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Curriculum Strategy to Increase College Student’s Motivation, Ability and Opportunity Resulting in Reduction in Wasted Food

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Curriculum Strategy to Increase College Student’s Motivation, Ability and Opportunity Resulting in Reduction in Wasted Food

By

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DCN DISSERTATION
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University of North Florida

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DEDICATION

I would like to dedicate this educational experience to God for granting me an inquiring mind and the time and ability to develop my skills in nutrition, and to my six children who have been the inspiration to keep going. Finally, to my Mom, Sarah Kent Blakemore Drummond, who was always a font of God’s love and who passed away days after the Defense.
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Concerns about Food Loss and Waste (FLW) have been rapidly growing worldwide as it came to be understood how the loss of about one-third of the edible food produced globally leads to environmental damage, leads to loss of about USD 1 trillion and keeps food from hungry people. Consumers in developed countries account for the largest majority of food that is wasted. College presents an excellent opportunity to reach young adults as they are developing their identity, self-efficacy and life skills. Utilizing the Motivation-Ability-Opportunity Framework, this research’s overall goal was to find a Curriculum Strategy to engage allied health students in sustainability awareness and practices towards reducing food waste. This quasi-experimental research project tested in an online college Fundamentals of Nutrition class (n = 197) if a series of classroom activities including System and Action Lectures and a Discussion post would result in raised Motivation, Ability, and Opportunity (MAO) scores and in reduced Food Waste. A pre- post-survey of 60 questions asked sociodemographic and Likert scale questions about Food Waste Prevention Practices and questions related to MAO. To test for behavior change, the outcome measure was personal food waste collected for three days pre- and post- curriculum activities. Results showed food waste was significantly lower from pre- to post- at p = .0012. The summed constructs of Motivation and Ability were significantly raised from pre- to post. There was no significant relation found between the sociodemographic variables and the amount of pre-food waste. The only significant connection found between Prevention Practices and pre-food waste was Impulse Buying with higher levels significantly related to higher levels of food waste p = .0011. The intervention lowered food waste and raised Motivation and Ability to reduce food waste.
INTRODUCTION

Concerns about Food Loss and Waste (FLW) have been rapidly growing worldwide since the early-2000s as it came to be understood how the loss of about one-third of the edible food produced globally\(^1\) leads to environmental damage,\(^2\) leads to loss of about USD 1 trillion\(^3\) and keeps food from hungry people.\(^4\) With the global population growing by 2 billion more inhabitants by 2050, it is going to be very difficult to feed all of us\(^5\) without severe damage to the environment. Food can be lost all along the food supply chain from farms, processing plants, transportation, storage, retail locations, and in homes. Consumers, though, play an outsized role in disposing of edible food, especially in developed industrialized countries where they account for the largest majority.\(^1,6,7–14,15–17\) The loss of edible food is particularly egregious when it becomes waste at the end of this chain – at the consumer level. At each step of the supply chain more and more resources are embedded in the food item so that food that has been grown/raised, processed, transported, distributed, stored/cooked and then thrown away has the most resources that are now simply wasted.\(^11,18,19\) The Academy of Nutrition and Dietetics (The Academy), the largest organization for nutrition professionals in the United States (US), wishes for all schools and internship programs teaching Dietitian/Nutritionists to develop their students/interns into sustainability aware and involved leaders. College presents an excellent opportunity to reach young adults as they are in a stage of life that is noted for significant changes - a time when they are developing their identity, self-efficacy and life skills.\(^20\)

Consumers throw edible food out for many reasons including lack of concern and awareness over the environmental, economic and social damage it leads to; for food safety reasons; and for a range of home provisioning habits and routines.\(^15,16,21–24\) The Motivation –
Ability – Opportunity Framework (MAO) combines both the psychological issues affecting Motivation of awareness, attitudes, and norms with the more habitual/routine Ability issues of food handling skills/knowledge and Opportunity issues of consumers fast paced lives making time and scheduling of meals difficult.  

This research’s overall goal was to find innovative pedagogical methods to engage allied health students, including those majoring in Dietetics/Nutrition, in sustainability awareness and practices. The Academy wishes sustainability added throughout the program, yet the Introductory Nutrition class, like all didactic classes, is already full of information to learn. This quasi-experimental research project, set in an Introductory Nutrition class at a large university in the Southern United States, tested if a series of pedagogical methods including System and Action Lectures, a Discussion post and collecting food waste resulted in raised MAO scores and reduced personal food waste (FW). The System Lecture covered broader concerns related to the global food system and targeted Motivation. The Action Lecture covered household/consumer level skills, knowledge and time factors to enable consumers to break routinized habits leading to food waste and targeted Ability and Opportunity. A Discussion post by the students engaged them in active learning. Together these are labeled Curriculum Strategy. A pre- post-survey provided outcomes related to MAO and to a range of food provisioning habits and routines called collectively Food Waste Prevention Practices. To test for behavior change, the outcome measure was personal FW that the students collected for three days and brought to campus to be weighed pre- and post-Curriculum Strategy.
CHAPTER ONE: LITERATURE REVIEW

Definitions of Food Loss and Waste

Research in the field of Food Loss and Waste (FLW) has been hindered by a wide range of definitions and methods of measurements. Even the terms Food Loss and Food Waste have no set meaning. This lack of consistency has made it difficult to compare results of research.\textsuperscript{27–30}

Three Definitions that are in common use:

United Nations Food and Agricultural Organization (FAO)\textsuperscript{31}:

- Food Loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retail, food service providers and consumers.
- Food Waste refers to the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers.

United States Department of Agriculture (USDA) Economic Research Service\textsuperscript{14}:

- Food Loss is the edible amount of food, postharvest, that is available for human consumption but is not consumed for any reason. It includes cooking loss and natural shrinkage; loss from mold, pests, or inadequate climate control; and food waste (puts food waste as just one aspect of food loss and usually does not include inedible).

There continues to be no consensus for Definitions of Food Loss and Food Waste, as it depends on the needs of the organization or government. An example is that the EPA is interested in how much food ends up in landfills, so they include inedible food while many
others do not. The Food Loss and Waste Accounting and Reporting Standard, described below, allows for a modular approach to definitions.\textsuperscript{32}

Food Loss and Waste in the Supply Chain

Food Loss and Waste occurs at each stage of the food supply chain at each actor along the path, and it greatly depends on the country as to which factors are barriers to or lead to FLW. It is generally agreed that less developed countries will have higher levels of FLW in the earlier segments due to less infrastructure such as roads and refrigerated storage and transport, etc. with low levels among consumers for whom food is expensive and precious,\textsuperscript{18,33} but both Spang et al.\textsuperscript{18} and Xue et al.\textsuperscript{28} state that this narrative is not necessarily proven as there is very little research on consumers in these countries. An example of contrary data is that in research from Ghana daily food waste ranged from 0.22 kg/capita/day in low-income areas to 0.235 kg/capita/day in higher income areas\textsuperscript{34} and these numbers are comparable to New Zealand\textsuperscript{35} a more developed country. More developed countries have been found to have lower levels in the beginning stages due to advanced infrastructure and transport but high levels at the consumer level partly due to an abundant supply of relatively inexpensive food.\textsuperscript{28,36,37} In the US, there is \~63 million tons of FLW annually. Of this 16\% is lost at the farm level, 2\% at the manufacturing level, 40\% at the retail level and 43\% at the household (HH) level.\textsuperscript{38} The recent pandemic caused by the Covid virus greatly upset food supply chains worldwide and led to many adjustments in local communities and HHs. Iranmanesh et al, 2022 conducted a systematic review of the many research articles that came out in 2021 on how Covid affected HH FW behavior.\textsuperscript{39} Some of these impacts such as limited eating out, more home food preparation, eating leftovers, and more checking of food stocks and planning purchases might last past the end of the pandemic.
Measuring Food Loss and Waste

Accounting for FLW is complex leaving much uncertainty.27 As the field of FLW has matured there has been a concerted effort to consolidate methodological approaches. The Food Loss and Waste Accounting and Reporting Standard (FLW Standard) has been developed by several global organizations including FUSIONS, WRAP (Waste and Resources Action Plan), and WRI (World Resources Institute). WRAP is one of the earliest organizations working in this field and has developed its own guide to Food Waste Measurement specifically for manufacturers, retail, and food service.40 FUSIONS is the effort to standardize all FLW accounting in the European Union and is coherent with the FLW Standard.27,41 Measuring the amount of food wasted at the consumer/household level will be covered in a later section.

Global Concerns of Food Loss and Waste

Currently, most every article or report on FLW refers back to the seminal work of the FAO, Global Food Losses and Food Waste: Extent, Causes, and Prevention, published in 20111 based on global data from 2007 that indicated roughly one-third of all food produced for human consumption is lost or wasted which is approximately 1.3 billion tons of food per year. “The study revealed that there are major data gaps in the knowledge of global food loss and waste. Further, that research in the area is urgent.” Many assessments and assumptions had to be made particularly at the distribution (retailers) and consumption stages as these stages had much less data. A major finding was that the more developed countries lost a substantial amount of food at the consumer level. Another finding was that industrialized countries lost fruits and vegetables at a high rate in the consumption stage.

The findings of this seminal study are understood to be very rough as they were at the regional level and many estimates had to be made, but these findings are still being used in
current papers for lack of better information on a global basis.\textsuperscript{18,42,43} Kummu et al\textsuperscript{9} expanded on the FAO study by using country level information and found similar results of about one-third of food is lost/wasted when measured by weight. These authors also calculated using the metric of kilocalories and found that 24\% of food by energy was lost. This would be enough to feed 1.9 billion people if the WHO value of 2,100 kcal/day was used.\textsuperscript{9}

As with measurement issues, the global community is engaged in finding ways to more accurately calculate and report data on country-wide bases.\textsuperscript{44} In 2019, the FAO announced a Food Loss Index which is now operational though still hampered by limited data.\textsuperscript{28,44} This Index, which measures the loss up to, but not including, the retail segment, is incorporating more than the physical quantities as the economic weight of the food is being included. This will allow more valuable foods to carry a larger weight. One of its first findings is that 13.8\% of the world’s production of food in 2016 was lost before it reached retail level.\textsuperscript{45}

The next step is still in progress as of late 2020 with the UN’s Environmental Programme (UNEP) responsible for developing the Food Waste Index which will aggregate data at the Retail/Consumer level.\textsuperscript{45} In addition, a Food Waste Atlas has been developed by a partnership between WRAP and the World Resource Institute (WRI) and is actively inputting data from all sources.\textsuperscript{44}

Food Waste and Environmental Damage

The pressures on the environment currently are already large and will only grow larger with the anticipated rise in global population. In 2020, there were about 7.8 billion people in the world. Estimates for 2050 place the population at \sim 9.8 billion, therefore, there will be a need to feed about 2 billion more people.\textsuperscript{46} In addition to there being many more people to feed, global income will triple\textsuperscript{46} and this will lead to many millions more people rising in socioeconomic
class and demanding more food and more animal-based foods.\textsuperscript{11} The forecast is that there will be an increase in demand for agricultural products of 35-50\% between 2012 and 2050.\textsuperscript{2} In the absence of technological change or mitigation measures it is expected that the environmental pressures on the food system will rise by 50-92\% for each indicator.\textsuperscript{2,47} Food loss and waste is just one aspect of the food system causing environmental damage, but halving FLW would lead to reductions in environmental pressures by 6 – 16\% per indicator when compared to baseline projections for 2050.\textsuperscript{2,47}

A major point to keep centered is that food can become FLW at any point along the supply chain. It is particularly egregious when it becomes waste at the end of this chain – at the consumer level. At each step of the supply chain more and more resources are embedded in the food item so that food that has been grown/raised, processed, transported, distributed, stored/cooked and then thrown away has the most resources that are now simply wasted. These resources include land, water, energy, fertilizer with nitrogen and phosphorus, soil, pesticides, human capital, etc. as will be shown below.\textsuperscript{11,18,19}

There are four main domains in which negative effects of food waste are exhibited. These are the three pillars that define sustainability in all disciplines - environment, economic and social - and the additional domain of nutrition that is peculiar to food systems.

Environmental Domain: Numerous aspects of the environment are impacted by food loss and waste. The three aspects that are more quantifiable are the carbon footprint, the land footprint and the water footprint.\textsuperscript{2}

\textit{Carbon footprint:} is referring to greenhouse gas emissions (GHG) produced along the whole supply chain in all aspects, not just food loss and waste. Food in its entirety is responsible
for about 26% of global GHG emissions. Food that is disposed of in landfills creates methane gas in copious amounts as it decomposes anaerobically which is particularly problematic, because methane has 28 times the warming potential of carbon dioxide. As reported in Chapter Five of the 2019 Intergovernmental Panel on Climate Change’s (IPCC) report on Climate Change and Land, global FLW during the years of 2010 – 2016 was responsible for 8 – 10% of total anthropogenic GHG emissions (a medium confidence level) and cost about 1 trillion USD 2012 per year (a low confidence level). The amount of GHG released from FW, all along the food supply chain, is about 3.3 billion tons. If this was a single country, then it would be the third largest emitter, just after the USA and China. To clarify, food has had much direct and indirect energy added to it and when that food is not consumed by humans, and instead lost or wasted, then all the energy that went into that food is lost also. Energy inputs into food have risen with the greater use of fertilizers, mechanization of agriculture, and more irrigation. Once the food is off the farm, then energy inputs continue with transportation and the increased processing, packaging, and refrigeration of food. These represent embedded energy.

Land Footprint: Cleared land is required to grow or raise most food crops/animals. Globally, it has been estimated that about 1.4 billion hectares of land, which is an area 1.5 times as big as the United States, is used to grow food that is then lost or wasted somewhere along the food supply chain. In the United States, some 30 million acres of cropland, which is approximately 7% of our cropland, is used to grow crops that are then lost/wasted. When analyzing just the land used for fruits and vegetables in the US the percentage rises to greater than 50%. Unless changes are made, by 2050 the need for cropland globally will have increased by 67%.
Water footprint: Water is also highly wasted when considering FLW. Agriculture is responsible for the use of 70% of global freshwater withdrawals. Water used to grow and contained within food that is lost/wasted constitutes 21% of fresh water used. Another way of visualizing the loss of water is to picture the Nile River twice over each year being used to irrigate food that is subsequently wasted. In the US, the lost water would fill 6 million Olympic-sized swimming pools.

As stated, the above three areas - carbon, land, and water footprints – are the most quantifiable, but a fuller listing of the resources embedded in food that is lost/wasted and the environmental damage done would include lost pesticides and fertilizers with all of the energy needed to create them - in the US this is 1000 Olympic-sized pools of pesticides and nearly 8,500 Olympic-sized pools of fertilizer. In addition, there is air pollution, water pollution from fertilizer run-off, damage to fisheries, soil erosion, and biodiversity loss, among other harms.

