THE EFFECT OF VERMICOMPOSTING KNOWLEDGE AND VISUAL CUES ON FRUIT
CONSUMPTION IN THE MIDDLE SCHOOL LUNCH ROOM

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ABSTRACT

THESIS: The Effect of Vermicomposting Knowledge and Visual Cues on Fruit Consumption in the Middle School Lunch Room

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Adolescents do not consume the recommended daily amount of whole fruit. As part of the effort to improve the dietary choices of adolescents, traditional nutrition education alone has not been successful. School cafeterias are a strategic place to focus efforts to promote positive behavior change at the site of students' food selection and consumption. Garden-based sustainability programs correlate with the state-mandated science standards taught in the middle school classroom and have been effective at increasing fruit consumption in children. This study measured the effect of a vermicomposting model on whole fruit consumption in the middle school lunch room. Students were introduced to the concept of vermicomposting in the classroom through a lesson plan. Students were invited to participate in the vermicomposting process by contributing their fruit scraps to a worm bin that was placed in the school cafeteria for the duration of the study. A significant increase in familiarity with the topic of vermicomposting was observed after implementation of the lesson plan. Compared to baseline, the control school experienced an overall increase in fully consumed and partially consumed fruit, while the intervention school experienced a simultaneous decrease in consumption. No significant changes in fruit selection were observed.

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CHAPTER 1

INTRODUCTION

Research has shown that a diet rich in whole fruits provides important nutrients that can support weight management and decrease the risk of many chronic diseases (Boeing et al., 2012; Van Duyn & Pivonka, 2000). By consuming recommended amounts of whole fruits, which are naturally low in calories, total energy intake can be reduced due to the displacement of alternative energy-dense food sources (Alinia, Hels, & Tetens, 2009). Despite the availability of research supporting the benefits of consuming whole fruits, approximately 80% of 12-18 year olds do not meet the recommended amount of daily fruit consumption (Lorson, Melgar-Quinonez, & Taylor, 2009). This could be partially due to the barrier of low family income; however, in 2010, the United States Department of Agriculture (USDA) implemented the *Healthy, Hunger-Free Kids Act* to improve access to healthy foods regardless of socioeconomic status (P.L. 111-296, 2010). As a result of this policy, students participating in the National School Lunch Program are required to select at least one fruit or vegetable at each meal (P.L. 111-296). Despite this attempt to improve the diets of children and adolescents, no increase in fruit consumption has been observed (Cohen, Richardson, Parker, Catalano, & Rimm, 2014). It is estimated that middle school students only consume about half of the fruit that they are served, with the remainder being wasted (Cohen, Richardson, Austin, Economos, & Rimm, 2013).

Schools can be a strategic place to focus efforts on increasing fruit consumption in children (Story, Kaphingst, & French, 2006; Story, Neumark-Sztainer, & French, 2002). Students spend the majority of their day in school, and many children receive up to half of their daily energy intake in the school lunch room (Cohen et al., 2014). This provides schools with a significant influence on students' food choices and dietary health. In the middle school age group specifically, much physical and psychological growth and development takes place. During this time of life, students discover a new sense of freedom in food choice, and life-long food preferences and habits can be created (Lake, Mathers, Rugg-Gunn, & Adamson, 2006). By implementing interventions in the lunch room, schools can promote a healthy food environment at the site of food choice and consumption (Briefel, Crepinsek, Cabili, Wilson, & Gleason, 2009).

Traditional nutrition education alone has not been shown successful at changing the long-term dietary habits of children and adolescents (Contento, 2008), leading to the development of new interactive methods in recent years focused on positive behavior change (Ammerman, Lindquist, Lohr, & Hersey, 2002). In a growing effort to improve the health of the nation's youth, a large subset of the research has focused on garden-based sustainability programs (Arneson, 2012; Heim, Stang, & Ireland, 2009; McAleese & Rankin, 2007; Ratcliffe, Merrigan, Rogers, & Goldberg, 2009; Robinson-O'Brien, Story, & Heim, 2009; Skinner, Chi, & The Learning-Gardens Educational Assessment Group, 2012). When implemented in the school setting, such programs have the potential to improve nutrition knowledge, attitudes toward food and the environment, and fruit and vegetable consumption (Heim et al., 2009; McAleese & Rankin, 2007; Robinson-O'Brien et al., 2009; Taylor & Johnson, 2013). Students can become engaged in the goal of environmental stewardship and learn what it means to protect the planet,

while at the same time improving their health and well-being. These garden-based programs and sustainability curriculums integrate well into the required educational standards that are taught in the middle school science classroom (Indiana Department of Education, 2010).

One specific garden-based sustainability program that can be implemented in schools to promote behavior change is vermicomposting. This practice uses worms to aid in the decomposition of organic materials, such as food scraps, creating a nutrient rich soil that can be used as a fertilizer (Pagan & Steen, 2004). By implementing such a program in the middle school lunch room, students are provided with a visual cue that encourages a connection to the environment. This environmental support provides a fun incentive for students to increase their fruit consumption by allowing them to contribute their fruit scraps to the process. Vermicomposting in schools can lead to improved health outcomes, a greater sense of environmental responsibility, and reduced levels of food waste.

Problem

Approximately 80% of 12-18 year olds do not meet the recommended amount of daily fruit consumption (Lorson et al., 2009). Research indicates that increased fruit consumption can lead to better weight control and overall health in children (Alinia et al., 2009). After implementation of the *Healthy, Hunger-Free Kids Act*, Cohen et al. (2014) observed a 16.2% increase in student vegetable consumption (excluding potato products), but no corresponding change in fruit consumption. In addition, an estimated 40-75% of selected fruits and vegetables served are being discarded in elementary and middle school cafeterias (Cohen et al., 2014). Middle school is a strategic time and place to implement programs that aim to improve the dietary habits of students (Story et al., 2002). Traditional nutrition education has not been shown successful at changing the dietary habits of young people (Contento, 2008). Garden-based

sustainability programs correspond with the state-mandated sciences standards taught in the middle school classroom and have been effective at increasing fruit consumption in children (Heim et al., 2009; Indiana Department of Education, 2010). There exists a need for innovative approaches to increase fruit consumption among middle school students in the school lunch room.

Purpose

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room.

Research Questions

The following research questions were examined in this study:

RQ#1. Does the introduction of vermicomposting in the middle school lunchroom increase fruit consumption?

RQ#2. Is there a relationship between knowledge about the process of vermicomposting and fruit consumption in the middle school lunch room?

RQ#3. Does an academic lesson about vermicomposting increase knowledge of vermicomposting among middle school students?

RQ#4. Does the addition of a visual cue (sticker) increase fruit consumption above:

- a) baseline measurements?
- b) levels observed after exposure to the process of vermicomposting?

Rationale

The aim of this research study was to determine if whole fruit consumption can be increased through the introduction of a fun, interactive visual cue within the middle school lunch room. By teaching the students about vermicomposting and allowing the students to visually witness the process, this intervention forms a connection between what is learned in the classroom and a real-world example of a sustainable practice. Students are encouraged to participate by contributing their leftover fruit scraps to the vermicomposting bin. Not only can participation in vermicomposting increase the amount of fruit that is consumed by middle school students, providing many health benefits and preventing chronic disease, but it also promotes environmental stewardship and reduces cafeteria food waste. This intervention has the ability to provide educational, health, and environmental benefits to middle school students and open the door for similar measures to be implemented in other school systems.

Assumptions

The researcher made the following assumptions in the implementation of the study and in the interpretation of the data:

1. The schools included in this study were currently complying with all National School Lunch Program standards, including the requirement that each student select one fruit or vegetable with every meal.
2. The fruit consumption observed and accounted for by the researcher and research assistants was complete and provided an accurate representation of all fruit consumed in the lunchroom.
3. All data collection completed by research assistants was done in accordance with the training provided by the researcher.

Definitions

For the purpose of this study, the following definitions were used:

1. Visual cue – an object that serves to connect actions and thoughts to the implemented program;
2. Fully-consumed fruit – refers to fruit that has been $\geq 50\%$ consumed;
3. Partially-consumed fruit – refers to fruit that has been 1-49% consumed;
4. Unconsumed fruit – refers to fruit that has been 0% consumed;
5. Vermicomposting – using worms to aid in the decomposition of organic material, creating compost that can be used as a plant fertilizer.

Summary

Eating habits that are developed during the middle school years are significantly likely to continue into adulthood. The current dietary habits of this age group include fruit intakes below the recommended amounts. In the national effort to encourage healthy food choices in children and adolescents, schools play a unique role. Nutrition education alone has not been shown to increase fruit consumption in children. However, the use of environmental supports in the school lunch room has the potential to increase fruit consumption and decrease the prevalence of childhood overweight, obesity, and related chronic diseases. By introducing the concept of vermicomposting to middle school students, schools have the ability to improve the dietary health of children, promote a common sense of purpose, and reduce cafeteria food waste. Students will be introduced to the topic of sustainability and be given the opportunity to work together to protect the environment by contributing their leftover fruit scraps to the vermicomposting bin. Thus, a vermicomposting program has the potential to promote positive dietary behavior change.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room. This chapter will present an examination of the literature related to current fruit consumption trends among children, benefits of increased fruit consumption, food waste in school cafeterias, and the use of visual cues and garden-based approaches to increase fruit consumption, including the implementation of vermicomposting as a garden-based sustainability program.

Introduction

Current research consists of a variety of approaches to improve the health and nutrition of school-aged children and adolescents, including interventions aimed at increasing nutrition knowledge, changing dietary motivations, and engaging children in hands-on activities (Fahlman, Dake, McCaughtry, & Martin, 2008; Gratton, Povey, & Clark-Carter, 2007; Lakshman, Sharp, Ong, & Forouhi, 2010). Although these studies have achieved positive immediate results, long-term behavior changes have not been substantiated. From 1986 to 2007, nutrition education research increased by nearly 85%, indicating a recognized need for a long-lasting solution to the declining nutritional status of the American population, particularly children (Contento, 2008).

Middle school is a strategic time and place to promote dietary behavior change. Eating patterns that are developed in adolescence are significantly likely to continue into adulthood (Lake et al., 2006). The middle school years are a period of rapid physiological and psychological growth. Much change and experimentation occurs during this time of life as a result of an increased level of freedom, a developing sense of self, and a desire to fit in (Jenkins & Horner, 2005). These factors can have a substantial, and often negative, effect on eating behavior and nutritional health (Story et al., 2002). As students spend the majority of their time outside of the home, schools can play a vital role in the development of healthy eating habits (Briefel et al., 2009). By promoting a wholesome food environment, schools can have much influence over the dietary choices and health outcomes of adolescents (Briefel et al., 2009). Within the school lunch room, nutrition interventions can be tactically implemented to encourage healthy eating at the site of food choice and consumption.

Fruit Consumption among Children

Research indicates that the current generation of children and adolescents do not consume the suggested amount of fruit for optimal health. For children ages nine to thirteen years, the United States Department of Agriculture (2016) recommends intake of at least one and a half cups of fruit per day. This recommendation increases to one and a half to two cups per day for children ages fourteen to eighteen years (USDA, 2016). Using data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES), Lorson et al. (2009) assessed fruit and vegetable intakes among individuals aged 2 to 18 years compared to current dietary recommendations. When examining fruit consumption by age, Lorson et al. (2009) found significantly higher intakes of fruit among younger children than adolescents. Children aged 2 to 5 consumed an average of 129.7% of the recommended daily amount of fruit, while children

aged 6 to 11 and adolescents aged 12-18 consumed 71.5 and 54.6%, respectively. Similarly, it was found that 80.5% of 12-18 year olds do not meet daily fruit intake recommendations (Lorson et al., 2009).

Kimmons, Gillespie, Seymour, Serdula, and Blanck (2009) analyzed the 2-day, 24-hour recall data from the 2003-2004 National Health and Nutrition Examination Survey (NHANES), to determine the median fruit and vegetable consumption from all dietary sources among adolescent and adult consumers, both overall and by various demographic characteristics. Results indicated only 6.2% of adolescents met fruit intake recommendations, with 100% fruit juice, specifically orange juice, the main source of fruit intake among this age group (Kimmons et al., 2009). Among adolescents, no significant differences in overall fruit consumption were found between genders (Kimmons et al., 2009). Similarly, when compared to females, Lorson et al. (2009) found that male children and adolescents consumed a greater percentage of fruit in the form of juice, rather than whole fruit. Although 100% fruit juice can contribute to a healthy diet, the 2015 Dietary Guidelines for Americans recommends that the majority of fruit intake is in the form of whole fruit (USDA & DHHS, 2015).

Benefits of fruit consumption

According to the Dietary Guidelines for Americans (USDA & DHHS, 2015), a diet rich in a variety of fruits and vegetables is essential for the health of children and adolescents. Not only does adequate fruit intake provide important nutrients and phytochemicals for proper growth and development, but it also supports weight management and decreases the risk of many chronic diseases (American Heart Association, 2015; Lowry, Lee, McKenna, Galuska, & Kann, 2008).

An analysis of the most recent National Health and Nutrition Examination Survey (NHANES) data indicates 34.5% of individuals aged 12 to 19 are overweight or obese (BMI greater than or equal to the 85th percentile on the BMI for age growth chart). Additionally, 20.5% of the same population were classified as obese, with a BMI for age and gender at above the 95th percentile (Ogden, Carroll, Kit, & Flegal, 2014). The 2011-2012 NHANES data indicates that obesity among adolescents in the United States has increased by 3.1% in the last eight years (Ogden et al., 2014). Although the increase in prevalence has slowed in recent years, childhood obesity continues to be a major problem facing American youth (Ogden et al., 2014).

