreement for this statement: Many people I know like to compost.	9	0.9
6	Rate your level of agreement for this statement: Many people I know visit a community garden.	7	0.7

Item #	Item	Number of Responses for ALL Constructs	μ
1	Rate how important it is to you that composting reduces the environmental impact of garbage.	15	0.17
2	Rate how important it is to you that composting recycles kitchen scraps into garden soil.	16	0.18
3	Rate how important it is to you that if people composted, we could keep about half of our garbage out of landfills.	17	0.19
4	Rate your level of agreement for this statement: My friends think composting is a good idea.	16	0.18
5	Rate your level of agreement for this statement: Many people I know like to compost.	14	0.16
6	Rate your level of agreement for this statement: Many people I know visit a community garden.	12	0.13

Constructs: A) __Knowledge__, B) __Behavior___, C) ___Barriers____

Set 1, Q1
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (1-0.12) = 0.66$

Set 1, Q2
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (1-0.14) = 0.65$

Set 1, Q3
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.7-0.12) = 0.44$

Set 1, Q4
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.9-0.13) = 0.58$

Set 1, Q5
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.8-0.09) = 0.53$

Set 1, Q6
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.5-0.12) = 0.29$

Set 1, Q7
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.8-0.08) = 0.54$

Set 1, Q8
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.8-0.09) = 0.53$

Set 1, Q9
$I_{ik} = \left(\frac{3}{(2x3-2)}\right) x (0.9-0.12) = 0.59$

Constructs: A) ___Behavior____, B) ___Values_____, C) ___Social Norms_________

Set 2, Q1

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (1-0.17) = 0.62$$

Set 2, Q2

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (1-0.18) = 0.62$$

Set 2, Q3

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (0.9-0.19) = 0.53$$

Set 2, Q4

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (0.9-0.18) = 0.54$$

Set 2, Q5

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (0.9-0.16) = 0.56$$

Set 2, Q6

$$I_{ik} = \left(\frac{3}{2\times3-2}\right) \times (0.7-0.13) = 0.43$$

Appendix C: Short Composting Survey

These questions are about what you know and believe about composting.

1. Thinking about what's typical for you, how often do you:

a) compost at least some of your kitchen scraps.
Every day Most days Two or three days a week Once a week Never
Please explain____________________

b) prepare at least some meals in your kitchen (from scratch cooking or convenience foods).
Every day Most days Two or three days a week Once a week Never
Please explain____________________

c) eat at least some food that you grew yourself.
Every day Most days Two or three days a week Once a week Never
Please explain____________________

2. For the following statements, rate your level of agreement.

a) I don't have time to compost.
Strongly agree Agree Not sure Disagree Strongly disagree

b) I don't have room to compost.
Strongly agree Agree Not sure Disagree Strongly disagree

c) Compost smells bad.
Strongly agree Agree Not sure Disagree Strongly disagree

3. Which of the following can be composted? Circle true or false, or circle DK if you don't know.

a) Paper towel rolls	True	False	DK	e) Bacon	True	False	DK
b) Plastic bags	True	False	DK	f) Egg shells	True	False	DK
c) Onion skins	True	False	DK	g) Batteries	True	False	DK
d) Strawberry stems	True	False	DK				

4. For the following statements, rate how important it is to you that:

a) Composting reduces the environmental impact of garbage.
Very important Important Not sure Not that important Not important at all

b) Composting recycles kitchen scraps into garden soil.
Very important Important Not sure Not that important Not important at all

c) If people composted, we could keep about half of our garbage out of landfills.

Very important Important Not sure Not that important Not important at all

5. For the following statements, rate your level of agreement.

a) My friends think composting is a good idea.
Strongly agree Agree Not sure Disagree Strongly disagree

b) Many people I know like to compost.
Strongly agree Agree Not sure Disagree Strongly disagree

c) Many people I know are involved with a community garden.
Strongly agree Agree Not sure Disagree Strongly disagree