Economic Domain: Economic concerns are the second pillar of sustainability. Loss of economic value of global FLW is yearly USD 1 trillion. If the cost of environmental and social costs is included, then the global cost yearly is approximately USD 2.6 trillion. To put this in perspective, this amount is about two times the annual food expenditure in the United States. The cost of FLW along the whole food chain in the United States is approximately $166 billion to $218 billion/year. As food moves along the food chain the economic value contained in it increases. Consumers are paying retail costs for their food, therefore the financial burden of wasting food at the consumer level is going to be highest and accounts for about $144 billion/year in the US. Food waste at the HH level cost American consumers on average $371/person/year. Data from the National Health and Nutrition Examination Survey
(NHANES) from 2001 – 2006 found that 59% of food was consumed, 14% was inedible parts, and 27% was wasted.\textsuperscript{59} Food waste therefore accounted for over one-quarter of the daily food budget, was >$3.50/day\textsuperscript{60} and was about 0.93 lb/day.\textsuperscript{54} Figure 7 shows the daily per capita cost of food purchased, inedible, wasted, and consumed. The average American in 2019 spent only 9.5% of their disposable income on food which included both food at home and food away from home. This is a historic low.\textsuperscript{61} As will be pointed out later, this low cost of food is one reason consumers are little concerned with waste.\textsuperscript{62} While this percentage is much less than most any other country, the number varies greatly depending on one’s total income. Those in the lowest quintile of income in the US spend about 35% of their disposable income on food.\textsuperscript{63} It is apparent that those in the lower income brackets will be most hurt by unnecessary food waste.

Social Domain: The third pillar of sustainability is social. As mentioned above, global population is rising rapidly (though less rapidly than in the years between 1970 and 2010).\textsuperscript{4} In 2005/2007 there was technically enough kilocalories present in the global food supply (about 2,770 kcal/day) to provide everyone alive with sufficient kilocalories,\textsuperscript{4} though this does not mean there was sufficient healthy, nutritious kilocalories.\textsuperscript{57} Global inequities along with food distribution problems prevent the equal distribution of food across the globe.\textsuperscript{64} The World Resources Institute calculated the result for the global population in 2009 and, as expected in 2050 if we were relying on the food we produced in 2009, even if it was distributed evenly around the world. In 2009 there was barely enough when considering actual waste that occurs. In 2050 there is not enough to feed everyone even with zero waste factored in.\textsuperscript{5}

Prior to the global pandemic in 2020 caused by Covid-19, 690 million people were undernourished (severe food insecurity) which is 8.9% of the global population.\textsuperscript{57} This number had been dropping for many years, but since 2014 it has been rising again with 60 million more
people added by 2019. The Covid pandemic was so disruptive of livelihoods and countries, that it is estimated some 83 to 132 million more people are now undernourished. In addition to the 690 million people who were affected by severe food insecurity (pre-Covid), many more people were affected by moderate food insecurity having to reduce the quantity and/or the quality of their diet so that the total of those who experienced hunger or who did not have regular access to nutrition and sufficient food was 2 billion people which is ~26% of the global population. An additional billion people can be added when calculating those who cannot afford a healthy diet, which goes beyond a diet that just provides enough kcal or a diet that provides basic nutrients, to a diet that provides enough variety to not only protect against malnutrition in all its forms, but that will also protect against non-communicable diseases such as diabetes and heart disease as well. Health costs related to inadequate/poor diets are rising and expected to reach USD 1.3 trillion in 2030.

Food losses and waste removes healthy food from people’s diets. Produce and animal products are the most perishable and suffer the higher losses. These are nutrient-rich foods lacking in some 3 billion people’s diets. Preventing FLW would allow the resources that went into those food items to be used more efficiently and very possibly reduce the cost of food so more can afford it. Alternately, instead of being lost or wasted, the food could be used to feed food insecure people. In America, 4.1% of the population were very food insecure in 2019 and 6.4% were low food insecure for a total of 10.5% affected by food insecurity. Gunders estimated in the 2012 Report for the National Resource Defense Council (NRDC) that if wasted food was reduced by just 15% there would be enough food to feed 25 million Americans. There are also direct negative effects of FLW from the excess production of food including pollution caused by pesticides and fertilizer. Many fieldworkers, meatpackers, and fisherpeople
work under dangerous conditions\textsuperscript{67} for very low wages which is part of the reason food in America is inexpensive. More efficient production could lead to higher wages and better working conditions.

Nutrition Domain: The last domain to consider is nutrition. The level of waste in the US upstream portion of the food supply chain - farming, processing, and transport - is approximately 310 kcal/person/day which is sufficient kcal to feed 40 million people 2,000 kcal/day/person.\textsuperscript{53} Downstream (retail and consumers), it is approximately 800 kcal/person/day which could feed 120 million people 2,000 kcal/day/person.\textsuperscript{37} When added to the upstream these yield \(\sim 1110\) kcal/person/day.\textsuperscript{53} This is a similar number to the 1334/person/day reported by Kummu et al.\textsuperscript{9} Lost and wasted food contains, therefore, both embedded energy costs from the energy it takes to farm, transport, process, cook, etc. and embodied energy from the kilocalories in the food that are lost when the food is not used for human consumption.

Spiker et al\textsuperscript{68} comments that, "US landfills represent vast repositories of lost nutrition." In addition to the lost kilocalories, about 33 grams of protein/capita/day are wasted in the US.\textsuperscript{54} Other nutrients of concern that are lost include fiber, calcium, potassium and vit D,\textsuperscript{60} and, in reality, every nutrient and phytochemical found in the food. North America threw out the most fruit of all the world regions amounting to the equivalent of 110 days of fruit needs of the average person.\textsuperscript{43} North America also threw out 88 days of vegetables.\textsuperscript{43} In the United Kingdom, it was found that the food thrown away by the average consumer contained enough nutrient value to provide a healthy diet to an average person for 42 days, which is 11\% of the year.\textsuperscript{69}

Global Concerns Over Food Waste

Concerns about FLW has been rapidly growing since the early-2000s as it came to be understood how the food system leads to environmental degradation and contributes to climate
change and how it is going to be exceedingly difficult to feed approximately 2 billion more inhabitants of earth by 2050 without further damage. Parfitt and colleagues\textsuperscript{13} in their 2010 review article, “Food waste within food supply chains: quantification and potential for change to 2050,” were one of the first to highlight the scale of the FLW problem giving historical information and explaining three global trends: urbanization would greatly affect supply chains; dietary transition from cereal grains/starchy food staples to increased levels of more fresh fruits and vegetables, dairy, meat, and fish, particularly in BRIC countries (Brazil, Russia, India and China) increases loss of these shorter shelf-life foods; and increased globalization of trade.

Demand for more food, and more animal-based food will increase the demand for agricultural products by 35 - 50% by 2050.\textsuperscript{57,70} Where this food is going to be sourced from is a question of major importance. Reducing the current high levels of FW is one of the options. Earlier it was indicated that about one third of the food in the world is lost/wasted.\textsuperscript{1} Huber et al\textsuperscript{71} 2017, calculated that this much food would be enough to feed 2 billion people per annum. There will always be some degree of food lost and wasted, as parts of food are inedible, and also it is important to maintain some reserve in the food supply to allow for resiliency in the case of climate change, droughts, and other food shocks, but even lowering FLW by up to a half would make available a much larger quantity of food. Lipinski et al\textsuperscript{55} estimated that “if the current rate of food loss and waste were cut in half – from 24% to 12% - by the year 2050, the world would need about 1,314 trillion kilocalories less food per year than it would” if we maintained the current levels. “That savings is about 22% of the 6,000 trillion kcal per year gap between food available today and that needed in 2050.\textsuperscript{55}”

In 2016, the United Nations declared seventeen Sustainable Development Goals (SDG) to be accomplished by 2025. SDG 12.3 places reducing FLW as a crucial action for the world to
undertake. It states: *By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.* Reducing FLW will have multiple ripple effects on many of the other SDGs. SDG 12.3 is to be measured by Indicators of the Food Loss Index and the Food Waste Index as discussed earlier under Measurement. With FLW lowered, approximately 2 billion people could have enough healthy food to solve their nutritional deficiencies. To promote forward movement, the UN FAO celebrated the 1st International Day of Awareness of Food Loss and Waste on Sept 29, 2020.

**United States Concerns Over Food Waste**

In 1997, researchers with the USDA Economic Research Service (ERS), Kantor, Lipton, Manchester and Oliveira wrote a review article for Food Review titled, “Estimating and Addressing America’s Food Losses,” which has been one of the most cited in literature involving FLW. Many of the studies it was based on were quite dated, from the 1970’s, but it was a start towards showing the level of and importance of wasted food. Some of their findings were that America had an abundant food supply that supplied about 3,800 kcal/day and that people were not concerned with food loss. ERS calculated the loss at the Retail, Foodservice and Consumers level (downstream) of about 27% of edible food supplies and that most were fresh fruits and vegetables. They also estimated that since each person eats approximately 3 lbs. of food a day, recovering just 5% of the wasted food would be enough to feed 4 million people for a year.

Another frequently cited report is by Hall and colleagues titled, “The Progressive Increase of Food Waste in America and its Environmental Impact,” published in 2009. They reported that in 1974 about 900 kcal/person/day was wasted in America and that this grew to about 1400 kcal/person/day in 2003 for about 150 trillion kcal/year thrown out. This equated to
~30% of the available food supply in 1974 but closer to 40% by 2003. Walia & Sanders point out that in this same period the US population increased by 37% so US food waste in that period more than doubled.

The level of concern and involvement of the United States in reducing food loss and waste has trailed Europe by about a decade, but interest began rising especially with the 2014 report from the ERS by Buzby et al titled, “The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States.” They used primary data from 2010 to estimate that ~31% of food produced was not available for human consumption at the retail/consumer level of the food system (133 billion pounds lost out of 430 billion pounds available at that level). Retail was 10% and consumer was 21%. This loss cost consumers $372/per capita/year or 9.2% of average food spending. This amount of food loss represented 1,249 uneaten kcal/per capita/day out of a possible 3,796 kcal/per capita/day.

The USDA estimates that FLW was about 133 billion pounds in 2010. ReFED (Rethink Food Waste Through Economics and Data) estimates 125 billion pounds in 2015 so very similar numbers. The Natural Resources Defense Council (NRDC) announced a 40% estimate in a famous report, “Wasted: How America is Losing up to 40% of its Food from Farm to Fork to Landfill,” by Dana Gunders in 2012 with a revised report in 2017. In the REFED 2016 report, the stage at which food is lost/wasted was estimated to be ~16% farm, 2% processing, 40% retail (grocery, restaurants, etc.), and 43% consumers (home). Fruits and vegetables were the most lost of the food groups at 42%. The value of the waste was USD 218 billion or 1.3% of GDP. Some 52 million tons of food is sent to landfills annually, and food waste is the largest single item in America’s landfills at 15% of total municipal solid waste. Wasted food accounted for
20% of the land, water, and fertilizer used for food in the United States, and 8% of global GHG emissions.\textsuperscript{84}

Based on this growing level of interest worldwide and in the United States, in 2015 the USDA and EPA called for our first national goal to reduce by 50% by 2030 the amount of FLW.\textsuperscript{49} The EPA has developed its Food Waste Hierarchy which shows that the best solution for all is to prevent FLW in the first place. The next best solution is to feed hungry people as in food donations, then animals and on down. The least desirable is to send unwanted food to landfills/or to be incinerated as that is food that is completely wasted and creates large quantities of methane and other greenhouse gases (GHG).\textsuperscript{85}

In 2019, the USDA, EPA and FDA all joined in the Winning on Reducing Food Waste Initiative with the EPA publishing a strategic plan.\textsuperscript{85} The National Academies of Sciences Engineering and Medicine (NASEM) held a workshop in 2018 on Reducing Impacts of Food Loss and Waste, followed by a report in 2019 summarizing the findings of the workshop. In 2020, NASEM published a report titled, “A National Strategy to Reduce Food Waste at the Consumer Level.”\textsuperscript{49} It is apparent that in recent years interest and concern has swelled in the United States.

Consumers and Wasted Food

It has been shown many times that the largest contributor to FW in developed, industrialized countries is consumers at the HH level.\textsuperscript{1,6–9,11–17,86} A sample study is the State of Oregon funded a large study using kitchen diaries, surveys, and waste sorting (sorting through garbage). The HHs studied threw away 2.3 lb. per capita per day and of this 71% had been edible at one time. The other 30% was never edible such as eggshells and bones.\textsuperscript{6} We have seen that FW at the consumption level has the highest environmental, economic, and societal implications,
therefore prevention of consumer FW has become a major push for research and action. Sustainable agriculture is recognizing the importance of incorporating consumers. One example is the FAO is now in partnership with Consumers International which recognizes that “consumers around the world can be a powerful force for change towards more sustainable and equitable agrifood systems.” Research though on HH FW, while increasing, “remains scarce and fragmented.”

Very interestingly, consumers often consider that they themselves waste less food than other people when the reality is often in sharp contrast to actual results from physical assessing of FW. Neff conducted the first US national consumer survey focused on wasted food. The majority of US consumers participating in this survey reported discarding 10% or less of their food and only 10% reported discarding 30% or more. 73% reported discarding less than the average American HH.

Chen et al reported that the average North American consumer threw out 23% of the total weight of food entering the HH. This falls between 15% and 30% as found in several other studies. Stenmarck et al found much higher HH amounts (~50%) in a study of EU food waste. When consumers eat at restaurants, they leave 17% of their meal uneaten and 55% of the leftovers are not taken home. Even when taken home the leftovers are often thrown away. Conrad et al analyzed US government data sets to find that US consumers wasted about 25% of the weight of their food daily for an average of 0.93 lb/day. Stated as kcalories, it was a loss of 30% of their daily kcalories.

Reasons Consumers Discard Edible Food

With the scientific understanding that FLW is a major contributor to environmental degradation and climate change, and that consumers are a major contributor to FW, this decade
has seen a growth in research interest in the role of consumers in the generation of FW, particularly since 2015.\textsuperscript{24,28,94} Even so, the field is still scarce and fragmented\textsuperscript{18} with a variety of approaches and measures being used, making it difficult to compare studies or draw conclusions about the reasons that consumers waste food.\textsuperscript{89}

Most of the research that has been done on consumer food waste does not include an intervention.\textsuperscript{36,49,95} The Committee developing the National Strategy to Reduce Consumer Food Waste found only 64 peer-reviewed intervention studies between 2005 and June 2019 in the areas of Food Service, Retail, and HH. Of these only 6 HH studies made the cut to Tier 1 exhibiting the high standards of well-done intervention research.\textsuperscript{49} Those studies with interventions have often not been based on a theoretical framework to inform the research process.\textsuperscript{36} Reynolds et al\textsuperscript{36} suggested that more rigorous studies need to be done.