Research has shown that an increase of whole fruit in the diet can assist individuals of all ages in maintaining a healthy weight (Lowry et al., 2008; Whigham et al., 2012). Weight gain occurs when the amount of energy consumed exceeds the amount of energy spent (Boeing et al., 2012). By increasing consumption of fruits, which are naturally lower in calories, an individual can consume a larger volume of food, causing greater satiety and decreased energy intake (Alinia et al., 2009). In a systematic review of the literature, Alinia et al. (2009) found a significant association between fruit intake and weight loss, reduced risk of overweight and obesity, and a smaller increase in body weight, providing evidence to support the beneficial role of fruit consumption in weight management.

Overweight and obesity increase the risk of developing chronic diseases, such as cardiovascular disease, hypertension, and type 2 diabetes (American Heart Association, 2012; Boeing et al., 2012; Daniels, 2006). These diseases, traditionally found among the adult population, have increased in prevalence among children and adolescents over the last few decades (American Heart Association, 2012). Although obesity can be a contributor to such diseases, these morbidities can also occur as a result of a poor diet in the absence of overweight

(USDA & DHHS, 2015). Consumption of whole fruits, a source of vitamins, minerals, and other nutrients that contribute to optimal health, can aid in the prevention of chronic disease (Boeing et al., 2012; Van Duyn & Pivonka, 2000).

Specifically, whole fruits are a significant contributor of soluble fiber (USDA, 2016). The fiber found in whole fruits can help prevent the development of many diseases and conditions. Consumption of adequate amounts of dietary fiber can decrease an individual's risk of hyperlipidemia and heart disease by lowering cholesterol levels. Soluble fiber supports bowel health by promoting regularity and preventing conditions like constipation and diverticulosis. Additionally, soluble fiber increases satiety by slowing down gastric emptying, making it easier to consume fewer calories and maintain a healthy weight (USDA, 2016).

Efforts must be taken to increase whole fruit consumption, particularly among children and adolescents. By focusing behavior change efforts on the middle school population, healthy eating habits can be developed early, increasing the likelihood that they will continue later in life (Lake et al., 2006).

Barriers to fruit consumption

Income level can be a significant barrier to achieving recommended levels of fruit intake. Fruit consumption was found to be highest among individuals living above 350% of the federal poverty level and lowest among food insecure households, indicating a relationship between income level and diet (Lorson et al., 2009). Up to half of the daily energy intake of many children from low-income families comes from the meals provided by schools through the National School Lunch Program, requiring schools to play a critical role in the health of U.S. children and adolescents (Cohen et al., 2014).

In an attempt to improve child nutrition and provide equal access to fresh fruits and vegetables to all children regardless of socioeconomic status, the United States Department of Agriculture (USDA) implemented the *Healthy, Hunger-Free Kids Act* passed by Congress in 2010 (P.L. 111-296; Cohen et al., 2014). This improvement in school meal standards requires schools to offer more whole grains, fruits, and vegetables to students in the lunch room, in order to better meet the 2010 *Dietary Guidelines for Americans* (USDA & DHHS, 2010). The policy mandates upper limits on total calorie, sodium, and fat contents of provided meals. Additionally, students are required to select at least one fruit or vegetable at each meal (P.L. 111-296). Cohen et al. (2014) examined the effects of this legislation on food selection and actual consumption among elementary and middle school students. A 16.2% increase in student vegetable consumption, but no corresponding change in fruit consumption, was observed. Research has shown that policy changes such as this are not a sufficient means to promote dietary behavior change in children and adolescents.

Food Waste

School lunch policies that require students to select foods that they do not want to consume contributes to the issue of food waste. Approximately one-third of all food that is produced in America is wasted, meaning edible food is discarded unconsumed and sent to the landfill (Blondin, Djang, Metayer, Anzman-Frasca, & Economos, 2014; Wilkie, Graunke, & Cornejo, 2015). This food waste can occur at any step of the food production and consumption chain; however, a large majority of food waste occurs at sites of institutional food service (Wilkie et al., 2015). Blondin et al. (2014) estimates that an additional 25 million people could be fed if only 15% of the food waste in America was reduced or diverted. Food waste and landfill disposal contributes to detrimental environmental and social issues that can be avoided,

including increased greenhouse gas emissions, reduced food system sustainability, and climate change (Blondin et al., 2014).

Food waste in school cafeterias

School cafeterias are a major contributor to the substantial food waste in America (Blondin et al., 2014; Wilkie et al., 2015). The *Healthy, Hunger-Free Kids Act* currently requires the selection of a fruit or vegetable from the lunch line in public schools, but it cannot mandate the consumption of such foods (P.L. 111-296, 2010). Without concomitantly addressing the underlying dietary motivations and behaviors, policies such as this have the potential to increase food waste rather than instigate beneficial dietary changes. In a plate waste study by Cohen et al. (2013), middle school students consumed on average only half of the food that they were served, including only 53% of their fruit. It was estimated that the cost of wasted food averages to \$0.26 per day per middle school student, resulting in approximately \$47.12 in food waste per student annually (Cohen et al., 2013).

Methods to divert food waste

School cafeterias are an ideal candidate for food waste diversion techniques, as meal preparation and service occurs on a large scale at a single location (Wilkie et al., 2015). Although some strategies have been proposed to reduce food waste in schools, such as extending eating time, serving lunch after recess, and serving fruit in ready to eat forms, food waste continues to be a significant problem facing public schools (Blondin et al., 2014). Thus, methods of diverting waste become necessary.

Composting programs present a cheap, low maintenance solution to the food waste problem (Gleason, Ause, & Hein, 2013; Wilkie et al., 2015). In fact, many schools have begun to integrate the concept of composting into the lunchroom as a way to reduce food waste, while

teaching students about environmental stewardship (Wilkie et al., 2015). Composting involves the decomposition of organic, plant-based materials into a nutrient-rich substance that can be used as a fertilizer to grow more food (Singh, Singh, Araujo, Hakimi Ibrahim, & Sulaiman, 2011). In the school cafeteria setting, food wastes such as vegetable scraps and fruit peels can contribute to this process, allowing students to actively give back to the environment on a daily basis (Wilkie et al., 2015).

Approaches to Increase Fruit Consumption

Within the effort to improve the health of the nation's youth, many approaches have been taken specifically to increase fruit consumption (Delgado-Noguera, Tort, Martínez-Zapata, & Bonfill, 2011; Knai, Pomerleau, Lock, & McKee, 2006; Perikkou, Gavrieli, Kougioufa, Tzirkali, & Yannakoulia, 2013). As traditional nutrition education alone has not been shown successful at changing the dietary habits of children and adolescents (Contento, 2008), new interactive methods have emerged in the research in recent years, including the implementation of garden-based programs (Ammerman et al., 2002).

School garden programs

It is well established that garden-based learning among children and adolescents provides substantial benefits (Arneson, 2012; Heim et al., 2009; McAleese & Rankin, 2007; Ratcliffe et al., 2009; Robinson-O'Brien et al., 2009; Skinner et al., 2012). Not only do school garden programs have the potential to increase nutrition knowledge, but they have also been shown to improve underlying attitudes toward and willingness to try new types of food. In a review of the literature, Robinson-O'Brien et al. (2009) examined the impact of garden-based youth nutrition intervention programs. The eleven studies that were included in this review were published between 1990 and 2007, involved children and adolescents, and took place in the United States.

Included studies examined the impact of garden-based nutrition education on one or more of the following outcomes: fruit and vegetable intake, willingness to try new fruits and vegetables, preferences for fruits and vegetables, or other nutrition-related outcomes. Among younger children, an overall increase in willingness to try new fruits and vegetables was observed as a result of garden-based learning. Robinson-O'Brien et al. (2009) concluded that targeting children at a younger age has the potential to increase exposure to fruits and vegetables and aid in the development of healthy eating patterns.

Many studies have observed significant increases in fruit and vegetable consumption after the implementation of garden-based programs (Heim et al., 2009; McAleese & Rankin, 2007; Robinson-O'Brien et al., 2009; Taylor & Johnson, 2013). McAleese and Rankin (2007) conducted a study among sixth grade students (n=99) at three different elementary schools. Each school was assigned to either the control group or one of two different treatment groups. Participants in both treatment groups participated in a 12-week nutrition education program. In addition, one of the treatment groups took part in garden-based activities, such as planting, weeding, watering, harvesting, herb drying, and preparing recipes using harvested produce. Using food recall workbooks, students self-reported their dietary intake throughout the study. A repeated-measures one-way ANOVA was conducted using the number of fruits and vegetable servings that subjects consumed before and immediately after the intervention. Compared to the control school and the experimental school receiving only nutrition education, fruit and vegetable consumption increased significantly ($p<.001$) among students at the experimental school that took part in both garden-based activities and the nutrition education program (McAleese & Rankin, 2007). The results of this study provide support for the efficacy of school gardening programs as a method of improving child and adolescent nutrition.

When children are given a chance to take part in the growing process, they become engaged in a “bigger than themselves” goal of nurturing and caring for the planet (Arneson, 2012; Heim et al., 2009; Robinson-O'Brien et al., 2009). Skinner et al. (2012) utilized an adapted version of the Self-Determination Theory (SDT) to explain the effects that garden-based learning can have on student academic achievement and personal development. This model focuses on the personal and social factors that contribute to intrinsic motivation and student engagement. Cooperative, experiential garden-based education programs have the ability fulfill the need of a student for relatedness, competence, and autonomy (Skinner et al., 2012). In cooperation with the Learning Garden Laboratory, a garden-based education program for minority, low-income middle school students, Skinner et al. (2012) observed the impact of the gardening on the previous outcomes. Teacher and student reports were used to determine the degree of impact on intrinsic motivation and engagement. When given the opportunity to develop a sense of purpose and ownership for the garden, students exhibited increased engagement in the process. This observed enthusiasm in participation also has the potential to influence interest in preparation and consumption of the garden harvest (Heim et al., 2009; McAleese & Rankin, 2007; Ratcliffe et al., 2009; Robinson-O'Brien et al., 2009).

Vermicomposting

Vermicomposting is a garden-related environmental practice that can engage students in caring for the earth. This specific type of composting utilizes worms to break down organic scraps, such as food and yard waste, and return the nutrients back to the soil (Pagan & Steen, 2004). Vermicomposting worms create a type of fertilizer, called worm castings, that contains beneficial nutrients from the decomposed scraps, along with healthy microflora from the gut of the worms (Lleo et al., 2013; Singh et al., 2011). When compared to a traditional compost pile, a

vermicomposting system speeds up the decomposition process (Lleo et al., 2013). If implemented in the school setting, vermicomposting allows students to visually witness the process and understand the connection between their actions and the finished product (Wilkie et al., 2015). Current literature on this topic is aimed at the environmental and educational implications; however, there is a gap in the literature regarding the impact of vermicomposting as a means to improve the dietary habits of children and adolescents.

Stanton (2015) conducted a pilot study, investigating this potential association. Fruit consumption data was collected and analyzed at two K-5 elementary schools: an intervention school (n=560) and a control school (n=491). After baseline fruit consumption data was collected, students at the intervention school were introduced to the process of vermicomposting and allowed to contribute their fruit scraps to a worm bin in the school lunch room. Fruit scraps, or “worm food,” were collected two times per week for four weeks, and fruit consumption was recorded as “consumed” ($\geq 50\%$) or “not consumed” ($< 50\%$). In addition to the vermicomposting bin, compostable stickers featuring a worm motif were placed on whole fruits prior to selection as a visual cue. Fruit scraps were collected for two more days and recorded as before. Compared to baseline measurements, a significant increase in fruit consumption ($M=12.03$, $p<.001$, $n=62$) was observed per grade after students were introduced to the process of vermicomposting. This increase was equal to 0.19 pieces of fruit per student who received the school lunch meal. Similarly, when stickers were added to the intervention, a significant increase in fruit ($M=9.29$, $p<.001$, $n=63$) was observed per grade compared to baseline, with an increase of approximately 0.15 pieces of fruit per student. With the addition of stickers, no significant changes in fruit consumption were observed compared to the vermicomposting bin intervention alone. In the control school, a significant decrease in fruit consumption was found ($M=-5.81$, $p=.001$, $n=65$)

per grade between the vermicomposting and the vermicomposting plus stickers stages of the study (Stanton, 2015).

Sustainability curriculum

Within the classroom, garden-based sustainability programs correspond with the state-mandated sciences standards taught at the middle school level (Indiana Department of Education, 2010). Environmental education effortlessly meets the objectives of natural science education, while informing students how to protect and improve the world around them (Zhanbao, 2004). This subset of the curriculum serves to promote environmental awareness, knowledge, skills, values, and attitudes. In this way, schools play a critical role in shaping the environmental attitudes and behaviors of middle school students (Gleason et al., 2013; Johnson & Manoli, 2008; ŞAhin & Erkal, 2010). In fact, in a questionnaire exploring the level of environmental attention of sixth, seventh, and eighth grade students, schools were listed as the most important source of information from which students learned about the environment (ŞAhin & Erkal, 2010).