Food “has become more anonymous and its production more distant from the average consumer (in industrialized societies) than perhaps ever in human history.\textsuperscript{96}” As mentioned earlier, food in America is inexpensive and plentiful, which naturally leads to consumers underestimating the value of food.\textsuperscript{97,98} Throwing out edible food can be seen as a ‘rational’ economic decision whereby the consumer is comparing the cost of the food to the costs of time and materials, such as the time it would take to store it or fix into another meal,\textsuperscript{42} but there are many other factors that push back against rationality. On a societal basis, consumers are not aware of the negative externalities embedded in the foods they are throwing out, including the environmental inputs of water, land, etc. and the damage done by pollution. If these, and the many other externalities, were taken into account, food would be much higher priced.\textsuperscript{42} Secondly, it has been shown that consumers handle food, like many other routine HH tasks, with little rational thought but instead on the level of routines and habits.\textsuperscript{13,42,99–101}
A wide range of food provisioning behaviors are being analyzed as part of the social-practice theoretical framework explained further in Chapter Two. These include how one plans before a shop, shopping habits, storage of food, preparing foods, and handling leftovers which turns out to be one of the major causes of FW. By the time food is thrown away, the opportunity to prevent that food from becoming waste has often passed. Inconvenience has been shown to be a significant factor in FW and to reduce FW consumers having access to necessary equipment is important. Figure 1 shows one conceptual framework incorporating many of the factors that are possibly affecting consumer FW and where they fit in the path of food entering the house.

![Conceptual framework of the generation of consumer food waste](image)

**Figure 1.** Conceptual framework of the generation of consumer food waste

Consumer choices are constrained by Choice Architecture which refers to the choices presented to consumers, such as the package sizes that may not fit their needs, the serving sizes of retail foods, bulk discounts encouraging to buy more than needed, and date labels that are confusing at best. Many consumers understand that fresh fruits and vegetables are healthier
and therefore purchase them, but then do not get around to eating them in time.\textsuperscript{93} If they understood that frozen and canned are quite suitable, then there would be less FW.\textsuperscript{49} Date labels are mentioned in most studies as confusing consumers.\textsuperscript{23,49,56,79,105–107} In fact, Quested et al\textsuperscript{23} found that consumer confusion about date labels accounts for more than 30\% of FW. Food follows a path through the store and home and there are many opportunities for taking actions that will promote the food being eaten instead of being discarded.\textsuperscript{22}

Consumers are part of an entire food system with wider societal, governmental, economic, technological issues that are beyond the individual’s intrapersonal role such as the retail level pushing both overproduction of food and overconsumption which are structural reasons that lead to food waste.\textsuperscript{49,108,109} Consumers add to this by expecting cheap food with lots of variety and fully stocked shelves that never run bare, and they have this expectation because retail and the broader society has been pushing that narrative for many years.\textsuperscript{91,105,110}

Spang et al\textsuperscript{18} has compiled a concise listing of the Drivers and Pressures leading to HH level FW (Table 1) and each of these possibilities has research that shows agreement but incomplete evidence. They used the Driver-Pressure-State-Impact-Response (DPSIR) Framework.

\begin{table}[h]
\centering
\begin{tabular}{|l|p{5cm}|p{13cm}|}
\hline
Drivers & Market standards & Includes demand for consistently high-quality food; abundance; biological aging (e.g., sprouting of tubers); food standards in schools 11,14,21,81 \\
\hline
 & Sociocultural standards & Includes demand for consistently high-quality/culturally appropriate food; discounts and offers; expectations of food portions/serving sizes 11,14,15,21 \\
\hline
Pressures & Household food management & Planning, shopping, storing, cooking, eating, and disposing; includes participation in specific behaviors like meal planning 21–24 \\
\hline
\end{tabular}
\caption{Drivers and pressures leading to household level Food Waste\textsuperscript{18}}
\end{table}
<table>
<thead>
<tr>
<th>Perception of ‘good’ food</th>
<th>Determining whether food is fresh, what parts are edible, including managing leftovers and navigating food safety concerns</th>
<th>16,21–24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date labels</td>
<td>Can prompt consumers to discard safe and edible food; need for consistency</td>
<td>15,16,21–24</td>
</tr>
<tr>
<td>Packaging</td>
<td>Properties of packaging can both increase and decrease FLW; can lengthen shelf life of food; inadequate labeling and packages prompting over purchasing</td>
<td>16,21–24</td>
</tr>
</tbody>
</table>

Distal Factors

Distal factors include various socio-demographic attributes of consumers and research literature has found these to be of mixed importance. Overall, those of a younger age tend to waste more food than those older.16,111 HH size and composition have been related to quantity of FW with larger HH wasting more than smaller, but when the HH are corrected for the number of people in the HH then they actually waste less per capita.112 If a HH has children though, then the HH wastes more food.91 Income and gender have mixed results.12,8,111,113 Education is interesting in that higher levels of education seem to be related to higher levels of self-reported FW.111,113 Why that would be the case is not known, though possibly it shows a person who is more interested in the subject and more willing to be objective about their own FW tendencies.

Reducing Consumer Food Waste

Roe et al114 stated in 2020 that there is still “little guidance on which consumer-focused strategies would yield the greatest food waste reduction.” And it was still the case in December of 2022 that there was no model to explain the food disposal behavior of HHs.104 As shown in the previous section, there are so many potential variables that have been suggested and researched.
It is well understood that simple knowledge and awareness of an issue is not sufficient to elicit intentions and to be followed by behavior of reducing food waste.\cite{24,80,100,115} It is, however, a start and an underlying condition. Bajzelj et al,\cite{42} based on numerous reports,\cite{13,23,24,116} labeled higher awareness of food waste as a ‘fostering condition’ which is needed along with widespread measurement and reporting as the basic condition to reduce the levels of food waste across all stages of the supply chain. Priefer et al\cite{11} stated that, “All studies agree on the fact that consumer information and education are crucial instruments to influence their behaviour.”

REFED (Rethink Food Waste Through Economics and Data) have used data to arrange in order of most effect to least effect the solutions for the United States to reduce FW where the benefits outweigh the costs. When analyzing Financial Benefit, the two most effective solutions were first, Consumer Education, and second, Standardized Date Labeling. When comparing solutions to reduction of GHGs, Consumer Education tied for second and Standardized Date Labeling came in fourth. To save water, Consumer Education and Standardized Labeling were second and third. Overall, Consumer Education Campaigns could divert 584 K tons of food waste at an economic value per ton of $4,531, reduce GHGs by 2336 K tons and save 281 billion gallons of water.\cite{38}

In the National Strategy to Reduce Food Waste published in 2020 by the National Academy of Science, Engineering and Medicine,\cite{49} pages 2 – 8 are devoted to the development of a centralized platform led by the USDA, EPA and FDA for a behavior change campaign. This campaign will be part of the Federal Winning on Reducing Food Waste Initiative. In addition, two other aspects of their Strategy are: 1) Spread and amplify messages about FW through influencers (such as professional groups) and 2) Include instruction and experiential learning
about food literacy in education curricula to include the social, environmental, and economic impacts of FW and ways to reduce it.

Benson and colleagues\textsuperscript{117} interviewed numerous public agencies working on reducing FW. One factor mentioned by many of the interviewees was, “the importance of improving and broadening education to a national scale” such as around date labeling and how to utilize healthy food donations like sweet potatoes…. and being willing to eat ‘ugly’ produce. The UN Environment Programme (UNEP) interviewed in September 2020 Ms. Kakabadse, co-chair of the Environmental Sustainability Task Force of the UN Millennium Project, and she stated that “Most adults don’t contemplate the connection our food has on the planet and the impact it has on biodiversity. By making this connection in educational programs, we create a positive impact on the next generation of adults and accelerate change.\textsuperscript{35}” This concept that consumers are seldom aware of negative externalities, of the connection between their food choices and the environment has been seen in many research studies as pointed out in earlier sections.

“......consumers are not fully aware of the magnitude and impacts of FLW. There is wider room to engage them and nudge them towards changing behavior.\textsuperscript{37}” Prevention actions “require a fundamental re-thinking of the current practices and system in place, on both the demand and the supply sides.\textsuperscript{89}” Food is not being considered the valuable resource it is.

Thyberg & Tonjes,\textsuperscript{118} in “Drivers of food waste and their implications for sustainable policy development,” found that a package of prevention policies is needed. The three areas are:

- Values – to address values and perceptions that drive behaviors such as how FW wastes resources both money and environmental, moral issues over FW – a Values policy can be an educational campaign to explain environmental and social issues, economic impacts, FW quantities, etc.
• Skills – such as reading date labels, shopping, cooking, and food safety skills
• Logistics – affects retail and processors such as improving packaging and improving forecasting of supply versus demand

Diaz-Ruiz et al\textsuperscript{119} conducted in-depth interviews with 24 actors along the food supply chain who discussed a wide range of possible measures to prevent and reduce FW. From these interviews a Delphi questionnaire was developed and in two rounds it was determined what these experts considered were the measures with the highest efficacy.

• Education in values and valuing food and diet
• Awareness campaigns to increase consumer concern
• Change of habits to reduce food waste volumes
• School teaching on food waste
• Promoting food purchase planning

Measuring Consumer Food Waste

There have been few studies in the US on consumer FW and particularly few in the US or elsewhere that measure actual food waste instead of self-reports. There is a simple reason for this in that the actual measurement of FW is time-consuming, messy, involved, and expensive.

Following are some of the positives and negatives of various methods of measuring HH FW. Self-report methods include survey questions, which are the simplest, and they may ask on a Likert scale how much food was wasted in the last week by percentage. This is relying on memory with a strong bias towards socially desirable answers and will generally yield responses that under-estimate FW by a large amount.\textsuperscript{28,94,113,120} Diaries can be used, and these will give more reliable and detailed information, but respondents can quickly become tired of the process.
and high drop-out rates may result. One drawback of diary keeping is that just the action of writing down FW will increase awareness and may lead to behavioral reactivity such as reducing the amount of FW (social acceptability bias) or delaying cleaning out the fridge to avoid having to write all that down.\textsuperscript{121} Another is selection bias which is likely to happen in most studies of most methods in that only people willing to take the time to complete the assignments will do so.\textsuperscript{121} It also limits the number of study participants since quantifying the diaries is time-intensive for researchers. Photographic methods are being trialed. Dr. Roe and his team at Ohio State have been researching the use of various apps to allow study participants to take photos of all their food in different stages of use and disposal. These photos are then uploaded to a research institute (Pennington Biomedical) where trained staff code the photographs. This has great promise for the future but currently it is quite expensive (personal conversation with Dr. Roe).

Methods that do not rely on self-reporting provide more reliable answers but have many drawbacks. Weighing all food will be accurate but will involve much more expense as each respondent will need an accurate scale and to be trained in its use, or the food will have to be collected and brought to a central source where it is weighed. Due to its drawbacks, weighing will limit the size of the study. The most accurate is garbage sorting, or more politely called waste compositional analysis, where all the garbage from a HH is collected (and possibly the fluid waste too) and trained individuals sort it into types of food waste such as animal products, bones, produce, etc.\textsuperscript{7,122,123} This will be very accurate, and if simply picking up waste curbside, will be less likely to alter participants behavior,\textsuperscript{120} but obviously an expensive and involved project and this method greatly limits the number of HH that can participate.

Self-collection of food waste that is then turned in for measuring has promise. Respondents are asked to put any FW into a bin or caddy (tub with lid) or other container which
is then collected and weighed. There will be social desirability bias, but overall, it is a relatively simple method. A major drawback will be picking up the containers.

Van Herpen et al first asked 13 experts to evaluate five methods, listing advantages and limitations. The methods considered best for large samples were diaries, surveys and waste compositional analysis. They were less familiar with kitchen caddies but were interested as a possibility. Diaries, survey, photograph coding and kitchen caddies were then tested against each other. All measures gave lower amounts than had been found with waste compositional analysis in Dutch neighborhoods. The weekly survey gave much lower figures. The combination of diary and caddies was the highest. On their own, the diary, photos, and caddy gave in between amounts and correlated well to each other.

Kitchen caddies have seldom been used for food waste research with only a handful of prior studies found. Elimelech et al studied a Daily Family Waste Collection method. FW was collected in bags, then brought to a sorting tent. The results were successful, allowing for the physical measurement of HH FW daily. In a very recent study, Nguyen et al, 2022, found that Australian HHs were more likely to sort their food waste into sustainable streams when they had a kitchen caddy at home. Kitchen caddies appear to be a valid method even when the waste is simply weighed, particularly if the aim of the study is to obtain an estimate of the relative amount of total food waste in a HH.

The Academy of Nutrition and Dietetics Emphasizes Sustainable Food Systems

Registered Dietitian/Nutritionists (RDNs) are the profession most aligned with the intersection of food and health. RDNs work in numerous venues including hospitals, long-term care facilities, military, incarceral facilities, government, businesses and community locations such as Extension. RDNs work wherever large numbers of people are fed, in the government
developing policies, and in community public health. As such, RDNs are intimately involved with promoting food sustainability.

In September 2020, The Academy of Nutrition and Dietetics (the Academy) published a Revised Standards of Professional Performance for Registered Dietitian Nutritionists in Sustainable, Resilient, and Healthy Food and Water Systems (SOPP) with one area of practice being “Minimizes Food Loss and Waste.”\textsuperscript{126} The Hunger and Environmental Nutrition (HEN) Dietetic Practice Group of the Academy was the lead on this document, which is the latest in the history of the Academy’s growing interest in Sustainable Food Systems. The Academy’s Future of Food project has recently published a Sustainable Food Systems Primer for RDNs and NDTRs composed of 7 webinars equal to 3 CEUs.\textsuperscript{127}

Dietitians’ interest in sustainable food systems can be traced to Kate Clancy and Joan Gussow who coined the term ‘sustainable diets’ in their article “Dietary Guidelines for Sustainability” in 1986.\textsuperscript{128,129} They showed nutrition educators how each of the Guidelines could be linked to dietary choices that were more sustainable. Soon after, in 1992, the House of Delegates of the American Dietetic Association (ADA), the precursor to the Academy, adopted a position paper laying out the role of dietitians in natural resource conservation and waste management,\textsuperscript{130} which was revised in 2001 and again in 2007. At the ADA 2004 Annual Conference the term ‘Civic Dietetics’ was coined by Jennifer Wilkins to “describe the promotion of a sustainable, just, economically viable, community-based food system.”\textsuperscript{130} The interest in Dietitians being involved in sustainability was growing.

In 2007, a Sustainable Food System Task Force was begun by the ADA in part to, “identify the role of ADA members in supporting a sustainable food supply that is healthful and safe,” and to encourage RDNs to assume leadership positions in this growing area.\textsuperscript{130} From this
Task Force a Primer was created titled ‘Healthy Land, Healthy People: Building a Better Understanding of Sustainable Food Systems for Food and Nutrition Professionals: A Primer on Sustainable Food Systems and Emerging Roles for Food and Nutrition Professionals.’

The Task Force defined food system sustainability as, “A sustainable and resilient food system [that] conserves and renews natural resources, advances social justice and animal welfare, builds community wealth, and fulfils the food and nutrition needed of all eaters now and in the future,” in the simplified report summarizing the Task Force Primer by Tagtow & Harmon (2009) titled, “Healthy Land, Healthy Food & Healthy Eaters: Dietitians Cultivating Sustainable Food Systems.”

The Task Force developed a theoretical model of a sustainable food system to show how the Dietitian’s role is very central. Other main points from this Task Force were that the inputs into the food system need to be ecologically sound, socially acceptable, and economically viable, that policy is at the root of the entire food system, and that dietitians need to cultivate a systems approach. The authors further explain that “Food and nutrition experts have the opportunity to be a critical element in the foundation of a sustainable food system. Dietitians can promote sustainable diets that contribute to human health, support local agriculture, conserve natural resources, minimize solid waste, and promote ecological sustainability through the varieties of roles they play in the food system.”

In 2012, the Academy Foundation, Feeding America, and the National Dairy Council came together to raise awareness of food insecurity as a public health issue and to increase access to healthy foods for all Americans. From this collaboration developed the Future of Food Initiative (FOF). In a Visioning process the Academy Council on Future Practice 2017 indicated that Sustainable Food Systems were one of five high-priority areas for the future of the
profession. The Academy’s Strategic Plan included a focus area on “Food and Nutrition Safety and Security” and included advancing sustainable nutrition and resilient food systems. As shown previously in Chapter One, our current food system is straining the boundaries of land, water, and biodiversity among other indicators. We will not be able to reliably feed our population or help the world feed 2 billion more people if we continue as is. Our food system is not as resilient as it should be to withstand shocks such as droughts and climate change. By moving to a more sustainable food system, in part by reducing FW which uses up resources unnecessarily, we will be better placed to keep our population, including those who are currently food insecure, fed and fed with healthy foods.

Further showing the Academy’s commitment to sustainable food systems, and in particular to reducing wasted food, the Academy funded a report in 2016 titled, ‘The State of America’s Wasted Food and Opportunities to Make a Difference’ by Vogliano & Brown. As part of this nine-page article, the Academy’s President wrote a comment box to promote the idea that nutrition and dietetic practitioners are ‘uniquely qualified’ to assist various actors in reducing the amount of food that is wasted each year. The article proceeds to give an excellent primer on what wasted food is, where it occurs at each section of the food system, the hidden costs of food waste, efforts to reduce it at each section of the food system, donations of extra food, global efforts to reduce food waste, and finishing with how RDN’s can help.

In 2018, the Academy Foundation, in collaboration with Nutrition and Dietetic Educators and Preceptors (NDEP) and the Accreditation Council for Education in Nutrition and Dietetics (ACEND), released the Sustainable, Resilient, and Healthy Food and Water System for Dietetic Interns which is a primer on the many ways in which didactic and intern programs can incorporate sustainability issues into their curriculum. The next phase of the FOF was then
launched to focus on advancing the new strategic direction for the next century and to position the Academy to address the issues of global food security, hunger, and malnutrition.\textsuperscript{135} Wasted food is one of the issues being addressed by resources including a Future of Food Toolkit titled ‘Tossed Treasures - How We All Can Waste Less Food’ and a 69 slide PP Presentation for teaching purposes.

As mentioned above, a revised version of the Academy’s SOPP for Sustainable, Resilient, and Healthy Food and Water Systems, was published in September 2020. It states that Sustainable Food Systems has moved to “the forefront of institutional and governmental policies and is central to the mission of many professional organizations involved with public health and the food system” and that “RDNs play a unique and pivotal role in promoting sustainable food systems.\textsuperscript{126}” The SOPP can be used to “guide the development of sustainable food system education....assist educators and preceptors in teaching students and interns the knowledge, skills, and competencies needed to work in sustainable food systems, and the understanding of the full scope of this focus are of practice,” and “Given that sustainable food systems are fundamental to the practice of nutrition and dietetics, all RDNs have the opportunity, and indeed the responsibility, to align their work with the principles of sustainable food systems.\textsuperscript{126}” Further solidifying the Academy’s position, Spiker et al\textsuperscript{26} wrote a companion piece developing a Framework for Action in which it is made clear that engagement with sustainable food and water systems is not a specialized practice area, but an area that is central to our profession. This Framework is the result of a 2-day ‘Roundtable on Sustainable Food Systems: Creating a Nutrition-Focused Framework for Action’ in November 2018. As seen in Figure 2, there were determined to be five Entry Points that leverage the strengths of RDN’s to cultivate sustainable food and water systems. Entry Point #5 is Reduce Waste.
Methods to accomplish Entry Point #5 ‘Reduce waste’ are included in Table 2.

**Table 2. Suggested ways to accomplish Entry Point ‘Reduce Waste’**

<table>
<thead>
<tr>
<th><strong>Suggested Methods</strong></th>
</tr>
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<tbody>
<tr>
<td>Education &amp; Training</td>
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<tr>
<td>• Sources of waste</td>
</tr>
<tr>
<td>• Drivers and Strategies for reducing waste</td>
</tr>
<tr>
<td>Research</td>
</tr>
<tr>
<td>• Which Nutrition Education Messaging will shift attitudes and behaviors</td>
</tr>
<tr>
<td>• What is relative effectiveness of strategies in various settings</td>
</tr>
<tr>
<td>Practice</td>
</tr>
<tr>
<td>• Identify ways to divert food waste from landfills</td>
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<tr>
<td>• Incorporate waste reduction messaging in Nutrition Education for patients/clients</td>
</tr>
<tr>
<td>Policy</td>
</tr>
<tr>
<td>• Develop policies to reduce food waste and increase composting</td>
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</table>

In addition, the Accrediting body (ACEND) for all dietetic college programs and interns includes as one of the Core Competencies - CRDN 4.6 - Propose and use procedures as appropriate to the practice setting to promote sustainability, reduce waste and protect the environment.
Many other public health organizations have committed to involvement in this area also, including the American Public Health Association, and the American Medical Association. A closely aligned group with the Academy is the Society for Nutrition Education and Behavior (SNEB). They published a position paper in September 2019 stating, “that environmental sustainability should be inherent in dietary guidance,” “improving the nutritional health of a population is a long-term goal that requires ensuring the long-term sustainability of the food system,” and indicating a need to “reduce … the amount of food wasted.” Changes in the curriculum of Nursing schools are also being promoted to center and engage nurses in acting as global citizens – “to be change agents for healthier communities.” Among many other aspects, this includes awareness of climate change and how nurses can mitigate its effects and assist global public health measures.

There is a general move towards understanding that nutrition is connected to many other fields of knowledge and can no longer remain in its silo. Food choice affects many other areas and is in turn affected by many other areas. There are numerous environmental consequences to food choices, and these greatly affect the ability of humans to feed ourselves now and in the future. A modelling study by Blackstone et al showed that the three dietary patterns advocated by the Dietary Guidelines produced very different results environmentally, helping us to see that the diet choices dietitians advocate can have a distinct effect on the environment. A diet that is mostly plant-based and minimally processed is both healthy and sustainable.

The public also is quite interested, and many consumers are now making food choices based on various environmental attributes such as FairTrade or Organic and consumers expect nutrition experts to be competent in guidance. The Advisory Committees to the Dietary
Guidelines (DG) which are revised and published every five years are now (2015 and 2020) making clear statements that sustainability of diets should be an integral part of the DG. These arguments are not being accepted, so far, by the government offices in charge of the DG, the USDA and the Department of Health and Human Services (HHS), but many organizations are pressing this issue. SNEB produced a 14-page Position Paper on ‘The Importance of Including Environmental Sustainability in Dietary Guidance,’ in 2018. The Academy produced an 80-page Comment paper in 2020 addressed to the Secretaries of both USDA and HHS in which three pages were devoted to pressing for sustainability and systems research to be included.

Food intended for human consumption but never consumed is a major sustainability concern. As we have seen, wasted food contains nutrients that are now unavailable to nourish bodies. Wasted food embodies all the resources that have gone into growing, processing, transporting, selling, and preparing them. Wasted food causes environmental damage both due to these resources and due to disposal efforts. Finding ways to reduce wasted food fits squarely in the stated goals of the Academy of Nutrition and Dietetics for RDN’s and also for students and interns. Making the connection between environmental issues and health issues is important as health professionals are trusted voices and can lead by example.

College Students

Higher Education is an important resource for moving our planet towards a sustainable future. Over the past 50 years there have been many global Conferences, Declarations and Charters in which Higher Education is included, including the Tbilisi Declaration, 1978; Brundtland Commission, 1987; UN Conference on Environment and Development (Rio), 1992; and the World Summit on Sustainable Development (Johannesburg), 2002. Some of these have been more specifically about the role of higher education in promoting sustainability such as the

Higher Education Institutions (HEIs) have an important role to play in developing professionals who are needed to manage resources, educate the public and design options as there are so many barriers to consumers making sustainable choices. Centers of Higher Education are where professionals are motivated, obtain the knowledge needed and are trained in the skills to be able to guide sustainability endeavors. Many colleges and universities have taken this role to heart. The Association for the Advancement of Sustainability in Higher Education (AASHE) is growing in numbers of members and partners. Higher Education also works together to promote health and well-being on their campuses and to incorporate sustainability education and practices. The Okanagan Charter: An International Charter for Health Promoting Universities & Colleges, 2015 is an example of Higher Education’s commitment to sustainability. The Vision statement of this Charter is “Health promoting universities and colleges transform the health and sustainability of our current and future societies, strengthen communities, and contribute to the well-being of people, places, and the planet.” Other statements include, "health promotion.... must.... take an explicit stance in favor of health equity, social justice and sustainability for all...," campuses need to “provide transformation teaching and learning environments that enable and inspire students, faculty and staff to become healthy and engaged citizens and leaders locally and globally,” and “integrate health, well-being and sustainability in multiple disciplines to develop change agents.” HEIs often will take the lead in community sustainability initiatives.
Young adults have been found to be one of the more food wasteful segments of the population,$^{30,101,147}$ and therefore research is now being directed more towards them.$^{89}$ As surprising as it may seem, in this time of climate change and public concerns over the future of the planet, college student’s knowledge and awareness of food waste is often limited.$^{80,93,101,148}$ “The complexity of the food system can be overwhelming. The disconnection that many of today’s youth have from the food system makes it especially hard for them to make connections between the food they eat, local agriculture, the environment, and the local economy.$^{149}$”

In many ways, this Generation Z age group are part of the ‘green generation,’ environmentally conscious and more likely to participate in green products and services.$^{150}$ Surprisingly, though, they are less likely to recycle.$^{151}$ While it would seem that recycling is an easy task, it does take knowledge of how to do it accurately and relies on various situational and contextual factors such as placement of recycling bins.$^{150}$ Reducing food waste is similar in that while it seems easy on the outside, there are many, many situational and contextual factors at play. Clark & Manning,$^{93}$ interviewed 50 United Kingdom (UK) college students. Not one student highlighted the environment as a primary reason to not waste food. Saving money was their primary concern, though most had to be prompted to realize how much it was actually costing them. Figure 3 is the Thematic Map derived from the Clark & Manning interviews. It shows the numerous variables at play in deciding if a particular food item gets discarded or not. Recall from an earlier section, that many of the ‘decisions’ in this tree are routine/habitual and not thought about on a conscious level.
Figure 3. Thematic map from interviews with college students in the UK.

Having positive attitudes towards pro-environmental behaviors and sustainability issues and yet not acting on these values has been found in many studies including those related to college students and may be labeled the value-action gap or the attitude-behavior gap.\(^{142,150,152-155}\) Mccarthy et al,\(^{95}\) has proposed that there is a research need to focus more on the individuals who generally support the ideals of sustainability and yet do not engage in reducing their consumption (value-action gap). This fits directly with many college students.

Generation Z students have been exposed to much fearful messaging about the earth and climate change along with messaging about how individuals and groups need to help save the planet.\(^{156}\) At a Midwestern University, almost 800 students responded to a survey designed to test the Extended Parallel Process Model’s ability to determine attitudes, motivations and methods concerning performing sustainable behaviors.\(^{156}\) This model is based on fear and efficacy. If a person perceives a threat and feels that recommended actions are both effective and
performable then they are likely to enter the ‘danger control path’ and follow the recommendations. If they feel the action is not performable or useful then they are likely to enter the ‘fear control path’ and reject the recommendations. Among the many findings of this study, it was seen that the main reason students perform sustainable behaviors was to help the environment with saving money being a minor reason. This is counter to the research by Clark & Manning reported above. Reasons for not performing sustainable behaviors included inconvenience and difficulty, lack of knowledge on how to, and lack of time. Possible motivators reported by students included providing more information, making it easy/accessible, and knowing the effects on the planet. Threatening messages need to be paired with high-efficacy messages for best results, therefore the study authors suggestions included discussing the serious impact of not doing a behavior along with the countering evidence of how that behavior will help mitigate the threat to the environment. Also suggested was to assist students in developing confidence in doing wanted behaviors.

Coursework focusing on food-related social issues, but not health issues, was emphasized in a college class on Food and Society in a research study reported by Heckler and colleagues in 2010. They used the topics as a stealth intervention to see the effect on the student’s diet choices. Food Frequency questionnaires showed that the students in this class, but not the students in a basic biology class, significantly improved their diets and also significantly increased their beliefs in the importance of healthy diets and the environment.

In other research, Bravi et al compared young consumers in the UK, Spain and Italy to elucidate factors affecting HH FW and found that the most “important action to reduce FW is to have a well informed and organized consumer.” Mondejar-Jimenez et al studied Spanish and Italian young adults at universities and found three positive main activities that aided in reducing
food waste – consuming HH leftovers, understanding the date-labels on food, and planning food purchases.