Visual cues

In the school setting, visual cues and environmental changes have often been used to influence the behavior of students through a psychological concept called behavioral economics, which seeks to understand behaviors and the motivations behind them (Just, Wansink, Mancino, & Guthrie, 2008). Specifically, behavioral economics has been used to promote positive dietary choices in school cafeterias (Just & Wansink, 2009; Just et al., 2008; Wansink, Just, & Payne, 2012). Subtle changes to the lunch room environment, such as moving fruit to the end of the line or making unhealthy choices less convenient, can guide the decision-making process, while allowing students to maintain control and ownership of their choice (Just & Wansink, 2009).

As an example of a visual cue, Wansink et al. (2012) examined the effect of branding on whole fruit selection among 208 eight to eleven-year-old children. Participants were enrolled at seven different schools in upstate New York. Baseline preferences were collected, during which children were free to choose between an apple and a cookie as a lunch component. Following baseline observations, stickers featuring the popular Sesame Street character, Elmo, were placed on the apples one day, and on the cookies the next day. Students' selections were recorded to determine any changes in preference as a result of the stickers. Compared to baseline, apple selection nearly doubled when the Elmo sticker was featured ($p=.06$). Similar to the branding that often occurs with unhealthy, highly-processed food items, the use of stickers and other visual cues has the potential to positively influence dietary choices among children (Wansink et al., 2012).

Similarly, Stanton (2015) observed an increase in fruit selection compared to baseline among elementary students with the use of stickers as a visual cue. However, in this study, the stickers were introduced in addition to a vermicomposting bin. The change in fruit consumption found with the use of stickers was not significant ($M=-2.73$, $p=.067$) when compared to the change seen with only a vermicomposting bin (Stanton, 2015). Stickers, especially compostable stickers, present a significant and continuous monetary burden to any organization wishing to implement a behavior change intervention. If garden-based interventions, such as vermicomposting, can exhibit the same effect on dietary behaviors, these methods may be preferable financially. The study by Stanton (2015) was the only research that could be found examining this particular topic.

Summary

In recent years, nutrition education research has increased in an effort to reverse the detrimental decline in the health of nation's youth. Research indicates that a diet rich in whole fruits can aid in the maintenance of a healthy weight and the prevention of chronic disease. However, most adolescents do not regularly consume recommended daily amounts of fruit for optimal health. The intervention studies that have been conducted in recent years, aimed at changing nutrition knowledge and dietary motivation, have not been successful as a long term solution to the poor dietary choices of this generation of children. Thus, an innovative approach to increasing fruit consumption among this age group is needed. The school lunch room is a strategic place to implement an interactive dietary intervention, as this is the primary location of food selection and consumption within the school. Additionally, the middle school years are a key time for the development of lifelong dietary habits and food selection preferences. Garden-based school interventions, along with corresponding environmental education, can be an effective way to increase fruit consumption in children and adolescents and encourage environmental stewardship. Specifically, exposure to an interactive vermicomposting model, utilizing visual cues and environmental supports, can provide a fun learning experience that encourages students to give back to the earth, while also increasing their fruit consumption.

CHAPTER 3

METHODOLOGY

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room. This chapter will describe the methods that were used to conduct the study.

Institutional Review Board

Prior to the implementation of this study, permission was requested from the Ball State University Institutional Review Board (Appendix A-1), with the study approved on September 24, 2015 as expedited. Informed consent was not required for this study, as no identifiable information was collected on participants. Collected data on vermicomposting knowledge and fruit consumption could not be connected to individual students. The researcher completed the Collaborative Institutional Training Initiative (CITI) training (Appendix A-2). All assistants who helped with the implementation of this study were CITI certified.

Letters of Support

Both school principals were informed of all study procedures, and letters of support were obtained (Appendix B-1; Appendix B-2). No identifiable information regarding students was recorded. Based on the IRB approval of study requirements and risk, no student or parental consent was required for the completion of this study.

Subjects

The subjects of this quasi-experimental study consisted of sixth grade students in the only two 6-8th grade middle schools in the Muncie Community School Corporation who received the National School Lunch Program meal. The sixth grade class in one school (n=191) served as the intervention school, while the students (n=246) enrolled at the second school served as the control school. This group of participants was chosen as a convenience sample, with the sample size dictated by current enrollment in each school. The intervention school was selected due to an expressed interest in working with the researcher on this project, and the control school was designated as the only other middle school in the community.

Instruments

Education

A lesson on vermicomposting (Appendix C-1) was developed to be taught in the science classrooms by the school's science teachers. This lesson plan was created by the Principal Investigator (PI) in collaboration with a teacher from the intervention school for the purpose of this study. A pre-test (Appendix C-2) and post-test (Appendix C-3) were created by the researcher to examine the effect of the lesson plan on knowledge of vermicomposting. These evaluation instruments were reviewed for content validity by two education professionals and

were pilot-tested for reliability during this study to provide baseline data for their use in future research.

Data Collection

A data sheet was adapted from the version created for the pilot study (Stanton, 2015) for the purpose of recording the student's fruit consumption (Appendix D-1). Space was provided on the data sheet to mark fruit scraps as not consumed (0%), partially consumed (1-49%), or fully consumed ($\geq 50\%$). A predetermined code was also shown on the data sheet to allow research assistants to record the type of fruit consumed. Images of real fruit (Appendix D-2) were provided as a visual aid in determining fruit consumption percentages.

Lunchroom Materials

A vermicomposting bin was created by the PI to allow students to visually witness the sustainable practice they learned about in the classroom. This lunchroom tool consisted of two 30-gallon plastic totes filled with red wiggler worms and a system of bedding made out of moistened recycled newspapers. The worm bin contained a viewing window on the side of the external tote to allow students to view the vermicomposting process. A removable flap featuring a worm motif (Appendix C-4) and a description of the vermicomposting process (Appendix C-5) was placed over the window.

Signs featuring an illustrated worm motif (Appendix C-4) were placed on the vermicomposting bin and the fruit scrap collection totes to serve as a visual cue. On the vermicomposting bin, this sign also served as a viewing flap that was lifted as the bin was wheeled down each aisle for the students to see.

The PI planned to use compostable stickers featuring the same illustrated worm motif (Appendix C-5) during the last two weeks of the intervention. Stickers were to be placed on the

whole fruits served to students prior to the data collection lunch periods. These stickers would have served as an extra visual cue to help students make the connection between their food choices and the sustainable practice of vermicomposting.

Intervention

Prior to Week 1

Prior to beginning of this study, during the summer of 2015, the PI contacted the principals of the intervention and control schools to gauge interest in participating in this study. The Food Service Director for the Muncie Community School Corporation was also informed about the procedures and implications of the study. Permission was obtained from all three authorities, and letters of support were provided by both school principals (Appendix B-1; Appendix B-2).

Also during the summer of 2015, the PI collaborated with one of the teachers from the intervention school to create a lesson plan on vermicomposting (Appendix C-1) that corresponds with the state-mandated science standards required in the middle school classroom. This lesson plan teaches vermicomposting vocabulary, benefits of vermicomposting, what can and cannot be added to a vermicomposting bin, and fun facts about worms. Interactive games that reinforced the student learning outcomes were also provided with the lesson plan to encourage students to participate.

During the fall 2015 semester, research assistants were trained in the use of the data sheets to ensure accurate and consistent fruit consumption data. This training included information on how to record the number of fruit scraps, the type of fruit, and the consumption percentage.

The PI visited both schools during the fall of 2015 to observe the layout of the lunchroom and determine the best location for placement of the vermicomposting bin and research assistants who collected the data. The PI contacted the Food Service Director to determine when whole fruit was scheduled to be served. Both schools followed the same menu, and data collection was scheduled to take place at each school on the same two days each week for the duration of the study.

In early December 2015, the week before the implementation of the lesson plan, a pre-test consisting of five multiple-choice questions related to vermicomposting (Appendix C-2) was given to the students at the intervention school by the school's science teachers. This pre-test was given to determine baseline knowledge on the topic. After completion, these tests were collected by the head of the science department and returned to the PI. The lesson plan was then taught by the science teachers in the intervention school during the last week of the 2015 fall semester.

Two weeks prior to the start of fruit consumption data collection, the PI constructed a vermicomposting bin using two 30-gallon plastic totes. Air holes were drilled evenly along the walls of a clear plastic bin. This bin was placed inside of an opaque bin to block the light and contain potential messes or leaks. A viewing window was cut in the side of the external opaque bin to allow the students to view the vermicomposting process. Two pounds of red wiggler worms were introduced into a system of bedding created by the PI out of moistened recycled newspapers. This process occurred prior to the start of the study to allow time for the worms to settle into the newly created system. A sign featuring an illustrated worm motif (Appendix C-4) and a brief description of the vermicomposting process (Appendix C-5) was placed over the viewing window as a flap that could be lifted for the students to see the worms.

Week 1 (Baseline)

At the beginning of the spring semester, in January 2016, the PI and research assistants visited during two lunch periods over one week in each school to visually observe baseline eating habits in the normal lunch session. All data collection was recorded on data collection sheets created for the purpose of this study (Appendix D-1). Initial observations occurred on days when whole fruit was served and provided a baseline for fruit consumption in both schools.

Weeks 2-6 (Vermicomposting Bin Intervention)

After baseline observations, the vermicomposting bin was placed in the lunch room of the intervention school on a wheeled cart where it remained throughout the duration of the study. The vermicomposting bin was maintained by the PI. A separate fruit scraps collection tote was also placed in the intervention school cafeteria, featuring a worm motif (Appendix C-4) that served as a visual cue, connecting the students' discarded fruit scraps to the process of vermicomposting.

After placement of the primary intervention during the sixth grade lunch period in the intervention school, a brief announcement was made by the assistant principal about vermicomposting and the students' role in the process. The announcement was directed by the PI and was given by the assistant principal in an effort to obtain the maximum attention and cooperation of the students. Throughout the intervention, the PI walked around the cafeteria and talked to the students about vermicomposting. When appropriate, the PI also wheeled the vermicomposting bin around the cafeteria to allow students to see the worms and witness the vermicomposting process. Whole fruit consumption in the intervention school was recorded twice per week over five weeks, using visual observation of the fruit remnants placed in the collection bin as it was wheeled down the lunchroom aisles. During the same time period, data

collection occurred in the control school as visual observation of fruit consumed. In both schools, fruit was considered fully consumed if $\geq 50\%$ was eaten, partially consumed if 1-49% was eaten, and not consumed if no bites were eaten. Both the PI and research assistants determined percent consumption based on set visual standards (Appendix D-2).

After Week 6

After the completion of fruit consumption data collection, a post-test on vermicomposting, identical to the pre-test previously implemented, was given to students at the intervention school by the school's science teachers (Appendix C-3). The post-test was implemented four weeks after the last day of data collection in an effort to avoid standardized testing and Spring Break vacation. This was planned to occur prior to the secondary sticker portion of the study. The tests were again collected by the head of the science department and returned to the PI for analysis.

For the final phase of the study, compostable stickers matching the worm motif on the collection bin were intended to be placed on whole fruit in the lunch line in both schools as an additional visual cue. The PI planned to record fruit consumption again in both schools for two weeks during two lunch periods per week. This final portion of the study was not able to be completed due to foodservice management changes and major revisions to the lunch menu. As a result of this change to the study design, the final research question, regarding the impact of compostable stickers on fruit consumption, was removed from analysis.

Data Analysis

All data collected at both schools was initially entered into Microsoft Excel 2013 spreadsheets to combine and organize data in a common location. One spreadsheet was created for pre- and post-test data and included headings for the stage of the study (pre- or post-test), the

provided response for each question, and the percent correct on each test. A second spreadsheet was created for fruit consumption data. This sheet included headings for the week, date, type of fruit, total number of each fruit selected, number of non-consumed pieces of fruit, number of partially consumed pieces of fruit, and number of fully consumed pieces of fruit. Two tabs were created, each containing identical headings: one for the intervention school and one for the control school. The data was then uploaded into SPSS v.23.0. For the pre-test and post-test data, descriptive statistics, Chi-square tests, and an independent t-test were run to determine the overall trends in knowledge about vermicomposting and the observed effect of the lesson plan. Descriptive statistics included frequencies and means. The questions were tested for internal consistency using Cronbach's Alpha to determine how closely the items were related in their ability to test vermicomposting knowledge. Descriptive statistics were also run on all recorded fruit consumption data to examine trends in fruit selection and consumption in each school. This included frequencies, means, and standard errors for each school, week, type of fruit, and category of consumption. An independent t-test was run using overall fruit selection excluding baseline at both schools to determine any differences in fruit selection between the control and intervention schools. Tables of means were created, and the *difference in difference* statistical model, along with confidence intervals, was used to determine changes in fruit consumption from baseline within the intervention school. This statistical model was recommended by Dr. Jim Jones, Director of Research and Academic Effectiveness at Ball State University. The researcher was unable to complete and analyze the final stage of the study, using stickers as an additional visual cue, due to changes in foodservice management and major revisions to the lunch menu. Statistical significance was set at $p \leq .05$. Results were determined to be approaching significance at $.05 < p \leq .10$.

Summary

This quasi-experimental observational study, conducted on a convenience sample of two sixth-grade classes in Muncie, Indiana, tested an innovative method to improve whole fruit consumption in the middle school lunch room. By introducing the students to the concept of vermicomposting and allowing them to witness the process in action, this intervention allowed the students to connect their food consumption habits to a sustainability practice that they learned about in the classroom. This project served to promote positive dietary behavior change and improve the health of middle school students in a non-traditional way. Nutrition education alone has not been shown successful at changing the long-term dietary habits of children and adolescents (Contento, 2008). Thus, this intervention presented an interactive garden-based program that seeks to increase fruit consumption without the use of nutrition education. Fruit consumption was measured before, during, and after the proposed intervention, and the data was used to evaluate differences between and within the intervention and control groups.

CHAPTER 4

RESULTS

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room. This chapter will present an overview of the results of the research study by answering each of the research questions and presenting tables and graphs to support the findings.

Demographics

The participants for this quasi-experimental observational study consisted of sixth grade students participating in the National School Lunch Program in two middle schools (grades 6-8). The schools were comparable in size with sixth grade student enrollment of 191 and 246, in the intervention and control schools, respectively. At the school level, 85% of students at the intervention school participated in the National School Lunch Program in 2015 by receiving free or reduced price meals. This number was slightly lower at the control school with 69% participation. Based on the information provided by the Indiana Department of Education website, the ethnic distribution was similar between sites. The intervention school student population was 69.6% Caucasian, 17.8% African American, 10.1% multiracial, and 2.5% other ethnicities. Similarly, the control school population was 59.2% Caucasian, 25.1% African

American, 9.9% multiracial, and 5.8% other ethnicities. No identifiable information concerning individual student identity was recorded.

Research Findings

After data was collected, it was transferred into Microsoft Excel 2013, then uploaded into SPSS v.23.0 for Windows for statistical analysis. Descriptive statistics, chi-square tests, and an independent t-test were run on pre- and post-test data to determine the overall trends in knowledge about vermicomposting and the observed effect of the lesson plan. Descriptive statistics were also run on all recorded fruit consumption data. Tables of means were produced, and the *difference in difference* statistical model, along with confidence intervals, were used to determine changes in fruit consumption within the intervention school between baseline observations and the intervention stage of the study.

Research questions:

The following research questions were examined in this study:

RQ#1. Does the introduction of vermicomposting in the middle school lunchroom increase fruit consumption?

RQ#2. Is there a relationship between knowledge about the process of vermicomposting and fruit consumption in the middle school lunch room?

RQ#3. Does an academic lesson about vermicomposting increase knowledge of vermicomposting among middle school students?

Impacts on vermicomposting knowledge

Reliability statistics were run on the content questions of the pre-test and the post-test, number 2 through 5 (Appendix C-2; Appendix C-3), to determine the internal consistency of the questions comprising the knowledge test on vermicomposting. Cronbach's Alpha coefficients were moderate for both tests, .628 and .699 for the pre-test and the post-test, respectively.

Descriptive statistics and chi-square tests were run on the pre- and post-test data to determine baseline knowledge and any changes in knowledge of vermicomposting as a result of the implemented lesson plan. The post-test showed a significant increase in the number of students who answered "yes" to the question, "Do you know what vermicomposting is?" ($p < .001$) (Table 1).

Table 1. Do you know what vermicomposting is?

		Pre-test	Post-test
No	N	118	58
	%	82.5%	52.7%
Yes	N	25	52 ^a
	%	17.5%	47.3%

^a $\chi^2=26.06$, $df=1$, $p < .001$

For the content questions, numbers two through five on the pre- and post-tests (Appendix C-2; Appendix C-3), the percent of correct answers increased for each question, but the difference was not significant (Table 2).

		N (%)		<i>p</i> value
		Pre-test	Post-test	
Q2. What is vermicomposting?	Correct	63 (43.8)	58 (51.3)	.188
	Incorrect	81 (56.3)	55 (48.7)	
Q3. What is the benefit of vermicomposting?	Correct	47 (32.6)	44 (38.9)	.374
	Incorrect	97 (67.4)	69 (61.1)	
Q4. What types of food scraps can be composted?	Correct	111 (77.1)	92 (81.4)	.306
	Incorrect	33 (22.9)	21(18.6)	
Q5. What types of food should not be composted?	Correct	104 (72.2)	85 (75.2)	.927
	Incorrect	40 (27.8)	28 (24.8)	

^a See Appendix C-2 and C-3 for complete pre- and post-test questions.

Each content question contained an option “a,” reading “I don’t know.” This option was provided on the pre- and post-tests to remove any pressure to answer or risk of discomfort for students who did not possess any knowledge on the topic of vermicomposting. A second chi-square analysis was performed with a focus on answer options “b” through “d.” This was done to account for the students who may have selected “I don’t know” for every answer in an effort to complete the tests quickly, regardless of any true knowledge. After removing answer option “I don’t know” from the analysis, the percent of students answering correctly increased on the post-test compared to the pre-test for questions two through five. However, the results were statistically insignificant (Table 3).

Table 3. Change in percent correct for Q2-5^a on the pre-test versus the post-test with answer “a” excluded

		N (%)		<i>p</i> value
		Pre-test	Post-test	
Q2. What is vermicomposting?	Correct	63 (75.9)	58 (89.2)	.091
	Incorrect	20 (24.1)	7 (10.8)	
Q3. What is the benefit of vermicomposting?	Correct	47 (49.5)	44 (60.3)	.216
	Incorrect	48 (50.6)	29 (39.7)	
Q4. What types of food scraps can be composted?	Correct	111 (87.4)	92 (91.1)	.172
	Incorrect	16 (12.6)	9 (8.9)	
Q5. What types of food should not be composted?	Correct	104 (85.2)	85 (85.9)	.988
	Incorrect	18 (14.8)	14 (14.2)	

^a See Appendix C-2 and C-3 for complete pre- and post-test questions.

An independent samples t-test indicated that there was no difference ($t=1.31$, $df=255$, $p=.193$) in overall percent score on the post-test ($M=61.73$, $SD=33.08$) compared to the pre-test ($M=56.42$, $SD=31.67$). The average score of those students who indicated no knowledge of vermicomposting on question one of the pre-test ($n=118$) was 50.42 ($SD=30.66$), six points lower than the overall average score. This score decreased significantly ($p=.023$) to 41.81 ($SD=27.46$) among those who answered “no” on question one on the post-test ($n=58$).

Impacts on fruit consumption

Fruit consumption data were analyzed using descriptive statistics and confidence intervals. Tables of means were produced, and the *difference in difference* model was used to determine overall changes in fruit consumption. ANOVAs were run on the data to create confidence intervals from which to determine the significance of any observed changes in fruit consumption. The baseline stage of the study was labeled as week one, and the intervention stage (vermicomposting bin) was labeled as weeks two through six.

Mean fruit consumption (Table 4) was calculated for each consumption category by averaging the number of pieces of whole fruit that were non-consumed (0%), partially consumed (1-49%), and fully consumed ($\geq 50\%$) during lunch periods within each week of the study. As seen in Table 4, mean fruit consumption in each category varied greatly throughout the duration of the study, with no discernable pattern or trend. Figure 1 depicts mean fruit consumption at the intervention school for each category by study week.

Table 4. Mean fruit selection and consumption by study week

School	N	Week	Daily Average Selected	Daily Average Non- Consumed (0%)	Daily Average Partially Consumed (1-49%)	Daily Average Fully Consumed ($\geq 50\%$)
Control	246	1	65	34	10	22
		2	110	50	24	37
		3	87	33	21	33
		4	48	15	20	13
		5	68	31	13	24
		6	92	30	18	44
Intervention	191	1	92	28	20	44
		2	48	23	8	17
		3	78	29	11	39
		4	68	16	15	37
		5	96	43	14	40
		6	111	50	42	19

Study Weeks: 1) Baseline, 2-6) Vermicomposting bin

Figure 1. Mean intervention school fruit consumption by study week.

Overall differences in mean fruit consumption between baseline and the vermicomposting intervention (Table 5) were determined for each consumption category via the *difference in difference* statistical model. This model utilized simple subtraction of the average intervention fruit consumption from the average baseline fruit consumption for each school. The change in fruit consumption at the control school was then subtracted from the change in fruit consumption at the intervention school to determine the relative effect of the vermicomposting intervention on fruit consumption. For the fully consumed and partially consumed categories, the control school experienced an increase from baseline to the intervention stage of the study. In contrast, the intervention school experienced a decrease in fruit consumption for the same categories. For the non-consumed fruit category, the results were reversed; the control school decreased, and the intervention school increased.

Table 5. Difference in difference for fruit selection and consumption

	School	Baseline	Weeks 2-6	Difference
Selected	Control	65	81	16
	Intervention	92	80	-12
		27	-1	-28
Non-consumed (0%)	Control	34	32	-2
	Intervention	28	32	4
		-6	0	6
Partially consumed (1-49%)	Control	10	19	9
	Intervention	20	18	-2
		10	-1	-11
Fully consumed (≥50%)	Control	22	30	8
	Intervention	44	30	-13
		22	0	-21

An ANOVA was attempted for the combined fruit consumption data, using weekly averages to determine confidence intervals and examine the significance of any observed changes in consumption. However, due to the small sample size, the data had insufficient degrees of freedom. Results were unable to be calculated, and the tables returned unpopulated. During data collection, fresh oranges tended to be an unpopular fruit among the middle school students, and the majority of selected oranges were discarded untouched. A second ANOVA was performed, removing oranges from the data analysis and focusing only on apples, bananas, and other fruit. Additionally, daily fruit consumption values were examined, rather than weekly averages. After the implementation of these changes, several of the study weeks consisted of less than two observations per cell, causing insufficient degrees of freedom and the statistical testing to remain invalid. However, estimated confidence intervals and standard errors were able to be determined (Table 6).

Table 6. Mean fruit consumption by week with oranges excluded^a

	School	Week	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Non-consumed (0%)	Control	1	27	6.1	12	41
		2	40	6.1	25	54
		3	33	6.1	18	47
		4	15	6.1	1	29
		5	10	6.1	-4	24
		6	29	8.6	9	49
	Intervention	1	28	6.1	14	42
		2	19	8.6	-1	39
		3	29	6.1	14	43
		4	16	6.1	2	30
		5	20	8.6	0	40
		6	50	8.6	30	70
Partially consumed (1-49%)	Control	1	0	5.3	-4	21
		2	24*	5.3	12	36
		3	21	5.3	9	33
		4	20	5.3	8	32
		5	9	5.3	-4	21
		6	18	7.5	1	35
	Intervention	1	20	5.3	8	32
		2	10	7.5	-7	27
		3	11	5.3	-2	23
		4	15	5.3	2	27
		5	17	7.5	0	34
		6	42*	7.5	25	59
Fully Consumed (≥50%)	Control	1	21	11.9	-7	48
		2	31	11.9	3	58
		3	33	11.9	5	60
		4	13	11.9	-14	41
		5	17	11.9	-11	44
		6	43	16.9	4	82
	Intervention	1	44	11.9	16	71
		2	14	16.9	-25	53
		3	39	11.9	12	66
		4	37	11.9	10	64
		5	47	16.9	8	86
		6	19	16.9	-20	58

Study Weeks: 1) Baseline, 2-6) Vermicomposting bin

^a Data analysis includes apples, bananas, and other fruit.

*Value falls outside of the 95% confidence interval for the previous week, indicating a significant change.

Based on the confidence intervals in Table 6, a significant increase in fruit consumption was observed for partially consumed fruit during week two in the control school and week six in the intervention school. However, the standard errors were relatively high for each study week, indicating much variability in the data.

For apples, bananas, and other fruit, an independent samples t-test was performed to compare the changes in fruit consumption from baseline at the control school with the changes at the intervention school (Table 7). The difference between the schools was significant for the partially consumed category ($p=.027$) and approached significance for fully consumed ($p=.080$).

Table 7. Mean differences in fruit selection and consumption by school with oranges excluded^a

	df	Mean Difference	Std. Error	Sig. (2-tailed)	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Selected	14	29	14.8	.072	-3	61
Non-Consumed	14	1	6.9	.904	-14	16
Partially Consumed	14	13	5.2	.027	2	24
Fully Consumed	14	15	8.1	.080	-2	32

Study Weeks: 1) Baseline, 2-6) Vermicomposting bin

^aData analysis includes apples, bananas, and other fruit.

In an attempt to obtain valid statistical results regarding changes in fruit consumption, further tests were performed on the same dataset (ie. apples, bananas, and other) using only the data from the weeks which had at least 2 observations. An ANOVA was run using only weeks 1 (baseline), 3, and 4. When comparing the data by study week, the change in fruit consumption approached significance ($p=.085$). When means were adjusted for baseline differences, changes

by week continued to approach significance ($p=.085$). However, when comparing the results by group, the intervention school and the control school were significantly different for the partially consumed category ($p=.033$) (Table 8). When examining the effect of the interaction between group and week on fruit consumption, results were insignificant for all categories. Figure 2 depicts fruit consumption trends for the partially consumed category, with data adjusted for baseline observations. The control school experienced an overall increase from baseline in partially consumed fruit, while the intervention school experienced an overall decrease from baseline in the same consumption category.

Table 8. Difference from baseline in fruit consumption for weeks 3 and 4 with oranges excluded^a

Independent Variable	Consumption Category	Type III Sum of Squares	df	Mean Square	F	Sig.
Group	Non-consumed (0%)	12	1	12	0.14	.724
	Partially consumed (1-49%)	507	1	507	7.65	.033
	Fully Consumed ($\geq 50\%$)	80	1	80	0.21	.661
Study Week	Non-consumed (0%)	498	2	249	2.83	.136
	Partially consumed (1-49%)	18	2	9	0.14	.876
	Fully Consumed ($\geq 50\%$)	238	2	119	0.32	.741
Group and Week	Non-consumed (0%)	19	2	9	0.11	.092
	Partially consumed (1-49%)	266	2	133	2.01	.215
	Fully Consumed ($\geq 50\%$)	193	2	97	0.26	.782

^a Data analysis includes apples, bananas, and other fruit.