At a Midwestern university a survey was deployed to assess student’s beliefs about FW and sustainability.\textsuperscript{158} FW in the cafeteria was collected for 6 weeks. In the third week prompt-type messages were deployed which simply suggested not wasting food. In the fifth week, feedback messages were deployed, showing details on how much FW is collected each day in the cafeteria. The survey was given at the beginning, in week four, and in week six. A small number of students (21) completed all three surveys, and in this cohort there was no significant change in attitudes and beliefs based on the messaging. A larger group of 296 students had their cafeteria trays coded for FW analysis at all three time periods. There was a 15\% reduction in FW after the prompt messages and no further reduction after the feedback messaging was deployed. The authors suggested that couching feedback messages in social issues such as feeding hungry children, instead of in how many ounces of food was wasted, might resonate better with college students and further enhance the action of reducing FW.\textsuperscript{158}

As reported in 2021, researchers at Portland State University developed a program titled ‘No Scrap Left Behind’ to reduce FW in the cafeteria and to assess changes in attitudes and knowledge.\textsuperscript{159} The program was extensive with a tagline of ‘Plan, Portion, Compost’ designed to give students specific actionable steps. Tabling and signage were two main ways used to reach the students. Napkin holders had fun, actionable messaging, and a quiz. To give visibility to the quantity of FW generated each day at the cafeteria the FW was weighed, the amount posted, and a buffet was set up with the wasted food. These activities were done for one week each semester.\textsuperscript{159} Student FW decreased about 27\%. Attitudes though changed little, which could be explained by the student population already being disposed towards the issue of FW. The two
significant changes reported were to think about FW reduction more and to put more effort into FW reduction.\textsuperscript{159}

Young adults, in this time frame of higher education, are in a stage of life that is noted for significant changes - a time where they are developing their identity, self-efficacy and life skills.\textsuperscript{20} This ‘emerging adulthood’ stage of life can be an “important age for establishing long-term health behavior patterns”\textsuperscript{160} If this environmental consciousness of young adults can be engaged to understand and appreciate the environmental damage done by wasted food then a generation of leaders will enter into society as change agents.

System Knowledge and Action Knowledge

Increasing consumer awareness and knowledge of the consequences of high levels of FW and how consumers can participate in reducing FW is recommended by many, though there is little research on how knowledge affects them. The studies that have been done mostly focus on action-related knowledge such as shopping tips, storage methods, etc., that help consumers waste less food.\textsuperscript{161} Many information campaigns, though, focus on system knowledge, such as the effects of FW on the environment, economics, and social issues, yet presentation of system knowledge has seldom been studied.\textsuperscript{161}

Objective environmental knowledge can be divided into three dimensions: system knowledge (knowing what), action-related knowledge (knowing how) and effectiveness knowledge (knowing when and why).\textsuperscript{162} System knowledge looks at how the ecosystem operates and awareness of environmental problems. Action and effectiveness knowledge are linked. Action knowledge is the knowing how to accomplish a task while effectiveness knowledge is understanding the benefit that comes from accomplishing a task such as the ecological benefit to be obtained from storing food properly or from eating leftovers. Effectiveness knowledge allows
the individual to choose the most effective action among various possible actions. As mentioned earlier in this report, studies have found that college students (and most people) have very little accurate objective knowledge, system or action or effectiveness, about food waste.

Community of Learners

Generation Z are digital natives having grown up with technology at their fingertips. One platform that is very popular with young adults is blogging. Blogs are a web-based journal which often has graphics, photos, videos, and links to other sites. Blogs can be effective teaching tools providing active participation, enhancing a student’s motivation to learn more about a subject, allowing for self-direction and student-centered learning. “Blogs support collaborative learning by enhancing knowledge acquisition, knowledge sharing, and reflective processes.” The freedom of a blog allows a student to create content to share with the class, putting value on the student’s contribution to a community of learners. Another similar method to allow students to engage with each other and be part of a community in an online class situation is a Discussion Board. If well-structured, these can also be creative, as videos, concept maps and other display methods can be used. Recent developments include the use of new tools such as VoiceThread and FlipGuard to respond to each other. Seeing other students who are interested in food sustainability can assist with self-efficacy. An effective measure is to have students work in smaller groups. Which method an Instructor uses to engage students with each other will depend on what the school’s Learning Management System allows for and the Instructor’s own comfort level with using new technology.

Gaps in Knowledge

Consumer FW is a burgeoning area of research and there remains large gaps in knowledge. The FAO in 2019 explained that the “lack of data is particularly acute for FW at
the consumer level because of both methodological challenges and the measurement costs involved.” As reported in an earlier section, there have been few studies on FW aimed at consumers and very few aimed at college students. Those that have been done are mostly in cafeteria settings and not classroom settings. Research is needed to understand how students engage in sustainable behavior.  

150 In 2021, Alattar and Morse explained that students have responded in the few programs researched, and the authors state that “developing and assessing educational food waste diversion tools is an essential next step towards decreasing food waste.159+ Research on college campuses “may have potential to affect both individual behavior and develop a more skilled community in relation to health and sustainable food,20” as HEIs are at the forefront of developing knowledgeable, skilled, and motivated leaders to be change agents for global sustainability.

To assist in developing the motivation, awareness, knowledge, skills, and abilities of dietetic/nutrition and other allied health students, this project will test Curriculum Strategy in a college-level Introductory Nutrition class that will easily fit into the curriculum and be transferable to other colleges. This project will test a suite of Curriculum Strategy and their effect on FW behavior via survey questions relating to food waste prevention practices, to motivation, ability, and opportunity, and by collecting actual FW. System knowledge will cover the environmental, economic, social, and nutritional consequences of food waste. Action knowledge will cover everyday practices, many of which tend to be routinized or habitual, along the path food takes from retail to disposal such as planning food purchases, understanding the date-labels on food, and consuming leftovers being emphasized. A Discussion post by the students will allow them to engage with FW in creative ways and to engage with their fellow students. To give a rough estimate of the amount of FW for each student The Kitchen Caddy method will be used.
CHAPTER TWO: LITERATURE REVIEW

Three main ontological approaches are being used in Consumer Food Waste (FW) studies. These three approaches are an individual-based approach, a society-based approach, and a blend of the two.

Individual-Based Approach

The first approach includes psychology-oriented theories which “aim to single-out and measure specific intra-personal, cognitive, motivational and structural factors and processes either driving or impeding pro-environmental behaviour.” It puts the individual at the center as the cause of consumer FW due to lack of motivation and lack of knowledge about the consequences. In this approach, attitudes, norms, perceived control, among other behavioral factors, are studied. With the topic of consumer FW being quite new, researchers have taken leads from the well-developed pro-environmental behavior (PEB) literature. One of the main theoretical frameworks used in PEB has been the Theory of Planned Behavior (TPB). TPB, developed by Icek Ajzen, shows that attitudes toward the behavior and subjective norms about the behavior lead to intentions. Perceived behavioral control (self-efficacy) moderates the individual’s attitudes and subjective norms and therefore leads indirectly towards intention. If people have a sufficient degree of actual control, then they are expected to carry out their intentions. “Intention is thus assumed to be the immediate antecedent of behavior.”

TPB has been used many times now in consumer FW research. It has proven, though, to have limited explanatory power to predict intentions or actual behaviors. This is likely because TPB was developed to predict behavior that is intended or planned in advance, and wasting food is not planned, and wasting food is not actually itself a
behavior, but the result of ‘routinized’ behaviors related to food management.\textsuperscript{25} In addition, most wasting of food by consumers takes place at home and is therefore not very visible to others, which will tend to reduce the effect of social norms on the behavior.\textsuperscript{99} To extend the ability of TPB to explain intentions and behavior, researchers have been adding to it other theories such as Self-Determination Theory,\textsuperscript{150} Norm-Activation Model,\textsuperscript{110} Value-Belief-Norm Theory,\textsuperscript{175} Health Belief Model,\textsuperscript{176} Theory of Interpersonal Behavior and the Comprehensive Model of Environmental Behaviour,\textsuperscript{99} or other variables such as price consciousness and taste.\textsuperscript{177}

Society-Based Approach

The second ontological approach removes the focus from the individual being responsible for wasting food and takes into account that individuals are embedded in a wider context of life including cultural, economic, and social factors that they must negotiate.\textsuperscript{24,144} One such theory, Social Practice Theory, looks beyond the individual to the wider factors of everyday routines. Such research looks to how “broader structures drive individual food wasting practices: barriers to local and daily shopping; imperatives around healthy eating; food safety and hygiene; and the challenges of feeding a (sometimes fussy) family.\textsuperscript{108}” “Food waste is thus argued to be not a problem of feckless consumerism at the HH level, but a side effect of a deeply embedded failure to value food at a structural (rather than individual) level.\textsuperscript{109}”

Evans\textsuperscript{178} opened up the door to this view of the consumer in relation to food with his discussion of Theories of Practice (practice-theory) which has developed in the field of sociology since around the year 2000 in a variety of subject areas. He further suggests in Evans et al\textsuperscript{179} that in the first wave of consumer FW research, from about 2007 – 2013, the ‘responsibilized’ consumer was the dominant framing of the issue, but this gave way to an emergent sense of distributed responsibility during the second” wave starting about 2013.\textsuperscript{179} In the first wave,
consumers were considered profligate, uncaring, unaware of consequences and without the kitchen skills to avoid FW. In the second, there has been increased awareness of the wider system, the social context in which the consumer functions.

There is also now more understanding that consumers are often not acting in a rational manner, but instead in an “automatic, reactive and habitual aspect.” Consumers do not intend to waste food; they do not buy food assuming they will just throw it out. Consumers have many food-related goals other than avoiding waste and many of these goals take higher priority in their lives such as consumers wish to be ‘good providers,’ to eat when they want, to be able to be spontaneous, to eat safe food, to get children to eat, and to fit meals within a busy schedule. Therefore, consumers end up wasting food due to a wide range of trade-offs such as maintaining a supply of food that allows for all to eat when and what they want, wishing to eat a healthy diet thereby purchasing produce which then goes bad, and being cautious about food safety so quick to throw out suspect food, and they feel that these ‘higher order’ priorities take precedence over reducing food waste. “Reduction in food waste is typically subordinate to and in conflict with other goals.”

HH behaviors related to food planning, shopping, up through disposal are routinized. Russell and colleagues studied the role of emotions and habits and found habits to be the most important predictor of food waste behavior. They concluded that developing interventions that break habits would be useful, such as focusing on meal planning and storage, and helping consumers develop a stronger sense of control. Changing habits can be quite difficult. TPB’s Perceived Behavioral Control (which aligns with self-efficacy) has been found to have a strong direct effect on FW, suggesting that consumers with a higher sense of control may have more motivation to act to prevent FW and more likely to do so.
Motivation-Ability-Opportunity Approach

Both of the above ontological approaches (the individual and the sociological) have value and together might better explain HH FW leading to improved interventions to reduce it. 

REFRESH (Resource Efficient Food and Drink for the Entire Supply Chain) was the European Union’s four-year research project to tackle food waste. It finalized in 2019 having produced a number of methodological reports and platforms which continue to inform the EU’s FW efforts on all parts of the Food Supply Chain.\textsuperscript{183} The Consumer Behaviour Working Group developed a theoretical framework for the Causes & Determinants of Consumers Food Waste. After considering the two ontological approaches, individual-based and societal-based, they concluded that interaction between individual and societal factors drives consumer FW.\textsuperscript{25} Their conceptual model is shown below in Figure 4 and is organized on the Framework of Motivations – Abilities – Opportunities (MAO). MAO, also labeled MOA, was first proposed by MacInnis & Jaworski\textsuperscript{184} in 1989 for the field of information processing. From this start it has been used in a variety of fields in which there is a decision-making process.\textsuperscript{185} Rothschild\textsuperscript{186} (1999) expanded it into the arena of Public Health.
Motivation, ability, and opportunity are interrelated. Motivation is needed to learn and engage in new routines. Efforts at trying to reduce FW that do not work can lead to reduced motivation. If opportunities to reduce FW are lacking, then that reduces ability which can also reduce motivation. “In summary, a lack of motivation results in a resistance, whereas the lack of ability or opportunity results in an inability to engage in waste preventing behaviours and in turn affects motivation. Therefore, it is best if all three factors are present for a consumer to successfully reduce waste levels.” For these reasons, REFRESH includes both the individual factors of Motivation and Ability which are sufficient to prevent food waste but only if the situational factors of Opportunity are present also.

The National Academy of Sciences, Engineering, and Medicine (NASEM) conducted a consensus study of ways to reduce US FW at the consumer level in order to focus support for the consumer which has been lacking. Members of the committee were experts in many areas that touch on food waste such as psychology, marketing, sociology, public health, and food systems. After reviewing research from the social and behavioral sciences, including six related...
domains (i.e., recycling, weight management and others), about what drives consumer behaviors, they developed a “strategy for reducing food waste at the consumer level.\textsuperscript{49}” From the various possible models and frameworks used in these fields, the committee chose the MOA framework “as especially useful for identifying and analyzing individual behavioral drivers while also taking into account the importance of context and habit in driving behavior.\textsuperscript{49}”

The areas of MAO fits well also with the package of prevention policies suggested by Thyberg & Tonjes\textsuperscript{118} as discussed in Chapter One. Values fit with Motivation, Skills fit with Abilities, and Logistics fit with Opportunities. With this backing and with both the European Union’s REFRESH working group and NASEM Consensus Committee choosing to use the MAO Framework, this current research project also used this Framework, as it allows for multiple drivers at both the individual level and the wider sociological level. Following are the MAO constructs and the Dimensions that compose them that will be used in the proposed research followed by the distal factors that indirectly affect FW behavior.

MAO Constructs

A. Motivation is goal-directed arousal.\textsuperscript{184} Motivational drivers that have had the most influence in prior studies are Awareness of FW, Attitudes towards FW and Social Norms that affect FW and food in general. The combination will determine Motivation and will equate to the individual’s willingness to behave in a way that avoids FW.

a. Attitudes “refers to a persons’ appraisal of the act of disposing food\textsuperscript{168}” and “includes the feelings or emotions and related thoughts, beliefs and ideas that are brought to the surface by disposing food.\textsuperscript{25}” These attitudes can include guilt and other negative feelings due to wasting money or causing environmental damage or social damage due to undernourished people needing that food.
b. Awareness includes being aware of your own FW levels and also the consequences of FW.

c. Social Norms can be split into injunctive (a consumer recognizes that others who are important to them disapprove of FW) and descriptive norms (a consumer recognizes that others prevent food waste).

B. Ability “refers to a person’s proficiency to solve the problems that he or she encounters when changing behaviour, including breaking well-formed habits and routines or countering the arguments of peers." Ability will involve both Skills and Knowledge sets necessary to perform a behavior successfully. Ability fits with the concept of self-efficacy and refers to the capacity of consumers to do the actions, not the actual doing.