Figure 2. Mean difference from baseline for apples, bananas, and other fruit partially consumed (1-49%).

Impact on Amount of Fruit Picked Up by Students

Mean fruit selection (Table 9) was also examined at each school for each week of the study. Within each week of the study, fruit selection was determined by averaging the number of students who selected a whole fruit during each lunch period. This number was determined by the quantity of the pieces of fruit that were recorded by researchers on the data sheets. At baseline, 65 pieces of fruit were selected at the control school and 92 pieces at the intervention school. Mean fruit selection during the intervention stage of the study was 81 and 80, at the control school and the intervention school, respectively. This difference between schools was not significant ($p=.959$).

Table 9. Mean fruit selection by study week

School	N	Week	Daily Average Selected
Control	246	1	65
		2	110
		3	87
		4	48
		5	68
		6	92
Intervention	191	1	92
		2	48
		3	78
		4	68
		5	96
		6	111

Study Weeks: 1) Baseline, 2-6) Vermicomposting bin

The *difference in difference* statistical model was also used to determine overall changes in mean fruit selection from baseline (Table 5). As with each fruit consumption category, the change in fruit selection at the control school was subtracted from the change in fruit selection at the intervention school to determine the overall impact of the vermicomposting intervention on fruit selection. Similar to the partially consumed and fully consumed fruit consumption categories, average fruit selection from baseline to the intervention stage of the study increased at the control school and decreased at the intervention school.

When looking at fruit selection by study week, weeks one through four exhibited much variation in the average number of pieces of fruit selected by students at each school (Figure 3). However, from week four until the end of the study, fruit selection increased steadily in both schools.

Figure 3. Mean fruit selection at each school by study week.

An ANOVA was performed, removing oranges from the data analysis and focusing only on apples, bananas, and other fruit. Daily fruit selection values were examined, rather than weekly averages. Consistent with the fruit consumption statistical analysis, several of the study weeks consisted of less than two observations after the implementation of these changes, and the statistical testing remained invalid. Again, estimated confidence intervals and standard errors were able to be determined (Table 10). Based on the confidence intervals in Table 10, a significant increase in fruit selection was observed at the control school during week 6.

Table 10. Mean fruit selection by week with oranges excluded^a

Group	Week	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	1	56	17.4	15	96
	2	94	17.4	54	134
	3	86	17.4	46	126
	4	48	17.4	8	88
	5	35	17.4	-5	75
	6	90*	24.6	33	147
Intervention	1	92	17.4	51	132
	2	43	24.6	-14	100
	3	78	17.4	38	118
	4	68	17.4	27	108
	5	84	24.6	27	141
	6	111	24.6	54	168

Study Weeks: 1) Baseline, 2-6) Vermicomposting bin

^aData analysis includes apples, bananas, and other fruit.

*Value falls outside of the 95% confidence interval for the previous week, indicating a significant change.

Similar to with the fruit consumption data, an attempt was made to generate valid statistical results by performing an ANOVA excluding oranges and using only data from weeks 1, 3, and 4. The effects of group, study week, and the interaction between group and study week on fruit consumption were analyzed, and no significant results were found (Table 11).

Table 11. Mean difference from baseline in fruit selection for weeks 3 and 4 with oranges excluded^a

Independent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Group	752	1	752	0.97	.364
Study Week	1211	2	606	0.78	.501
Group and Week	988	2	494	0.63	.563

^aData analysis includes apples, bananas, and other fruit.

Summary

From the vermicomposting pre-test to the post-test, the results of the education portion of this study showed a significant increase in the number of students who answered “yes” to the question, “Do you know what vermicomposting is?” ($p < .001$). However, the post-test saw an insignificant ($p = .193$) increase of approximately five points in overall percent score ($M = 61.73$, $SD = 33.08$), compared to the pre-test ($M = 56.42$, $SD = 31.67$). During the vermicomposting bin intervention, the control school experienced an increase in whole fruit consumption when compared to baseline observations for the fully consumed and partially consumed categories. In contrast, the intervention school experienced a simultaneous decrease in consumption for the same categories. When excluding oranges from the analysis and focusing on apples, bananas, and other fruit, the difference between the schools was significant for the partially consumed category ($p = .027$) and approached significance for fully consumed ($p = .080$). After further narrowing the dataset to include only weeks 1 (baseline), 3, and 4, the change in fruit consumption approached significance ($p = .085$) in a comparison by study week. The means were then adjusted for baseline, and the schools differed significantly for the partially consumed category ($p = .033$). Average fruit selection from baseline to the intervention stage of the study increased at the control school and decreased at the intervention school. However, no significant changes in fruit selection were observed.

CHAPTER 5

DISCUSSION

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room. This chapter will present a discussion of the results and the implications of the findings within the school lunch room environment. It will also compare and contrast the findings of this study with the studies that have been previously discussed in chapter two.

Summary of Findings

The pre- and post-tests from this study, implemented to evaluate students' knowledge of vermicomposting, indicate that exposure to the process of vermicomposting via a science lesson and a visual cue in the lunch room resulted in an increase in familiarity with the concept. However, no related increase in knowledge about the topic was observed. The increased exposure to vermicomposting over the course of five weeks did not lead to an increase in whole fruit consumption by middle school students. When comparing the vermicomposting stage of the study (weeks 2 through 5) to baseline (week 1) at each school, the control school exhibited an increase in fruit consumption, while an overall decrease in fruit consumption was observed at the intervention school. At the control school, an increase of 8 and 10 pieces of fruit fully consumed and partially consumed was observed in total for the sixth grade class (N=246) between baseline

and the vermicomposting intervention stage. In contrast, a decrease of 2 non-consumed pieces of fruit was observed at the control school. At the intervention school, a decrease of 13 and 2 pieces of fruit fully consumed and partially consumed was observed for the sixth grade class (N=191) in the same time period. An increase of 4 non-consumed pieces of fruit was observed.

No significant differences were found between the intervention and the control school for overall fruit selection during the intervention stage of the study (weeks 2 through 5). Similar to the partially consumed and fully consumed fruit consumption categories, average fruit selection from baseline to the intervention stage of the study increased at the control school and decreased at the intervention school. However, when evaluating fruit selection by week, the control school experienced a significant increase ($M=90$, 95% CI=-5, 75) in fruit selection during week 6 of the study.

Role of Garden-Based Education among Adolescents

Nutrition education alone has not been shown effective at changing dietary behaviors in adolescents (Contento, 2008). Similarly, this study indicates that education on the topic of vermicomposting alone did not increase fruit consumption. Vermicomposting education via lessons in the classroom may be the incorrect interception point for linking knowledge to behavior change; or, more than a single lesson may be needed to reinforce core concepts. Likewise, educator training with multiple points for interaction may be needed to strengthen messaging.

According to Fleming (2005), middle school students are more inspired to make the decision to get involved if they understand the reason behind what they are being invited to do. In a study evaluating the perception of, desire for, and achievement of autonomy among early and late adolescents, Fleming (2005) found that adolescents of all ages have an increased desire

for emotional, behavior, and value autonomy, beginning at the start of puberty. Autonomy was defined as “the ability to think, feel, make decisions, and act on her or his own.” As this relates to the efficacy of a vermicomposting intervention to change dietary behaviors, middle school students are in a period of their lives when they are actively seeking to make their own choices and form their own values (Fleming, 2005). At this age, the students may not have much motivation to participate in a sustainability practice, such as vermicomposting, if they do not have an adequate understanding of the process and the environmental benefits.

It is possible that an understanding of the connection between food choices and the applications of the compost that is produced may be fundamental to the effectiveness of a vermicomposting bin at increasing fruit consumption among middle school students. Results of this study and observations of the PI suggest that the students did not fully understand the connection between the collected fruit scraps and how the vermicompost could provide nutrients to the earth. From the vermicomposting pre-test to the post-test, the results of the education portion of this study showed a significant increase in the number of students who answered “yes” to the question, “Do you know what vermicomposting is?” ($p < .001$). However, the increase in the knowledge questions (two through five) was insignificant ($p = .193$). This indicates an increase in familiarity with the concept of vermicomposting, but no corresponding increase in knowledge.

With more in-depth and interactive student involvement with the vermicomposting bin, a greater understanding and sense of responsibility could be created (Skelly & Bradley, 2007). Skelly and Bradley (2007) examined the effect of school gardens and related activities on the sense of responsibility and attitude toward the environment of 427 third-grade students. Results of a teacher questionnaire revealed consistently high scores in the areas of both student

responsibility and environmental attitudes after participation in garden-based learning. Although the Skelly and Bradley study was conducted with younger children, this study suggests that involvement in projects such as vermicomposting may have the potential to promote personal responsibility among students.

Garden-based education initiatives have been supported by the research as a viable method of increasing consumption of fresh fruits and vegetables (Heim et al., 2009; McAleese & Rankin, 2007; Robinson-O'Brien et al., 2009; Taylor & Johnson, 2013). For example, McAleese and Rankin (2007) involved sixth grade students in planting, weeding, watering, harvesting, herb drying, and preparing recipes using harvested produce. When the time came to consume the fruits and vegetables, students had a vested interest in the process, and a significant increase in fruit and vegetable consumption was observed ($p < .001$). Many of the studies utilizing garden-based education involved students at every step of the growing process (Heim et al., 2009; McAleese & Rankin, 2007). In the present study, the vermicomposting intervention was designed as a visual cue in the lunch room. Exposure was limited to a thirty-minute lunch period in the school cafeteria, during which students were distracted by peers vying for attention and other environmental stimulants. In the study by Stanton (2015), elementary school students were enticed to participate in feeding the worms and did not require additional education or involvement. The PIs had control of the lunch area and were able to garner the students' attention. Fruit consumption significantly increased with the introduction of a vermicomposting bin without additional educational support (Stanton, 2015). However, at the middle school level, where students are actively seeking to make their own decisions, they may need stronger encouragement to get involved. It may be advantageous to implement vermicomposting as a

piece of a larger educational learning initiative, such as garden- or nutrition-focused instruction (Fleming, 2005; Gleason et al., 2013; McAleese & Rankin, 2007).

Utilizing Environmental Responsibility to Motivate Dietary Behavior Change

When children are given a chance to take part in the growing process, they become engaged in a “bigger than themselves” goal of nurturing and caring for the planet. Research has shown that environmental responsibility can be a significant motivator for behavior change at any age (Gleason et al., 2013; McAleese & Rankin, 2007). Skinner et al. (2012) evaluated the beneficial outcomes of garden-based learning among middle school students and found that engagement in the garden was significantly associated with students’ perceptions of their competence, autonomy, and intrinsic motivation to participate ($p < .001$). McBeth and Volk (2010) studied the general level of environmental literacy of middle school students in the United States, as well as several specific variables of environmental awareness, including ecological knowledge, commitment, and feelings toward the environment. A survey was given to a random sample of 2004 sixth and eighth-grade students. Survey results suggested that the outlook of middle school-aged students toward the environment was generally positive, and students indicated a high level of verbal commitment to pro-environmental behavior, or a strong intention to take action. When comparing the survey results of the two grade levels, eighth-grade students tended to show a higher level of environmental knowledge, while sixth-grade students scored higher on environmental sensitivity. McBeth and Volk (2010) postulated that younger middle school students may have a stronger connection to the environment than older students. These results indicate that middle school students have an interest in environmental conservation, making this age group a prime population for sustainability interventions. With this knowledge,

interventions focused on environmental stewardship have the potential to captivate the attention of adolescents and should be further explored as means to improve dietary habits.

The methods of this particular study are unique. Exposure to vermicomposting was limited to a brief introduction to the topic in the science classrooms and a worm bin in the lunch room as a visual cue. Modeled after the research of Just and Wansink (2009), which utilized the concept of behavioral economics in the lunch room, the present study aimed to change dietary behaviors without the use of an extended education intervention. However, as fruit consumption results were insignificant in the present study, future researchers may wish to investigate other garden-based education interventions that focus on the link between knowledge and behavior change, which present numerous possibilities for student involvement. Although results of this study did not show that vermicomposting can have a positive effect on the food consumption patterns of middle school students, vermicomposting is a cost-effective and low-maintenance piece of the farm-to-table initiative. In the long term, implementation of a vermicomposting bin in the middle school lunch room may open the door for further garden-based education programs. If resources allowed, a vermicomposting bin could provide a stepping stone toward the creation of a school garden for other educational opportunities.

Throughout the duration of this study, student exposure to the vermicomposting bin was limited in an effort to replicate a prior successful study design, which included minimal student involvement in the maintenance of the bin (Stanton 2015). In the present study, the vermicomposting bin was not intended to be used as a school project requiring regular student involvement, but rather as a visual cue in the lunch room. However, as an extended intervention, a vermicomposting bin could be managed by students. The bin could serve not only as a visual cue for behavior modification in the lunch room, but also as a classroom educational tool. If

adopted by students, this intervention could be used to develop a sense of responsibility, leadership, and self-discipline (Skelly & Bradley, 2007).

Nutrition Intervention for Elementary School vs. Middle School

Dietary patterns are being formed during childhood and adolescence that are significantly likely to follow students into adulthood (Lake et al., 2006). Middle school is a time of great transformation, including both psychological and physiological growth. Along with an increased level of freedom and a developing sense of self, experimentation is common in many areas of life, including consumption behaviors (Jenkins & Horner, 2005). Middle school is a time of life during which the desire for conformity to peers plays an important role in the formation of habits and behaviors (Eccles, 1999). When compared to younger elementary school students, middle school students are more likely to have developed habits based on the actions of their friends, rather than through a logical decision-making process (Eccles, 1999). Consequently, middle school students are less likely to change their habits as a result of a brief intervention (Story, 1999). In a review of the literature on school-based approaches to obesity prevention, Story (1999) found that interventions aimed at younger children (ages 5-10 years) were more successful at achieving behavior change than those targeting adolescents (ages 12-15 years). For this reason, it may be more effective to target nutrition interventions at a younger age group. If a child can be reached at an earlier age, it is less likely that the child is already set in his or her ways when it comes to consumption patterns.

Stanton (2015) conducted a pilot study, introducing elementary school students to the process of vermicomposting. At this young age, these students were enticed by the opportunity to participate by “feeding the worms.” Eccles (1999) explored the developmental differences between middle childhood (ages 6-10) and early adolescence (ages 11-14) and concluded that

younger children tend to be less influenced by peer pressure and the desire to fit in. In contrast, adolescents are more concerned with their appearance and the opinions of their peers (Eccles, 1999). In the present study, the PI observed that many students exhibited negative attitudes toward the vermicomposting intervention, including, indifference, cynicism, and even disgust. Some female students refused to even look at the bin as it was being wheeled by their table in the lunch room. This observation could be caused by many factors, but it likely has some root in the level of importance placed on personal appearance and social acceptance among middle school students.

Research shows that fruit intake tends to decrease as an individual ages (Lorson et al., 2009). When examining fruit consumption by age, Lorson et al. (2009) found that children aged 6 to 11 consumed an average of 71.5% of the recommended daily amount of fruit. In contrast, adolescents aged 12-18 consumed only 54.7%. Lytle, Seifert, Greenstein, and McGovern (2000) investigated the change in eating patterns of 291 children as they progressed from third grade to eighth grade. Fruit and vegetable consumption decreased significantly ($p < .05$) over this period of time, with only 37.1% and 41.6% of eighth grade students reporting consumption of at least one quarter cup of fruits and vegetables daily, respectively (Lytle et al., 2000). Future interventions may target older adolescents in an effort to increase their fruit and vegetable consumption after it has already declined. However, as an alternative approach to the problem, interventions may aim to build lifelong healthy habits in younger children that may follow them through adolescence and into adulthood.

School Lunch Room Setting

The school lunch room has been a popular setting for recent interventions aimed at changing dietary behaviors and can be a strategic place to focus efforts (Briefel et al., 2009;

Jaime & Lock, 2009; Story et al., 2006; Story et al., 2002). Students spend the majority of their day in school and receive up to half of their daily energy intake in the school lunch room (Cohen et al., 2014). Thus, schools have the potential to significantly influence students' food choices and dietary health. By implementing interventions in the lunch room, schools can promote a healthy food environment at the site of food choice and consumption (Briefel et al., 2009).

The school lunch room, however, is accompanied by several innate factors that are difficult to control in the research process without significantly interfering with the way that the lunch period is normally run on a day-to-day basis. For example, two-thirds of the way into the study execution, the district changed food service vendors, introducing new fruit options for students. Further, standardized testing days occurred just after the study was concluded, with test preparation days taking place during the study. This potentially led to increased stress and distraction among students during the lunch period. Were these issues able to be controlled, the study may have yielded alternative results regarding the impact of vermicomposting exposure on fruit consumption.

As an example of a natural characteristic of the school lunch room setting that may have affected fruit consumption, lunch menus were highly variable throughout the study. By design, some type of whole fruit was offered on each day that the PI and research assistants collected data. However, fruit cups were often offered to students as an alternative to whole fruit. This may have skewed the results of the study, as researchers only recorded consumption of whole fruits. Many students may have chosen the fruit cups instead of whole fruits as an easy-to-consume alternative to whole, unpeeled or uncored fruits. Because all types of fruit were not recorded in this study, true fruit consumption levels were not able to be obtained. Students also

exhibited a preference for certain types of fruit over others. For example, oranges seemed to be the least preferred fruit option, as evidenced by lower consumption percentages.

This study was designed based on the set menu that the school system followed for each monthly rotation. Prior to the final stage of the study, unexpectedly, the school system came under new food service management. After this change was implemented, menus began to offer a larger variety of food options, including types of fruit. New fruit options included blueberries, pears, strawberries, pineapple, and watermelon, which may have been more appealing to students who did not like the traditional options of apples, oranges, bananas, and grapes. The PI decided to eliminate the final portion of the study as this development introduced many new variables that could have skewed data to inaccurately reflect fruit consumption changes.

Researcher Observations

The PI observed that students were inattentive during the time that the intervention was being implemented. The thirty-minute period allotted for lunch time was likely the only time during the day that students could relax and converse with their friends. Students at this particular school were allowed to bring their iPads with them into the lunchroom. Because of these factors, the lunch period may not have been an ideal time to focus an intervention. It is possible that, by having the iPads in the lunchroom, students did not eat as much overall as they would without this distraction. As it relates to this particular intervention, the distraction of technology and time with friends may have prevented students from fully participating in the vermicomposting experience. By redirecting the primary intervention outside of the lunchroom and using the vermicomposting bin as an additional visual cue, students may be more likely to focus on the information and opportunities being presented to them.

Summary

The results of this study indicate that vermicomposting, as a primary intervention, was not effective at increasing fruit consumption in the middle school lunch room. Although some students expressed interest in the project, the majority of students were indifferent and did not seem to understand the purpose behind the intervention. Within the lunch room setting, students were faced by many distractions that hindered the ability of the researcher to obtain their full attention. Additionally, students did not seem to have an adequate understanding of the connection between their dietary choices and vermicomposting, making the vermicomposting bin ineffective as a visual cue. Adolescents have an increased desire for autonomy and tend to make decisions based on the opinions of their peers. In order for vermicomposting to have a positive effect on dietary choices, it may be that students in middle school be exposed to the concept through multiple means rather than just a visual cue in the lunchroom and one lesson. Although Wansink and others have experienced positive outcomes with just visual cues leading to food consumption behavior change, the results of this study suggest otherwise. By implementing vermicomposting as one piece of a larger nutrition or garden-based learning initiative, this intervention could potentially have a greater impact on the nutrition of middle school students.

CHAPTER 6

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

The purpose of this quasi-experimental observational study was to measure the effect of knowledge of vermicomposting (academic lesson) and exposure to vermicomposting (visual cues in the lunch room) on whole fruit consumption in the middle school lunch room. This chapter will present a brief summary of the results of this study and discuss the implications of its findings. It will also present the limitations of this study and provide recommendations for future research in order to expand the body of knowledge surrounding this topic.

Study Results

Results from this study indicate that exposure to vermicomposting may not be effective at increasing fruit consumption in the middle school lunchroom. During this study, the implementation of a lesson plan on vermicomposting led to a significant increase in familiarity with vermicomposting ($p < .001$), but no significant change in knowledge on the topic. After the placement of a vermicomposting bin as a visual cue in the school lunchroom, an overall decrease in fruit consumption was observed at the intervention school from baseline (week 1) to the vermicomposting stage (weeks 2-5). From baseline, a decrease of 13 and 2 pieces of fruit fully consumed and partially consumed was observed for the sixth grade class ($N=191$). In contrast, the control school experienced an overall increase in fruit consumption during the same time period, with 8 and 10 more pieces of fruit fully consumed and partially consumed for the sixth

grade class (N=246) during the vermicomposting intervention stage of the study. No significant differences were found between the intervention school and the control school for overall fruit selection. Similar to the partially consumed and fully consumed fruit consumption categories, average fruit selection from baseline to the intervention stage of the study increased at the control school and decreased at the intervention school.

Implications on the Health of Students

Research has shown that children and adolescents do not meet the recommended intakes of fruits and vegetables (Kimmons et al., 2009; Lorson et al., 2009). Additionally, 100% fruit juice is the main source of fruit intake among adolescents (Kimmons et al., 2009). A diet rich in whole fruits and vegetables is essential for the health of children and adolescents (USDA & DHHS, 2015). The nutrients and phytochemicals found in fruits and vegetables are important for growth and development, weight management, and prevention of chronic diseases (American Heart Association, 2015; Lowry et al., 2008). Unfortunately, this intervention was not effective at increasing fruit consumption among middle school students. In fact, a decrease in fruit consumption was observed. Without an adequate understanding of the connection between fruit consumption and vermicomposting, middle school students may not be likely to fully engage in such an intervention. And without student participation, a vermicomposting model may not have much potential to change dietary habits.

Implications on Environmental Stewardship among Middle School Students

This study focused on creating a sense of environmental stewardship within students by encouraging them to give back to the earth through feeding the worms. First, students were taught about the process and benefits of vermicomposting via a lesson plan in the science classrooms. Then, an actual vermicomposting bin was placed in the school lunchroom as a visual

cue that allowed students to participate in the process by contributing their fruit scraps. At the beginning of each day of the study, students were reminded of their role in the process. A gap of approximately four weeks occurred between the time that the information was initially taught in the classroom and the time that students were given the opportunity for hands-on participation. Future studies may see a positive impact on fruit consumption if the classroom education and hands-on experience occurred simultaneously. By allowing students to maintain a worm bin and witness the process of vermicomposting at the same time as they are learning about the benefits, students may be encouraged to become more involved. Additionally, the sustainability impact of a vermicomposting bin is extended when an outlet exists through which to use the compost that is produced. With a functional school garden in place, the educational opportunities could continue past the initial vermicomposting intervention. Other garden-based practices, such as planting, weeding, harvesting, herb drying, and preparing harvested produce could serve to reinforce the concept of environmental stewardship that vermicomposting can instill in students.

Limitations and Recommendations

Among the first of its kind, this study provides valuable insight into the potential effects of vermicomposting as a non-traditional method of increasing whole fruit consumption among middle school students. However, as with any research, there are several limitations that should be considered in the interpretation of the results.

As a result of the pilot study by Stanton (2015) being conducted among kindergarten through fifth grade students in the same town, some of the students in the present study had already been exposed to the process of vermicomposting during the previous school year. This prior exposure may have skewed the observed knowledge of vermicomposting and baseline eating habits of those students. With similar research studies being conducted in the same town

within a short period of time, options for the study sample were limited. However, the overlap in this particular study could have been avoided had the intervention been conducted among seventh- or eighth-grade students. When selecting a study population, researchers implementing future studies should consider any prior exposure that subjects may have had to the topic of vermicomposting.

When examining the effects of the lesson plan on knowledge of vermicomposting, many limitations occurred that affect the interpretation of the data. For example, although the lesson plan was created by the PI, and the same materials were given to all of the science teachers, the lesson was not taught by PI, nor did the PI witness the presentation of the information. The researcher cannot confirm that all students were exposed to the same information presented with the same emphasis. Additionally, as directed by the researcher, the vermicomposting post-test was given to students several months after the lesson was taught and may not be an accurate representation of the impact on short-term student knowledge. Due to the level of research clearance obtained by the researcher, the responses could not be tracked by student from the pre-test to the post-test. The resulting data is an average estimate of the knowledge of the entire sixth grade class at the intervention school. For future studies, it is recommended that the researcher either personally teach the lesson to the students, or make an effort to observe the presentation of the information. Additionally, if the classroom education and the experiential education with the vermicomposting bin were to be implemented simultaneously, the students may be able to better retain the information that they were taught. The post-test could then be given within a shorter time period and more accurately reflect student comprehension of the concepts.

Further limitations developed during fruit consumption data collection at the schools. Due to standardized testing, the intervention school had a varied class schedule, and the PI was

not always aware of the corresponding change in the lunch schedule. On two of the data collection days, an announcement was not able to be made reminding students of their role in the vermicomposting process, as the PI and research assistants arrived at the intervention school after the start of the lunch period. Additionally, changes in the class schedule and preparation for standardized testing could have resulted in increased stress levels and altered eating patterns among students.

The original design of the present study included a third study stage during which compostable stickers featuring a worm motif would be placed on whole fruits prior to selection in the lunch line. The researcher had planned to examine the impact of this secondary visual cue on fruit consumption in addition to the results obtained by the vermicomposting bin intervention. However, due to an unexpected change in food service management, the PI decided to conclude the study without the sticker component stage because the study design was compromised. The change in management resulted in an increase in fruit options available to students and may have skewed fruit consumption results if the study were to be completed as planned.

For future studies in this area, researchers may wish to implement more accurate data collection procedures. Due to the limited number of data collection days and the initial learning curve experienced by the PI and research assistants, it is possible that some pieces of fruit may have been misrecorded or missed altogether. Additionally, some variation in the interpretation of fruit consumption percentages may have occurred, despite the training and fruit consumption diagrams that were provided. In an effort to prevent these limitations, future researchers may choose to take pictures of the students' trays to allow for more careful record of the plate waste. This route would require a higher level of IRB approval and would necessitate the collection of a signed parental consent form and verbal assent from each student.