1. Examples of knowledge range from knowing proper storage techniques to prolong shelf life of your food, knowing proper temperatures to maintain the refrigerator, knowing how to interpret food package labels, particularly the use-by and best-before labels.

2. Skills involves being able to act on your knowledge, to develop routines that work to reduce FW such as planning meals, storing food properly, and being able to create meals from leftovers.

C. Opportunity involves the “availability and accessibility of materials and resources required to change behaviour." In their research of prior literature, REFRESH found that the following three aspects were relevant - time and schedule, technologies, and infrastructure – though there is little data from quantitative studies to support any of these.
a. Time and Schedule are serious hindrances in many HHs. This can lead to fewer shopping trips with more food purchased than can be stored well, eating out instead of using up what is at home, providing a variety of food to tempt picky eaters, etc. These and other trade-offs lead to a lack of opportunity to reduce FW.

b. Materials and Technologies refers to improper equipment at home such as a small freezer, insufficient storage, lack of a refrigerator thermometer, etc.

c. Infrastructure refers to a range of factors such as how accessible stores are, the quality of the food offered, the package sizes available.
CHAPTER THREE: METHODOLOGY

This quasi-experimental research project, set in an Introductory Nutrition class at a large university in the Southern United States, tested if a series of pedagogical methods including System and Action Lectures, a Discussion post and collecting personal food waste resulted in raised MAO scores and reduced personal food waste (FW). The System Lecture covered broader concerns related to the global food system and targeted Motivation. The Action Lecture covered household/consumer level skills, knowledge and time factors to enable consumers to break routinized habits leading to food waste and targeted Ability and Opportunity. A Discussion post by the students engaged them in active learning. Together these are labeled Curriculum Strategy. A pre-post-survey provided outcomes related to MAO and to a range of food provisioning habits and routines called collectively Food Waste Prevention Practices. To test for behavior change, the outcome measure was personal FW that the students collected for three days and brought to campus to be weighed pre- and post-Curriculum Strategy. This Study Protocol was approved by the University of Florida Institutional Review Board (IRB #202101514).

Study Aims

Aim One discerned the effects of this Curriculum Strategy on personal FW. The outcome was measured as the change in personal FW pre-Curriculum Strategy and post-Curriculum Strategy.

Aim Two discerned the effect of this Curriculum Strategy on Motivation, Ability and Opportunity scales. Outcomes were evidenced by Motivation, Ability and Opportunity scale scores from the survey being combined into a variable score for each construct, and the three Construct scores added together.
Aim  Three discerned whether sociodemographic factors and Food Waste Prevention Practice factors were associated with personal FW. Outcomes were evidenced by testing the Food Waste Prevention Practice scale scores and the Sociodemographic variables with the levels of pre-FW for each student.

Study Design

The current study was a quasi-experimental, quantitative design conducted with a convenience sample consisting of students in an online Introductory Nutrition class at a large university in the Southern United States. It consisted of a survey (Appendix G) that covered indicators related to Food Waste Prevention Practices, Motivation, Ability, and Opportunity along with appropriate sociodemographic questions. The survey was taken online as part of class both in the first weeks of class and in the last weeks of class. Curriculum Strategy was designed to include three Lectures and a Discussion post to see if this combination was effective at raising the Motivation, Ability and or Opportunity levels, and if this was sufficient to lower the amount of food wasted by the individual students. The quantity by weight of FW was tested by a simple ‘kitchen caddy’ method with the students collecting their FW in the first weeks of class and in the last weeks of class for three days each time bringing it to the office in plastic freezer bags for weighing. As this was an online class, not all the students lived near campus. Those who did not live near campus collected their FW in plastic freezer bags and snapped pictures to send in. These were not able to be weighed and were therefore not part of the data.

IRB approval was obtained from the University of Florida Institutional Review Board (Appendix A). This research fell into the Exempt category. The University of North Florida’s Institutional Review Board also approved this research since UF approved it (Appendix B). As each of the parts of the research was also a class graded assignment, the students did not need to
opt in or be told in the beginning that the survey or FW collection was part of a research project. Towards the end of the semester, students were informed about the research and given a Consent Form to sign allowing their data to be used in the research. (Appendix C) All students signed and returned the forms to the teaching assistant who made note of this.

Study Participants and Setting

The online version of the fall 2021 Introductory Nutrition class enrolled 197 students. This class is mandatory for all students who plan to major in Nutrition, Dietetics, Food Science, and Applied Physiology & Kinesiology. In addition, students from other health professions, such as those applying for nursing school, those in Health Promotion, and those planning on applying to various medical degrees were represented in class as were some who took it for personal interest. The survey, collection of FW and Discussion Post were all graded class assignments in which all students were expected to participate. For purposes of this study, inclusion criteria were all students over the age of 18. Those students under 18 participated in the class assignments, but their data was removed from the data analysis.

The class was online and synchronous and met three days a week. All students who lived near campus were expected to come by the Principal Investigator’s (PI) office in the first two weeks of class to pick up their freezer bags needed for FW collection. The PI is part of the Food Science and Human Nutrition faculty and had access to a large kitchen space where the food waste samples were brought to keep in a cooler and to be weighed on calibrated scales.

Power Analysis

Power calculations have been seldom done in consumer food waste up to this point. Larger surveys may see upwards of several hundred respondents found online, but research in which consumer food waste is actually measured is done on much smaller numbers of HHs. In a
search through the articles used in this report, only one was noticed that calculated power. van Herpen et al., for REFRESH, researched and developed a practical measurement approach for in-home food waste level. They selected five methods to test to determine how many total participants they should have. They used an alpha = .05 and power set = .80. They set H0: r = .80 and H1: r = .70 and the sample size would be n = 118. If H0: r = .70 and H1: r = .60 then the sample size would be 206. The Introductory Nutrition class had 197 students and so met this power analysis at the lower setting.

Survey Design

The survey (Appendix G) was mainly drawn from one used by REFRESH. As discussed earlier, REFRESH is the European Union’s research into consumer FW. It involved many aspects and reports. In order “to develop a pan-European insight into the causes of in-home food waste which can be used to identify potential targets for the reduction of food waste, and intervention strategies,” a large quantitative survey was conducted in Germany, Hungary, Spain and the Netherlands to further empirically test the model they were developing. The survey was validated.

The pre-survey used in this research contained sociodemographic questions (Appendix G) in order to assess a variety of basic variables about the student. This included age, gender, live on/off campus, work, live with, number adults in HH, and eating out meals. These were not included in the post-survey.

The next section covered Food Waste Prevention Practices (FWPP) practices in planning, provisioning, storing, preparing, and consuming. Then the survey questions covered the area of Motivation including Awareness, Attitudes and Norms. Ability in Skills and Knowledge was
covered with questions on perceived difficulty in planning, in creatively cooking to use leftovers, in assessing food safety, and in Knowledge of how to prolong shelf-life. Another barrier is in Opportunity. Of the three aspects of Opportunity found by REFRESH to be relevant upon their search of prior literature – Time and Schedule, Materials and Technologies, and Infrastructure – only Time & Schedule was considered useful for this survey of college students and kept in the survey. Time & Schedule refers to the prevalence of unforeseen events that prevent the consumer from keeping to their plan and using up the food already found in the home.\textsuperscript{188} One section was added to the survey – Date-Label Knowledge. The REFRESH survey asked only very general Food Safety Storage questions, yet it is known that the confusion over date-labels on food products is one of the biggest factors in unnecessary FW. In order to more specifically delve into the influence of knowledge, or lack of knowledge, about correctly reading date-labels, three validated questions from Visscher’s large Swiss survey\textsuperscript{113} were added.

Intervention

The study timing was the pre-survey in week 3, the pre-FW collection in week 4, weighing of the pre-FW collection week 5, the Curriculum Strategy of three Lectures and a Discussion Post in the middle weeks, the post-survey week 12, the post-FW collection week 13,14, and the weighing of the post-FW collection week 14.

\textbf{Curriculum Strategy}

\textbf{Lectures}

Three Lectures were each approximately 30 - 40 minutes long, quick paced, with a visually attractive Power Point.
System Lecture – designed to increase Motivation by developing Awareness of severity of FW to result in positive Attitudes and Social Norms towards reducing personal FW:

- **Awareness**
  - Present state of environmental indicators
  - Population Growth expected by 2050
  - Current level of food waste at different stages of supply chain

- **Attitudes**
  - Environmental damage from FW
  - Economic damage from FW
  - Social damage from FW
  - Nutrition damage from FW

Action I Lecture – designed to increase Abilities and Opportunity for reducing personal FW by developing Skills, Knowledge, and time/schedule Opportunities

- **Skills**
  - Planning grocery shopping trips
  - Storage tips to extend the life of food

- **Knowledge**
  - Date-Labels – how to properly read
  - How to discern if food is spoiled, when to throw out

- **Opportunities**
  - Quick meals
  - Leftovers tricks

Action II Lecture – to solidify information learned in Action I Lecture related to increasing Abilities for reducing personal FW by developing Skills and Knowledge

- The PP was designed for the students to keep the PP in editing mode which allowed the student to manipulate visuals on the PP thereby actively taking part in the learning process. Manipulations included slides where the students had to fill in a response or highlight the correct answer or move visuals around. There were deliberately a variety of types of actions to keep the students engaged.
Zoom allows Breakout Rooms and for this lecture the class was randomly split into groups of about 5 students. Each group was asked to have one student who shared the PP with the group and did the manipulating. The other students were to answer the questions and work together to make decisions.

The PP began with images taken of the FW the students had generated in order to give visual feedback on quantity of FW generated by our one class. Then examples were given of how to highlight or move visuals around on the slide. Three slides asked for ‘When to Toss’ various foods based on the information learned in Action I Lecture which was available for students to use as a reference. Next was a section called ‘It’s a Date.’ Students first decided which food item had the most accurate date-label, then each student was to go to the foodsafety.gov website and look up a food to see how long it could be kept in the refrigerator or freezer. The last slides were ‘It’s a Wrap’ to see if students remembered how best to store various items – should they be on the counter or in the fridge and what should not be stored near others.

Discussion Post

To further engage the students in interactions with each other, a Discussion Post was used as part of the Curriculum Strategy. The full Instructions are in Appendix F. Each student had to research a topic in the area of food waste. There was a listing of possible topics given to the students, and they could also choose another topic and ask the Lecturer if it was suitable. Examples of the topics researched were Home Composting, FW at Restaurants, FW at Grocery Stores, Eating Ugly Produce, and FW causing Methane Gas at Landfills. This Discussion post required researching the topic and presenting the information to the others in their Discussion group. The post had to be at least 300 words long. The students were divided up into groups of
about 18 so that they could engage with a small group of fellow students. Each student then was responsible for making a reply of about 100 – 150 words to two other students in their group.

**Food Waste Collection**

The first week of class, students were instructed on how to collect FW for this research project (Appendix E). Students who lived near campus were instructed to visit the PI’s office to collect the needed freezer bags. Students were provided with eight marked 1-gallon freezer bags. Several of the bags were considered ‘extras’ in case a bag broke or was lost. Markers were available to use in marking the bags with their name, which they were asked to do before leaving.

Students were instructed to collect all solid food waste from their kitchen, edible only. This was not to include anything that would not be eaten such as eggshells, bones, and peels. They were also asked not to collect any uneaten meat or fish as this could create a problem of bacterial contamination. They were to include any food that would have been placed in the garbage, or composted, or fed to an animal. A detailed list was given to clarify what to include. They were asked to carry a bag with them to collect any waste from food eaten away from home – food that would be sent back to the kitchen uneaten. They were asked to include three of the most normal days in their living situation. They were asked to include the fridge clean-out day in their three days of FW collection if that was a normal occurrence at their HH. For the post–collection another set of instructions was emailed, and the students were asked to use the same three days of the week. The bags of FW could be kept in their refrigerator until it was time to bring them in. Students did not seem to mind this messy project. In fact, they seemed quite interested and were willing to go through each of the steps. Over three days, they collected their food waste, which would have required some explaining to others depending on their living...
arrangement. The next step was to put those three, sometimes rather full bags of old food, into their school backpacks and bring it to the office. They were allotted a week’s period of time so they could choose what day in the week worked best for them to accomplish this. They brought it to a designated space and marked on a form that they had returned their bags. The whole cycle was then repeated towards the end of the semester.

This method is being trialed to see if it will give useful data for college classes. This method is to provide a visual, physical interaction with food waste to show how very quickly it adds up. Even if it does not prove to be a way to obtain reliable data, it is a useful means of engaging college students in the cause of reducing food waste.

Data Collection

The order of data collection was first survey given in week 3, FW collected in week 4 of the semester, second survey in week 12 and second FW collected in week 13. The survey was deployed through Qualtrics. Students accessed the survey as a part of their class site. A reminder was sent at the end of week one and another just before the survey opened for a one-week period, and again at the end of the semester for the post-survey. The survey was mentioned in class also. The data was exported via Excel Sheets.

Before the study began, the freezer bags were weighed in a group of ten from each box to determine the average weight of a bag. Each collection day, the Researcher carried the box of FW bags to the kitchen and weighed each bag, taring out the weight of the bag alone, and marking the results by hand. The collection of bags from each day was photographed, and afterwards each bag's contents were dumped into a compost hole in the ground. This was also photographed at the end of the collection period to show the students during class.
In order to enter the FW data into a useable form, a new Qualtrics was started and the complete food waste data from the handwritten forms was entered one time and then later a second time by the PI. Each student was given an ID # and the Qualtrics Excel sheet was ordered by ID# so that the two lines of data from each student could be compared via a method called equals-equals to make sure all data was entered accurately. Once any corrections were made, by confirming with the original sheets of data, one of the lines was removed leaving just one line per student. The data was now in a form that could be entered into the statistical program.