Although vermicomposting is a relatively low-maintenance sustainability practice, it may be more successful as a long-term intervention in the school lunch room if the project were designed to engage individuals from multiple areas of the school, including, but not limited to teachers, students, lunch room workers, and custodians. Future studies may benefit from involving students in the maintenance and promotion of the bin. Teachers may also be invited to direct and supervise student ownership of the project. Food service workers and custodians could be educated on the purpose behind the intervention. With these key personnel highly involved, a vermicomposting bin may provide a school-wide learning opportunity that has the potential to be sustained long-term.

Summary

In summary, the results from this observational study show that an interactive vermicomposting model in the middle school lunch room may not be an effective environmental stimulus to increase fruit consumption among sixth grade students. However, this study adds to the existing body of knowledge surrounding the topic of behavioral-economic education. More specifically, it opens the door for future studies to be conducted in the area of vermicomposting as a method of increasing fruit consumption. Future research studies should be built on the knowledge obtained in this study in order to improve the methodology, which should improve the data outcomes. If future initiatives were to succeed at increasing student participation in vermicomposting, a positive impact on the dietary habits of middle school students may be seen.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD MATERIALS

A-1: IRB APPROVAL LETTER

A-2: CITI CERTIFICATES OF COMPLETION

Appendix A-1 – IRB Approval Letter

Office of Research Integrity
Institutional Review Board (IRB)
2000 University Avenue
Muncie, IN 47306-0155
Phone: 765-285-5070

DATE:	September 24, 2015
TO:	Hannah Killion
FROM:	Ball State University IRB
RE:	IRB protocol # 773862-1
TITLE:	The Effect of Vermicomposting Knowledge and Visual Cues on Fruit Consumption in the Middle School Lunchroom
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
DECISION DATE:	September 23, 2015
EXPIRATION DATE:	September 22, 2017
REVIEW TYPE:	Expedited: This protocol had been determined by the board to meet the definition of minimal risk.

The Institutional Review Board has approved your New Project for the above protocol, effective September 23, 2015 through September 22, 2017. All research under this protocol must be conducted in accordance with the approved submission and in accordance with the principles of the Belmont Report.

Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Hannah Killian (ID: 4650408)
- **Email:** hmkillian@bsu.edu
- **Institution Affiliation:** Ball State University (ID: 1568)
- **Institution Unit:** Nutrition and Dietetics
- **Phone:** 765-639-4838

- **Curriculum Group:** Social & Behavioral Research - Basic/Refresher
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 15244360
- **Completion Date:** 02/19/2015
- **Expiration Date:** 02/18/2018
- **Minimum Passing:** 80
- **Reported Score*:** 95

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID:1127)	02/07/15	3/3 (100%)
Students in Research (ID:1321)	02/08/15	9/10 (90%)
History and Ethical Principles - SBE (ID:490)	02/09/15	5/5 (100%)
Defining Research with Human Subjects - SBE (ID:491)	02/11/15	5/5 (100%)
The Federal Regulations - SBE (ID:502)	02/11/15	5/5 (100%)
Assessing Risk - SBE (ID:503)	02/12/15	5/5 (100%)
Informed Consent - SBE (ID:504)	02/13/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID:505)	02/14/15	4/5 (80%)
Research with Prisoners - SBE (ID:506)	02/14/15	5/5 (100%)
Research with Children - SBE (ID:507)	02/15/15	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID:508)	02/15/15	5/5 (100%)
International Research - SBE (ID:509)	02/16/15	5/5 (100%)
Internet-Based Research - SBE (ID:510)	02/16/15	5/5 (100%)
Research and HIPAA Privacy Protections (ID:14)	02/17/15	4/5 (80%)
Vulnerable Subjects - Research Involving Workers/Employees (ID:483)	02/18/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID:488)	02/19/15	4/5 (80%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID:14928)	02/19/15	5/5 (100%)
Ball State University (ID:13475)	02/19/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing Institution identified above or have been a paid Independent Learner.

CITI Program
Email: citisupport@miami.edu
Phone: 305-243-7970
Web: <https://www.citiprogram.org>

Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: (ID: 4046274)
- Email:
- Institution Affiliation: Ball State University (ID: 1568)
- Institution Unit: Family Consumer Sciences
- Curriculum Group: Social & Behavioral Research - Basic/Refresher
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 1 - Basic Course
- Description: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.
- Report ID: 16748983
- Completion Date: 07/25/2015
- Expiration Date: 07/24/2018
- Minimum Passing: 80
- Reported Score*: 92

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	07/24/15	3/3 (100%)
Students in Research (ID: 1321)	07/24/15	8/10 (80%)
History and Ethical Principles - SBE (ID: 490)	07/24/15	4/5 (80%)
Defining Research with Human Subjects - SBE (ID: 491)	07/24/15	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	07/24/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	07/24/15	5/5 (100%)
Informed Consent - SBE (ID: 504)	07/24/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	07/24/15	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	07/24/15	4/5 (80%)
Research with Children - SBE (ID: 507)	07/25/15	4/5 (80%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	07/25/15	5/5 (100%)
International Research - SBE (ID: 509)	07/25/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	07/25/15	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	07/25/15	4/5 (80%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	07/25/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	07/25/15	4/5 (80%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	07/25/15	5/5 (100%)
Ball State University (ID: 13475)	07/25/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

CITI Program
Email: citisupport@miami.edu
Phone: 305-243-7970
Web: <https://www.citiprogram.org>

Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: (ID: 5082928)
- Email:
- Institution Affiliation: Ball State University (ID: 1568)
- Institution Unit: Family and Consumer Science
- Phone: 1-765-289-1241

- Curriculum Group: Social & Behavioral Research - Basic/Refresher
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 1 - Basic Course
- Description: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- Report ID: 17335399
- Completion Date: 11/01/2015
- Expiration Date: 10/31/2018
- Minimum Passing: 80
- Reported Score*: 86

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	09/26/15	3/3 (100%)
Students in Research (ID: 1321)	09/26/15	8/10 (80%)
History and Ethical Principles - SBE (ID: 490)	10/07/15	4/5 (80%)
Defining Research with Human Subjects - SBE (ID: 491)	10/07/15	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	10/07/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	10/07/15	5/5 (100%)
Informed Consent - SBE (ID: 504)	10/07/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	10/07/15	4/5 (80%)
Research with Prisoners - SBE (ID: 506)	10/07/15	4/5 (80%)
Research with Children - SBE (ID: 507)	10/07/15	4/5 (80%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	10/26/15	5/5 (100%)
International Research - SBE (ID: 509)	11/01/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	11/01/15	3/5 (60%)
Research and HIPAA Privacy Protections (ID: 14)	11/01/15	3/5 (60%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	11/01/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	11/01/15	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	11/01/15	4/5 (80%)
Ball State University (ID: 13475)	11/01/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

CITI Program
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Phone: 305-243-7970
Web: <https://www.citiprogram.org>

Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** (ID: 5263515)
- **Email:**
- **Institution Affiliation:** Ball State University (ID: 1568)
- **Institution Unit:** Family and Consumer Science

- **Curriculum Group:** Social & Behavioral Research - Basic/Refresher
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 18193273
- **Completion Date:** 12/23/2015
- **Expiration Date:** 12/22/2018
- **Minimum Passing:** 80
- **Reported Score*:** 96

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	12/23/15	3/3 (100%)
Students in Research (ID: 1321)	12/23/15	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	12/23/15	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	12/23/15	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	12/23/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	12/23/15	5/5 (100%)
Informed Consent - SBE (ID: 504)	12/23/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	12/23/15	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	12/23/15	4/5 (80%)
Research with Children - SBE (ID: 507)	12/23/15	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	12/23/15	4/5 (80%)
International Research - SBE (ID: 509)	12/23/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	12/23/15	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	12/23/15	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	12/23/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	12/23/15	4/5 (80%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	12/23/15	5/5 (100%)
Ball State University (ID: 13475)	12/23/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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 Web: <https://www.citiprogram.org>

Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

• Name: (ID: 4723160)
 • Email:
 • Institution Affiliation: Ball State University (ID: 1568)
 • Institution Unit: Dietetics
 • Phone: 765-524-6861

 • Curriculum Group: Social & Behavioral Research - Basic/Refresher
 • Course Learner Group: Same as Curriculum Group
 • Stage: Stage 1 - Basic Course
 • Description: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

 • Report ID: 15474135
 • Completion Date: 05/26/2015
 • Expiration Date: 05/25/2018
 • Minimum Passing: 80
 • Reported Score*: 92

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	05/10/15	3/3 (100%)
Students in Research (ID: 1321)	05/12/15	9/10 (90%)
History and Ethical Principles - SBE (ID: 490)	05/12/15	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	05/12/15	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	05/12/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	05/13/15	5/5 (100%)
Informed Consent - SBE (ID: 504)	05/14/15	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	05/14/15	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	05/25/15	4/5 (80%)
Research with Children - SBE (ID: 507)	05/25/15	4/5 (80%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	05/25/15	5/5 (100%)
International Research - SBE (ID: 509)	05/25/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	05/25/15	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	05/25/15	4/5 (80%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	05/25/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	05/26/15	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	05/26/15	4/5 (80%)
Ball State University (ID: 13475)	05/26/15	No Quiz

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Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: (ID: 5208662)
- Email:
- Institution Affiliation: Ball State University (ID: 1568)
- Institution Unit: Family and Consumer Sciences
- Curriculum Group: Social & Behavioral Research - Basic/Refresher
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 1 - Basic Course
- Description: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.
- Report ID: 17877578
- Completion Date: 11/28/2015
- Expiration Date: 11/27/2018
- Minimum Passing: 80
- Reported Score*: 100

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	11/24/15	3/3 (100%)
Students in Research (ID: 1321)	11/24/15	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	11/25/15	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	11/25/15	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	11/25/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	11/25/15	5/5 (100%)
Informed Consent - SBE (ID: 504)	11/27/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	11/27/15	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	11/27/15	5/5 (100%)
Research with Children - SBE (ID: 507)	11/27/15	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	11/27/15	5/5 (100%)
International Research - SBE (ID: 509)	11/27/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	11/27/15	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	11/28/15	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	11/28/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	11/28/15	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	11/28/15	5/5 (100%)
Ball State University (ID: 13475)	11/28/15	No Quiz

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Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: (ID: 5259264)
- Email:
- Institution Affiliation: Ball State University (ID: 1568)
- Institution Unit: Dietetics
- Curriculum Group: Social & Behavioral Research - Basic/Refresher
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 1 - Basic Course
- Description: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.
- Report ID: 18161825
- Completion Date: 12/22/2015
- Expiration Date: 12/21/2018
- Minimum Passing: 80
- Reported Score*: 88

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	12/17/15	3/3 (100%)
Students in Research (ID: 1321)	12/17/15	4/5 (80%)
History and Ethical Principles - SBE (ID: 490)	12/17/15	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	12/17/15	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	12/17/15	5/5 (100%)
Assessing Risk - SBE (ID: 503)	12/17/15	4/5 (80%)
Informed Consent - SBE (ID: 504)	12/17/15	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	12/17/15	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	12/17/15	5/5 (100%)
Research with Children - SBE (ID: 507)	12/17/15	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	12/17/15	4/5 (80%)
International Research - SBE (ID: 509)	12/17/15	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	12/17/15	4/5 (80%)
Research and HIPAA Privacy Protections (ID: 14)	12/17/15	4/5 (80%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	12/22/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	12/22/15	3/5 (60%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	12/22/15	3/5 (60%)
Ball State University (ID: 13475)	12/22/15	No Quiz

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Appendix A-2 – CITI Certificates of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: (ID: 4711190)
- Email:
- Institution Affiliation: Ball State University (ID: 1568)
- Institution Unit: Dietetics
- Phone: 5742294047

- Curriculum Group: RCR FOR SOCIAL, BEHAVIORAL & EDUCATIONAL RESEARCHERS
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 1 - RCR
- Description: This course is for investigators, staff and students with an interest or focus in Social and Behavioral research. This course contains text, embedded case studies AND quizzes.

- Report ID: 15720692
- Completion Date: 08/23/2015
- Expiration Date: N/A
- Minimum Passing: 80
- Reported Score*: 100

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Ball State University (ID: 13475)	05/05/15	No Quiz
Responsible Conduct of Research (RCR) Course Introduction (ID: 1522)	05/05/15	No Quiz
Mentoring (RCR-Basic) (ID: 16602)	05/05/15	5/5 (100%)
Using Animal Subjects in Research (RCR-Basic) (ID: 13301)	05/07/15	5/5 (100%)
Research Involving Human Subjects (RCR-Basic) (ID: 13566)	05/07/15	5/5 (100%)
Responsible Conduct of Research (RCR) Course Conclusion (ID: 1043)	08/23/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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APPENDIX B

LETTERS OF SUPPORT

B-1: INTERVENTION SCHOOL LETTER OF SUPPORT

B-2: CONTROL SCHOOL LETTER OF SUPPORT

Appendix B-1 – Intervention School Letter of Support

June 23, 2015

To Whom It May Concern:

I am writing to express my support for a project that I believe will open the doors to a new perspective of well-being for at-risk children within the Muncie Community Schools. This project aims to improve nutritious food consumption in middle school children through the promotion of vermicomposting as a way to improve the world around them and directly influence the food they eat, thus indirectly promoting the consumption of fresh whole fruit.