Data Analysis

The data sheets were examined for missing data, and random missing data was found in both the pre- and post-surveys. In the pre-survey there were 8 empty locations that were scattered throughout the Excel sheet and were determined to be random. In the post-survey there were 24 empty locations also scattered throughout the Excel sheet and also determined to be random. The missing data were replaced by taking the average of the column and using that number to replace the missing spot. This does not reduce the variability of the data set. Data was entered into JMP PRO version 17 for analysis. Data was examined for complete responses and outliers. Outliers were present in the Food Waste data sheets, and it was determined that this was actual food waste and not mistaken numbers. Descriptive statistics were presented to examine the data. All data were tested for normality prior to analysis, and, as all the data analyzed for this research were considered non-normal, nonparametric tests were utilized including Wilcoxon signed rank. Medians and interquartile were presented for continuous data. The survey questions used had been previously validated and Cronbach’s alpha coefficients calculated. To create a special visual, the data was also entered into R and analyzed through a ggplot2 package.
Scoring of the questionnaire proceeded as follows. Food Waste Prevention Practices, Motivation, Ability, and Opportunity scales were all ordinal level of measurement and used a 7-point Likert scale as seen in Appendix G. Likert scales may be considered approximately continuous for purposes of data analysis. Higher values correspond to stronger agreement with the statement. Various questions were reverse-coded. The individual questions in the survey are not used for statistical purposes. A basic principle of Likert scales is that they are not based on the response to one question. Instead, each idea, each subscale, being studied will have at least several questions to respond to, and it is the combination of questions grouped together which allows the subscales and statistics based on these to have value. Responses for each question were summed up for a single index number for the subscale. The various subscales were summed up for a single index number for each construct. The scores for the constructs of Motivation, Ability, and Opportunity were summed to make one score for MAO. Descriptive statistics were run on each subscale and each construct to find frequency, central tendency and variability.

Research Questions

Research Question One: Does this set of Curriculum Strategy affect levels of personal FW?

H<sub>0</sub>: There are no statistically significant differences in the effect of Curriculum Strategy on personal FW.

H<sub>a</sub>: There are statistically significant differences in the effect of Curriculum Strategy on personal FW.

The Independent Variable was the set of Curriculum Strategy. To examine Food Waste, a Wilcoxon test was conducted to compare median differences in the change in grams of food waste for each student and for the class as a whole by weight prior to and after the Curriculum Strategy. Food waste was measured in grams and treated as continuous data. The assumptions of
normality and homogeneity of variance were assessed, and the data was non-normal. Since the
distribution data for FW was not normal, a non-parametric test, the Wilcoxon signed rank test
was conducted instead of the \( t \)-test. The median score and associated p-value were reported.

Research Question Two: Does this set of Curriculum Strategy affect Motivation, Ability, and/or
Opportunity?

\[ H_0: \text{There are no statistically significant differences in the effect of Curriculum Strategy on}
Motivation, Ability, and/or Opportunity. } \]

\[ H_a: \text{There are statistically significant differences in the effect of Curriculum Strategy on}
Motivation, Ability, and/or Opportunity. } \]

The Independent Variable is the set of Curriculum Strategy. To examine the Scales and subscales in Motivation, Ability and Opportunity, as the distribution data for the subscales were not normal, a Matched Pairs test was run, and the Wilcoxon signed rank test was conducted instead of the \( t \)-test. The median score, the IQR, and the associated p-value were reported.

Research Question Three: Is there a relationship between sociodemographic factors and/or Food Waste Prevention Practices and personal FW?

\[ H_0: \text{There are no statistically significant differences in sociodemographic factors or Food}
Waste Prevention Practices and the amount of FW measured before the intervention. } \]

\[ H_a: \text{There are statistically significant differences in sociodemographic factors or Food}
Waste Prevention Practices and the amount of FW measured before the intervention. } \]

The Food Waste Prevention Practice subscales and summed score and the Sociodemographic scores were tested against the pre-FW level, both continuous variables, by a
correlation analysis utilizing the non-parametric Spearman \( \rho \). The Spearman \( \rho \) and the \( p \) were reported.

The sociodemographic variables had their means and SD’s (Table 3) reported and were explored for relationships to quantity by weight of FW in the first collection of FW data. Kruskal-Wallis was utilized to test the non-parametric, continuous pre-FW level against each in turn of the ordinal sociodemographic data in a one-way analysis. Reported were the median, IQR, and the Kruskal-Wallis \( p \) value.

**Table 3.** Sociodemographic variables with their method of analysis and level of measurement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Method of Analysis</th>
<th>Level of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Means and SD</td>
<td>Ratio</td>
</tr>
<tr>
<td>Gender</td>
<td>Means and SD</td>
<td>Nominal</td>
</tr>
<tr>
<td>Live on/off campus</td>
<td>Means and SD</td>
<td>Nominal</td>
</tr>
<tr>
<td>Work other than being a student</td>
<td>Means and SD</td>
<td>Ordinal</td>
</tr>
<tr>
<td>Live with</td>
<td>Means and SD</td>
<td>Nominal</td>
</tr>
<tr>
<td># of adults in HH</td>
<td>Means and SD</td>
<td>Nominal</td>
</tr>
<tr>
<td>Eat out breakfast</td>
<td>Means and SD</td>
<td>Ordinal</td>
</tr>
<tr>
<td>Eat out lunch and/or dinner</td>
<td>Means and SD</td>
<td>Ordinal</td>
</tr>
</tbody>
</table>

**Table 4.** Sociodemographic variables with their method of analysis and level of measurement

<table>
<thead>
<tr>
<th>Data Analysis</th>
<th>Research Question One</th>
<th>Research Question Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct</td>
<td>Scale</td>
<td>Method of Analysis</td>
</tr>
<tr>
<td>Does Curriculum Strategy affect levels of personal food waste?</td>
<td>Amount of Food Waste</td>
<td>Non-normal - Wilcoxon signed-rank test as groups come from the same population</td>
</tr>
<tr>
<td>Research Question Two</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Research Question Three</th>
<th>Does Curriculum Strategy affect Motivation, Ability, and/or Opportunity?</th>
<th>Motivation, Ability, Opportunity</th>
<th>Awareness</th>
<th>Non-normal Wilcoxon signed-rank test as groups come from the same population</th>
<th>Change in M, A, and O scales from pre- to post-</th>
<th>Curriculum Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there a relationship between sociodemographic factors and/or Food Waste Prevention practices and personal FW?</td>
<td>Sociodemographic predictors and Food Waste Prevention Practice predictors</td>
<td>Kruskal-Wallis if non-parametric Correlation Analysis - Spearman</td>
<td>Personal Food Waste – means - on the first collection of FW</td>
<td>Continuous variable Ratio</td>
<td>Sociodemographic Categorical and Ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Food Waste Prevention Practice</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continuous variable Ratio</td>
<td></td>
</tr>
</tbody>
</table>

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CHAPTER FOUR: RESULTS

The number of students in the Fall 2021 class began as 197 students. Due to various reasons shown in Figure 5 the number with usable FW data was 176 in the pre-FW and 174 in the post-FW collection. The number with usable survey data was 192 in the pre-survey and 188 in the post-survey.

Figure 5. Details of student numbers that completed the Food Waste collections and the two surveys
A total of 197 students filled in the pre-survey. Those five who were under 18 years of age were removed according to the IRB, and therefore the rest of the data from the pre-Survey is based on 192 respondents. As this was an online class in the Fall of 2021, in the middle of the covid pandemic, eleven of the students lived too far away to participate in the collection of FW, but these students were able to do the surveys and other aspects of the class. Five students did not participate in collecting FW, though they did participate in the survey. The five who were < 18 did participate in collecting FW, and their data was later removed. This left 197 – 21 = 176 students with valid data for the pre-Food Waste collection.

For the post collection, eleven of the students lived too far away to participate. Three students dropped class, and four students did not participate. The five who were < 18 did participate and their data was later removed. This left 174 students with valid data for the post-collection. For the post-survey, the under 18s were removed and three students dropped class, and one did not participate in the survey leaving a total of 188 useable surveys. Table 5 contains the sociodemographic data and household characteristics of the respondents from questions in the pre-survey.
Table 5. Summary statistics of socio-demographic and household characteristics (n= 192)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Frequency (f)</th>
<th>Relative Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2 = 18 – 24</td>
<td>189</td>
<td>98.44</td>
</tr>
<tr>
<td></td>
<td>3 = &gt; 24</td>
<td>3</td>
<td>1.56</td>
</tr>
<tr>
<td>Gender</td>
<td>1 = Male</td>
<td>35</td>
<td>18.23</td>
</tr>
<tr>
<td></td>
<td>2 = Female</td>
<td>157</td>
<td>81.77</td>
</tr>
<tr>
<td></td>
<td>3 = Other/Prefer not to say</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Living on Campus</td>
<td>1 = Yes</td>
<td>41</td>
<td>21.35</td>
</tr>
<tr>
<td></td>
<td>2 = No</td>
<td>151</td>
<td>78.65</td>
</tr>
<tr>
<td>Work other than being a</td>
<td>1 = None</td>
<td>112</td>
<td>58.33</td>
</tr>
<tr>
<td>student</td>
<td>2 = Part-time</td>
<td>72</td>
<td>37.50</td>
</tr>
<tr>
<td></td>
<td>3 = Full-time</td>
<td>8</td>
<td>4.17</td>
</tr>
<tr>
<td>Live with</td>
<td>1 = Alone</td>
<td>9</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>2 = Roommates</td>
<td>162</td>
<td>84.82</td>
</tr>
<tr>
<td></td>
<td>3 = Family</td>
<td>20</td>
<td>10.47</td>
</tr>
<tr>
<td># of adults in HH</td>
<td>1 = 1</td>
<td>17</td>
<td>8.85</td>
</tr>
<tr>
<td></td>
<td>2 = 2 – 4</td>
<td>155</td>
<td>80.73</td>
</tr>
<tr>
<td></td>
<td>3 = &gt;4</td>
<td>20</td>
<td>10.42</td>
</tr>
<tr>
<td>Eat out breakfast</td>
<td>1 = Seldom &lt;2 breakfasts/wk</td>
<td>152</td>
<td>79.17</td>
</tr>
<tr>
<td></td>
<td>2 = Some 2-3 breakfasts/wk</td>
<td>17</td>
<td>8.85</td>
</tr>
<tr>
<td></td>
<td>3 = Often 4-7 breakfasts/wk</td>
<td>23</td>
<td>11.98</td>
</tr>
<tr>
<td>Eat out lunch and/or dinner</td>
<td>1 = Seldom &lt;2 lunch, dinners/wk</td>
<td>62</td>
<td>32.29</td>
</tr>
<tr>
<td></td>
<td>2 = Some 2-6 lunch, dinners/wk</td>
<td>107</td>
<td>55.73</td>
</tr>
<tr>
<td></td>
<td>3 = Often &gt;7 lunch, dinners/wk</td>
<td>23</td>
<td>11.98</td>
</tr>
</tbody>
</table>

Of the respondents, 81% were female which tracks along with this class being a requirement for Nursing and for Dietetics, both of which careers commonly attract more females. Just under a quarter of the class lived on campus while the other three-quarters lived off campus. This is typical of a large State University. Just over a third of the class worked part-time and a small number (8) worked full-time while attending college. The majority of the class (58%) did not work. Eighty-five percent of the students lived with roommates while only 10% lived with their own family.

The number of adults in the HH tracked closely with the question of who they lived with - living alone, with roommates or with family. Nearly 80% of the respondents seldom ate breakfast away from home (<2 times in a week). This does not mean that they ate breakfast at
home as they may well have skipped eating breakfast at all. Only nine percent ate breakfast away from home 2 – 3 times in a week, while 12% ate breakfast away from home 4 – 7 times in a week. Surprisingly, one-third of the respondents seldom ate out lunch and/or dinner (< 2 times in a week), while 56% ate lunch and/or dinner out 2 – 6 times in a week, and seven percent ate lunch and/or dinner out > 7 times in a week.

Research Question One: Does this set of Curriculum Strategy affect levels of personal food waste?

Figure 6 shows the boxplot results of the pre- and post-FW collection. A Wilcoxon signed rank test found the pre-average was 199.96 grams (IQR 94 – 267) and the post-average was 170.47 grams (IQR 74 – 244). The P value was significant at .0012 and n = 174.

![Boxplot of Food Waste Averages](image)

*Figure 6. Box plot of Food Waste average (grams) PRE (left) and POST (right)*

Figure 7 shows another view of the pre- and post- food waste averages as a distribution histogram with the number of students indicated in each histogram bar. In the post- histogram the number of students with very high FW has been reduced and the number of students with lower amounts of FW has been increased.
Figure 7. Distribution histogram and boxplot PRE (left) and POST (right) FW (grams)

To better understand the variety in student personal FW between the pre- and post- a visual was created in the statistical program R using the ggplot2 package. Each blue dot in Figure 8 represents one student’s pre-FW collection quantity. On a vertical line, either above or below the blue dot, is a red dot that represents that same student’s post-FW collection quantity. Many students stayed close to their original level of FW, with some lowering their post-FW a small amount and others raising it by a small amount. In the lower two-thirds of the red line, it can be seen that more students were lowering their FW than raising it. The upper third of students FW values are much more scattered both high and low. (n=174)

Figure 8. Pre- and Post-Food Waste by each student participant
Research Question Two: Does this set of Curriculum Strategy affect Motivation, Ability, and/or Opportunity?

Both the pre- and the post- surveys contained questions directed to ascertain the students Motivation, Ability, and Opportunity to reduce FW. As reported in more detail in the Methods Chapter, the survey divided the construct of Motivation into four subscales to include Awareness, Social Norms both Injunctive and Descriptive, and Attitude. These four subscale scores were combined to determine the Motivation total score. Table 6 summarizes the results for each subscale both pre- and post- for those students who completed both surveys giving the median and the results of the Matched-Pairs test of significance - the Wilcoxon signed rank Prob $> |S|$.

**Table 5. Matched Pairs Wilcoxon signed rank for the Construct of Motivation (n = 188)**

|                     | PRE Median | POST Median | Wilcoxon Post-Pre Prob $> |S| |
|---------------------|------------|-------------|--------------------------|
| Awareness           | 36         | 40.6        | <.0001***                |
| Social Norm Injunctive | 15.1      | 15.4        | .3004                    |
| Social Norm Descriptive (R) | 12.9      | 11.8        | .0002**                  |
| Attitude (R)        | 22.3       | 23.3        | <.0001***                |
| Motivation TOTAL    | 86.3       | 91.2        | <.0001***                |

(R) reversed   * P < .05   ** P < .01   *** P < .0001

The Awareness and Attitude subscales were both found to increase in value and were significant at P < .0001. The subscale of the Social Norm Injunctive increased slightly and was not significant. The subscale of the Social Norm Descriptive declined by one point and was
found to be significant at P < .0002. The total score encompassing all of the subscales of Motivation increased and was found to be significant at P < .0001.

Table 7 shows the results of the descriptive statistics for each subscale and the results of the Matched-Pairs test of significance, the Wilcoxon signed rank Prob > |S|, for all the subscales of Ability and the Ability total and Opportunity total.