Sixth through eighth grade students will be introduced to the concept of composting by learning its purpose in the farm-to-table ideal. They will then be given the opportunity to feed the cores/peels of consumed fresh, whole fruit to a Lucite vermicomposting bin with the use of an illustrated worm as a guide through the process.

Not only is this project a fun opportunity for students, it also promotes a sense of citizenship by focusing the attention on taking care of the earth. In addition, by using the compost in the greenhouse, this project will give students the ability to take pride and ownership in building the local community, while reaping the health benefits of a more nutritious diet. As the majority of nutrition education tends to focus on learning lists of good food versus bad food, this novel approach to improving the health of children is something to be embraced.

The faculty at [REDACTED] Middle School is excited at the potential for our school's involvement with this project, and I ask that you help support it as we venture with Ball State students and faculty to open this new door to improving the health and well-being of the children in the Muncie Community Schools.

Thank you for the consideration of our request.

Sincerely,

[REDACTED]

Principal

[REDACTED] Middle School

Appendix B-2 – Control School Letter of Support

August 17, 2015

To Whom It May Concern:

██████████ Middle School is excited about potentially being a control school for a vermicomposting research project being conducted at Ball State University. Over the summer, I met with Hannah Killion, a Nutrition and Dietetics Graduate program student at Ball State University. She invited us to potentially be a control school for a study on vermicomposting. Our students will benefit from lessons in vermicomposting and the farm-to-table idea. I think this project will promote healthier eating and well-being among a very impressionable aged group of students.

Please consider this letter a letter of support of the project. We welcome lessons for our students to learn more. We appreciate being asked to be a part of the research as the control group. If you should need additional information, please feel free to contact me at ██████████ or via email, ██████████

Sincerely,

Principal
██████████ Middle School

APPENDIX C

STUDY INSTRUMENTS

C-1: LESSON PLAN

C-2: VERMICOMPOSTING PRE-TEST

C-3: VERMICOMPOSTING POST-TEST

C-4: ILLUSTRATED WORM MOTIF

C-5: WORM BIN AND WINDOW FLAP

Appendix C-1 – Lesson Plan

Vermicomposting Lesson Plan

Grade Level: Middle School Students (6th grade)

Title of Lesson: Introduction to Vermicomposting

Learning Objectives:

By completing this lesson, students will be able to:

- Identify the concepts of vermicomposting
- List several advantages of vermicomposting to recycle food waste
- Indicate how vermicomposting is beneficial to plants and soils
- Recall some ways earthworms have influenced history
- Describe categories of earthworms

Materials/Equipment:

Vermicomposting pre-test

Vocabulary glossary for teacher

Vermicomposting PowerPoint

Concentration game cards

Evaluation statements activity

Vermicomposting post-test

Preparation:

Write vocabulary words on the board, without definitions.

Introduction:

Give 5-question pre-test as a pre-assessment to check for background knowledge (not for a grade). Even if students answer “no” for question #1, they can still answer the rest of the test the best they can.

Explain that the decaying process is a natural part of the lifecycle of living things, and that all organic material begins to decompose, or decay, once it dies. Explain that decomposing material can be used to enrich soil and add nutrients by using worms in a process called vermicomposting. Vermicomposting uses worms and microorganisms to convert dead organic matter into nutrient-rich humus (a brown or black organic substance consisting of partially or wholly decayed plant or animal matter that provides nutrients for plants and increases the ability of soil to retain water). The organic matter passes through the worm’s digestive tract and is excreted as castings.

Appendix C-1 – Lesson Plan

Direct Instruction:

Use the PowerPoint presentation as the primary teaching tool for this lesson.

Review/Formative Assessment/Feedback:

Use concentration game cards to assess student understanding. Have students pair up and place all of the cards randomly upside down on a desk. Have the students take turns flipping over two cards at a time. If the pair of cards consists of a matching vocabulary word and definition, the cards can be collected by the student and two new cards can be flipped. The objective of this game is to collect as many matching pairs as possible.

Closure:

Divide the class into 5 groups, and give each group an evaluation statement card. Within each group, have the students read the statement and provide at least three facts from the presentation and their new knowledge that support that statement. Each group will then present to the whole class their supporting statements.

Give the 5-question post-test to assess the effectiveness of this lesson plan (not for a grade).

Resources:

Vermicomposting: A 5th Grade School Enrichment Curriculum

Classroom Composting by Earthday Network

Vermicomposting by Learning Gardens Laboratory

Earthworm Composting by Southern Region 4-H Wildlife Curriculum Committee

Vermicomposting Vocabulary Glossary

Anecic – an earthworm known for burying leaf litter in the soil and pulling it into underground burrows for consumption

Decompose – to rot; putrify

Endogeic – an earthworm that primarily feeds on soil and plant roots

Epigeic – an earthworm that lives primarily in leaf litter on the soil's surface and feeds on surrounding plant debris

Nutrients – substances that provide nourishment for growth or metabolism. Plants absorb nutrients mainly from the soil in the form of minerals and other inorganic compounds, and animals obtain nutrients from ingested foods

Organic – characteristic of, pertaining to, or derived from living organisms

Soil structure – determined by how individual soil granules clump or bind together

Species – a class of individuals having some common characteristics or qualities; distinct sort or kind

Vermicomposting – a form of composting that uses earthworms to convert organic waste into nutrient-rich fertilizer, referred to as worm castings

Worm castings – undigested material, soil, and bacteria deposited by a worm

What is vermicomposting?

Vermicomposting is the process of using worms and microorganisms to convert organic matter into nutrient-rich humus.

- Organic means characteristic of, pertaining to, or derived from living organisms.
 - Organic materials are any type of materials that are found in nature or are made out of items that are found in nature
 - Includes wood, paper, animal, and plant parts.
 - Organic materials contain carbon and naturally deteriorate over time.

What is vermicomposting?

- **Humus** is a brown or black organic **substance** (due to an accumulation of organic carbon) **consisting of decayed plant or animal matter** that **provides nutrients** for plants and increases the ability of soil to retain water. Humus is the life of your soil. Without it, soil is inactive and unable to produce plants, grass or flowers.

Where does vermicomposting take place?

Vermicomposting can occur **wherever food scraps or other organic matter are being generated** and need to be disposed of or thrown away.

- **Kitchen waste** such as vegetable peels, fruit peels and cores, egg shells, coffee grounds, and tea bags can be composted.
- In nature, worms convert **yard waste**, such as leaves and grass clippings to compost.

Things NOT to include when vermicomposting

Not everything should be added to a **vermicomposting bin**. Some food items will cause a bin to become **smelly** or be **harmful to the worms**. These items should not be composted in a vermicomposting bin:

- **Meat and bones** (smelly)
- **Dairy and fatty foods** (smelly)
- **Breads and cereals** (attracts gnats)
- **Sugary or processed foods** (attracts gnats)
- **Citrus rinds** (a few are alright, but the acidity tends to irritate worms)
- **Onions and garlic** (same as citrus rinds)

Where does vermicomposting take place?

Vermicomposting can be done on a **small scale by families** with household organic waste, within **a classroom or a school**, or on a **large scale by gardeners, farmers, and the food industry**.

- Worm composting **bins can be purchased or made** and placed in **classrooms, homes, or farms**.

What are some advantages of vermicomposting?

- It **saves electricity and water** that are consumed by garbage disposal units.
- **Trash cans won't get smelly** from decomposing scraps.
- It **adds nutrients and natural fertilizer to soil** through worm castings that improve the quality of the soil and increases harvests.
- It **requires little space, labor, or maintenance**.
- It generates worms as **fishing bait**.
- It **reduces the mass of waste** by 30%

What are some benefits of worm castings?

Worm castings are **undigested material, soil, and bacteria deposited by a worm.**

- Worm castings are the richest **natural fertilizer** known to humans.
- They are **packed with minerals** that are essential for plant growth, such as concentrated nitrates, phosphorus, magnesium, potassium, and calcium.
- Castings can be mulched or mixed into the soil in gardens and around trees and yard plants. They can also be used as a top dressing on outdoor plants or sprinkled on lawns as a **soil conditioner**.
- Castings **help air and water to permeate soil**.

Fun Facts About Earthworms in History

- Earthworms have been mentioned in history as far back as **Aristotle**, who **described them as “the intestines of the earth.”**
- In the time of the Egyptian pharaohs, **Cleopatra declared earthworms sacred** and established laws protecting them.
- **Charles Darwin studied earthworms for 39 years** and demonstrated that **they improve soil conditions and enhance plant productivity.** Darwin even went so far as to say,

“It may be doubted whether there are many other animals in the world which have played so important a part in the history of the world.”

More Fun Facts About Earthworms

Over 4,000 species

Largest ever found: 22 feet

Smallest worm is 1/2 inch

This is a 10-foot Giant Gippsland Worm

How do scientists classify different types of earthworms?

Earthworms have been **classified in several ways**; perhaps the most useful is **based on their behavior and habitat**. **Marcel Bouche developed a classification** that divides worms into the following three categories:

- **Epigeic** – **live at the surface** in freshly decaying plant or animal residues.
- **Endogeic** – **live underground** and **eat soil** to extract nutrition from degraded organic residues.
- **Anecic** – **burrow deep** in the soil but come to the surface at night to **forage for freshly decaying organic matter**.

Earthworms in the **epigeic category are most commonly used in vermicomposting**, such as the **red wiggler worm**.

Appendix C-1 – Lesson Plan

Concentration Game Cards (To be printed double-sided and cut out)

Appendix C-1 – Lesson Plan

Appendix C-1 – Lesson Plan

A CLASS OF INDIVIDUALS HAVING
SOME COMMON
CHARACTERISTICS OR QUALITIES;
DISTINCT SORT OR KIND

AN EARTHWORM THAT PRIMARILY
FEEDS ON SOIL AND PLANT
ROOTS

DETERMINED BY HOW
INDIVIDUAL SOIL GRANULES
CLUMP TOGETHER

CHARACTERISTIC OF, PERTAINING
TO, OR DERIVED FROM LIVING
ORGANISMS

AN EARTHWORM KNOWN FOR
BURYING LEAF LITTER IN THE
SOIL AND PULLING IT INTO
UNDERGROUND BURROWS FOR
CONSUMPTION

TO ROT; PUTRIFY

AN EARTHWORM THAT LIVES
PRIMARILY IN LEAF LITTER ON
THE SOIL'S SURFACE AND FEEDS
ON SURROUNDING PLANT DEBRIS

UNDIGESTED MATERIAL, SOIL,
AND BACTERIA DEPOSITED BY A
WORM

SUBSTANCES THAT PROVIDE
NOURISHMENT FOR GROWTH OR
METABOLISM. PLANTS ABSORB NUTRIENTS
MAINLY FROM THE SOIL IN THE FORM OF
MINERALS AND OTHER INORGANIC
COMPOUNDS, AND ANIMALS OBTAIN
NUTRIENTS FROM INGESTED FOODS.

A FORM OF COMPOSTING THAT
USES EARTHWORMS TO CONVERT
ORGANIC WASTE INTO NUTRIENT-
RICH FERTILIZER, REFERRED TO
AS WORM CASTINGS

Vermicomposting Evaluation Statement Cards

Vermicompost is beneficial in several ways when added to soil.

Vermicomposting is an environmentally friendly practice.

Earthworms can be classified by the way they behave and where they live.

Vermicomposting can be done in many different settings.

Not all wastes should be recycled in a vermicomposting bin.

Appendix C-2 – Vermicomposting Pre-test

Vermicomposting Pre-test

1. Do you know what vermicomposting is? (Please circle one): Yes or No
2. What is vermicomposting?
 - a.) I don't know
 - b.) Selling worms as a business
 - c.) Using worms to decompose organic waste
 - d.) Eliminating worms from your compost
3. What is the benefit of vermicomposting?
 - a.) I don't know
 - b.) It reduces food waste
 - c.) It returns nutrients to the soil
 - d.) b & c
4. What types of food or scraps can be composted?
 - a.) I don't know
 - b.) Fruit and vegetable scraps
 - c.) Plastic bags
 - d.) Soda cans
5. What types of food should NOT be composted?
 - a.) I don't know
 - b.) Apple cores
 - c.) Potato skins
 - d.) Meat and bones

Appendix C-3 – Vermicomposting Post-test

Vermicomposting Post-test

1. Do you know what vermicomposting is? (Please circle one): Yes or No
2. What is vermicomposting?
 - a.) I don't know
 - b.) Selling worms as a business
 - c.) Using worms to decompose organic waste
 - d.) Eliminating worms from your compost
3. What is the benefit of vermicomposting?
 - a.) I don't know
 - b.) It reduces food waste
 - c.) It returns nutrients to the soil
 - d.) b & c
4. What types of food or scraps can be composted?
 - a.) I don't know
 - b.) Fruit and vegetable scraps
 - c.) Plastic bags
 - d.) Soda cans
5. What types of food should NOT be composted?
 - a.) I don't know
 - b.) Apple cores
 - c.) Potato skins
 - d.) Meat and bones

Appendix C-4 – Illustrated Worm Motif

Appendix C-5 – Worm Bin and Window Flap

APPENDIX D

DATA COLLECTION DOCUMENTS

D-1: DATA COLLECTION SHEETS

D-2: FRUIT CONSUMPTION DIAGRAMS

Fruit Consumption Data Collection Sheet

Assistant Name _____

[illegible]

X – other

Appendix D-2 – Fruit Consumption Diagrams

Partially Consumed (1-49%)

Fully Consumed ($\geq 50\%$)