**Table 6.** Matched Pairs Wilcoxon signed rank for the constructs of Ability and Opportunity (n=188)

|                                | PRE Median | POST Median | Wilcoxon Post-Pre Prob > |S| |
|--------------------------------|------------|-------------|--------------------------|
| Difficult to Assess Food Safety (R) | 13.8       | 13.9        | .6032                    |
| Difficult to Cook Creatively (R)   | 18.9       | 18.6        | .3352                    |
| Difficult to Plan Accurately (R)   | 13.3       | 13.7        | .3369                    |
| Skills TOTAL                      | 46.1       | 46.2        | .7788                    |
| Shelf-Life Knowledge              | 16.1       | 19.6        | <.0001***                |
| Date Label Knowledge              | 13.4       | 15.1        | <.0001***                |
| Knowledge TOTAL                   | 29.6       | 34.7        | <.0001***                |
| ABILITY TOTAL                     | 75.7       | 80.9        | <.0001***                |
| OPPORTUNITY TOTAL                 | 13.5       | 14.1        | .0435*                   |

(R) reversed * P < .05 ** P < .01 *** P < .0001

The subscales making up Skills and Skills total were not significant at any level. The subscales making up Knowledge and the Knowledge total were all found to be positive changes and significant at P < .0001. The positive significance of the Knowledge section overcame the no significance of the Skills section so that the construct of Ability was a significant positive change.
at $P < .0001$. The construct of Opportunity was found to be a positive change also and slightly significant at $P < 0.5$.

Figure 11 below, split into three parts, shows the combined box plots of each survey subscale and Constructs including those for the Food Waste Prevention Practices. These box plots show the change from Post to Pre in relation to a zeroed line thereby allowing all the plots to be on the same scale. Each plot is notched at its median and the diamond shape in the center of each plot shows the confidence interval of the median. Asterisks are placed on each plot title to show level of significance.
Figure 9. Box plots of each survey subscale and construct with median notches and diamonds showing changes in responses from pre to post
* P < .05  ** P < .01  *** P < .0001
In conclusion of this section, the total scores for the three constructs of Motivation, Ability, and Opportunity were summed for each student and then the median found for both for the pre- and post-surveys. Figure 12 shows the box plots. A Wilcoxon signed rank test found the pre-median score total was 174 (IQR 158 – 192) and the post- median score total was 182 (IQR 166 - 205). The score increased and the P value was significant at .0001 (n= 188).

![Figure 12. Box plots of MAO construct scores pre (left) and post (right)](image)

Research Question Three: Are Sociodemographic factors or Food Waste Prevention Practices associated with personal FW?

In an effort to find if there are characteristics about a person and their HH and how much food they waste or the way they handle food and how much food they waste, analysis was run to explore any relationships. The non-parametric Spearman’s rho was calculated between the continuous variables of the FW Prevention Practice subscales and the pre-FW average. As seen in Figure 13, four of the subscales and the sum of the Prevention did not show significance. Only
the subscale of Impulse Buying was significant with higher levels of impulse buying positively related to higher levels of FW (n=174) = 0.244, \( P = .001 \).

| PRE - Survey   | Spearman | \( \rho \) | Prob > |p| |
|----------------|----------|-----------|--------|---|
| Planning       | -.002    | .98       |        |   |
| Overview       | -.056    | .46       |        |   |
| Impulse        | .244     | .0011**   |        |   |
| Cook           | -.001    | .99       |        |   |
| Precisely      |          |           |        |   |
| Leftovers      | -.06     | .43       |        |   |
| Total          | -.089    | .24       |        |   |
| Prevention     |          |           |        |   |

*Figure 11. Spearman rank correlation between quantity of pre-Food Waste averages and pre-Food Waste Prevention Practices (n=176). ** \( P < .01 \)*

To check for associations between the continuous variable of the pre-Food Waste and the categorical variables of the sociodemographic questions a Kruskal-Wallis test was run for non-parametric data. Figure 14 shows the results, including each variable and its levels, the average FW for that level with its IQR, and the Kruskal-Wallis with the corresponding p value.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Level (n=)</th>
<th>PRE FW Median grams</th>
<th>PRE FW IQR</th>
<th>Kruskal-Wallis&lt;sup&gt;a&lt;/sup&gt; p value</th>
</tr>
</thead>
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<td>175</td>
<td>70 - 294</td>
<td>.75</td>
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<tr>
<td></td>
<td>Female (148)</td>
<td>167</td>
<td>96 - 263</td>
<td></td>
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<tr>
<td>Age</td>
<td>18 – 24 (174)</td>
<td>167</td>
<td>93 - 265</td>
<td>.046*</td>
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<td></td>
<td>&gt;24 (2)</td>
<td>430</td>
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<td>118 - 251</td>
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<td>Live with</td>
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<td>181</td>
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<td># adults in HH</td>
<td>1 (14)</td>
<td>222</td>
<td>95 - 355</td>
<td>.47</td>
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<td></td>
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<td>196</td>
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<td>92 - 267</td>
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<td></td>
<td>Sometimes (16)</td>
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<td>160</td>
<td>50 – 236</td>
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<td>Eat out Lunch and/or Dinner</td>
<td>Seldom (55)</td>
<td>175</td>
<td>73 - 258</td>
<td>.14</td>
</tr>
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<td></td>
<td>Sometimes (100)</td>
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<td></td>
<td>Often (21)</td>
<td>193</td>
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*Figure 12. Kruskal-Wallis analysis of pre-food waste averages by sociodemographic variables*

<sup>a</sup> Kruskal-Wallis test for difference between groups  * significant for p value <.05

The only variables that showed promise for explaining FW were age and Impulse Buying.
CHAPTER FIVE: DISCUSSION

Many allied health organizations are encouraging their members to become both aware of and competent at promoting sustainability in their workplaces and this overflows into efforts to ensure that students in their field are engaging and developing these skills for the future. Since Dietitians are the experts at the connection of food and people, the Academy and their education arm, ACEND, have made it clear that dietetic students should be learning about sustainability. College students are particularly interested in sustainability issues and combining this interest with the needs of their future careers in healthcare makes for a good confluence.

One area of food sustainability is food waste. Food that is produced but not consumed is wasted along with all the resources that went into growing it, transporting it, manufacturing it, retailing it and even cooking it further in the home. All the resources embodied in that food are wasted, and all the nutrients in that food are no longer available to nourish a person. Once thrown out, much of the wasted food ends up in landfills where it creates methane gas, a very potent greenhouse gas, and contributes to warming of our atmosphere. It is well confirmed that in industrialized countries, it is the consumers at the HH level who are making the largest contribution to FW. With America having inexpensive and plentiful food, consumers often undervalue food and do not mind wasting it. Food is also often handled in a very routinized manner, with very little thought given. Tackling food waste at the consumer level will go a long way towards reducing GHGs and their effects.

In 2021, Alattar and Morse, in their research on college-students, stated that “developing and assessing educational food waste diversion tools is an essential next step towards decreasing food waste.” When college curriculums are already packed with needed information, a question becomes how to accomplish this. One model framework, The Consumers
Food Waste Model, combined both the individual and the sociological approaches by promoting Motivation and Ability and Opportunity. By combining these three constructs, the individual is more likely to actually waste less food. The European Union’s four-year research project to tackle food waste utilized this framework.25 The United States’ NASEM opted to use this framework also “as especially useful for identifying and analyzing individual behavioral drivers while also taking into account the importance of context and habit in driving behavior.49”

This project tested a set of curriculum activities designed to increase Motivation, Ability and Opportunity, in a college-level Introductory Nutrition class. One of these activities, the Discussion post, was designed to provide students with an interactive way to contribute to a community of learners.164 Preferentially, this aspect of the Curriculum Strategy would have been a blog which would have allowed for more creative aspects and possibly more collaborative learning as was discussed in the research by Kuo, Belland, and Kuo, 2017.166 The Learning Management System used on this campus was CANVAS, and it did not contain a blog feature. The closest that was practical in a large class was a more traditional discussion post and replies. By allowing the students to choose what topic they wanted to research and inform the other students of, students had more engagement in the material they were researching. It also made the Discussions much more interesting to read as they could pick from a variety of topics to read and reply to. By splitting the students up into smaller groups of a maximum of 20 students, this also allowed for more connection to their fellow students. The overall desire was to assist students in becoming engaged citizens so they can be leaders both locally and globally.146

This project measured actual FW which has seldom been done in the United States. This is understandable as measuring FW is difficult and messy and time-consuming, especially if attempting it on a larger number of respondents. Utilizing a Kitchen Caddy method has only
been studied a few times. Elimelech et al\textsuperscript{123} found that collecting food in bags and then bringing it to a sorting tent worked well. It was found to be a valid method even when the waste is simply weighed, and not sorted, particularly if the aim of the study is to obtain an estimate of the relative amount of total FW in a HH.\textsuperscript{124} Physically measuring the FW of a large class of college students was one way in which this project furthered research in this area. The kitchen caddy method was reduced in this case to heavy plastic freezer bags. For the purposes of a class project, this was a reasonable method to encourage students to participate reliably. The freezer bags allowed for each day to be kept separated and each could be placed in the refrigerator or freezer while waiting to be transported back to the PIs office for weighing. A freezer bag could also be carried in the student’s backpack to be used when collecting FW from the dining hall or a restaurant. The students did not complain and seemed to find the project edifying and useful, and if nothing else, this part of the project showed many students that they do waste a good deal of food on a regular basis.

The first research question was if this Curriculum Strategy affected the levels of personal food waste, and it was found that the average amount of FW decreased significantly. A useful question is how accurate this was? With the collection of food waste being at the student’s discretion, it is very possible that some deliberately collected less or that they made a concerted effort for those three days to use up their food more carefully.

The fact that there was a significant negative difference in the amount of food waste before and after the various class activities is a positive sign that the activities did promote more awareness and concern about their own food waste. There is also the possibility that simply handling their own food waste and seeing it up close and personal was enough to promote
changed behavior. In this sense, the collecting of food waste was both a way to measure the intervention but also part of the intervention.

The second research question was if the Curriculum Strategy was enough to significantly change scores on the post-survey that was measuring the student’s level of Motivation and Ability and Opportunity. Two of the subscales in Motivation were found to be significantly increased from the pre-survey to the post-survey. Awareness involves being aware of your own FW levels and also being aware of the consequences. The Lectures on the Food System and on Food Waste were well received by the students and are likely to be a main reason for this difference in scores, as many students would have only been somewhat aware of the many consequences of wasting food before this course.\textsuperscript{93,101,148} Attitude is the other subscale that had a significant positive change. Attitude involves more than simply being aware of the situation and its consequences. Attitude “includes the feelings or emotions and related thoughts, beliefs and ideas that are brought to the surface by disposing food.”\textsuperscript{168} Guilt can be part of this. Again, the Lectures and Discussion activity would help put the issue of food waste front and center and by increasing awareness will also associate that new awareness with the more emotional level of doing something wrong when wasting food.

Social Norm Injunctive had a very slight positive but not significant change. This norm measures if you recognize that others who are important to you disapprove of food waste. The important people to a student are more likely to be others such as family and friends who were not part of the course and therefore much less likely to have been changing their behavior as regards to food waste and this can be an explanation for why students did not change their scores over the semester. The construct Motivation, as a summation of the four subscales, was significantly positively changed.
The construct of Ability is a combination of having Skills related to food handling and Knowledge related to how to promote longer shelf-life and how to read date-labels. In this research study, Skills did not prove to be a significant improvement from the pre- to post-survey. The Lecture on Actions to Prevent Food Waste did cover issues of food safety, so it is disappointing that the subscale of Assessing Food Safety barely increased and not significantly. This would be a useful area in which to improve the Lecture for next time. The two areas of not being able to Cook Creatively and Difficulty with Planning Accurately are more understandable as these are skills likely improve only with time and much experience which college students are still gaining.

Whereas the area of Skills was not significantly affected by the Curriculum activities, the area of Knowledge was. Knowledge covered questions about knowing how to keep foods fresh and knowing how to read and use the date-label information on packages such as Best-By and Use-By. Both of these subscales increased significantly. They were covered by the Lecture on Actions to Prevent Food Waste, and it appears that the information gained was remembered. In the Action II Lecture, we practiced using the information learned on shelf-life and date-label in class via breakout rooms wherein the small group had to work together to manipulate words/images on PowerPoint slides to store food properly and to pick out correct date-label information. This appears to have been successful. Any effort that is successful in moving consumers towards an accurate understanding of date-labels is welcome. Consumers continue to be confused by date-labels, even the new industry-led efforts, and as Turvey, et al showed, consumers are confident in their misunderstanding. The construct Ability was split between no significance in Skills and positive significance in Knowledge. Together, the construct Ability increased positive significantly.
The construct Opportunity had only one subscale used to measure it in this project – Time & Schedule. College students are often constrained by tight schedules and tight schedules are a known factor for interfering with intentions to not waste food.\textsuperscript{196} The questions measured unforeseen events which included being too tired to bother preparing a meal, last-minute plans that derail your intentions to cook, and three other similar questions as to how circumstances and time pressures interfered with meal plans. Considering that during a college semester time constraints are likely to get more severe as the semester draws to a close, it is not surprising that this construct only increased by one point and that it was not a significant increase.

When the sum of each construct, M, A, and O, were summed together into an overall MAO score, the change from pre- to post was positive. Finding an overall positive relationship between the pre- and post-survey of Motivation, Ability and Opportunity indicates that there is potentially value in the methods used in the intervention.

The last Research question was if there was a relationship between sociodemographic factors or Food Waste Prevention Practices and FW. There has been much effort in recent years to find if there are any personal factors that can explain a person’s propensity to waste food and the results have been very mixed.\textsuperscript{111} The same goes with Food Waste Prevention Practices which are often very habitual. If there are factors that align more with food waste than other factors, then these can become the points to educate people on or be a way to identify which age groups or genders or any other identifying factor should be the most targeted for education.

Of the five subscales in Food Waste Prevention Practices only one of them showed any significant correlation, Impulse Buying, which showed a positive relation to food waste. Impulse buyers will buy extras or specialty items they never get around to using. Overpurchasing is seen as an important factor in producing FW and Impulse Buying is so easy to do when we are
surrounded with tasty food and retailers make it so easy, or we shop when hungry. The fact that the other subscales were not correlated was a little surprising as planning food shopping based on an overview of what you already have, matching the amount of food you cook with the amount needed, and utilizing leftovers are all known ways to reduce food waste. Possibly most students in this class did not actually engage much in these food provisioning areas as they simply ate at the dining hall or at their fraternity/sorority houses or their food shopping was very routine with little deviation one week to the next.

As the sociodemographic variables were categorical, a Kruskal-Wallis test was performed. Only one of the variables turned out to have any level of significance and that was age. Two out of 176 students were over the age of 24, and they also happened to have turned in large amounts of food waste. It appeared that this was not of any importance to pursue farther. Of the other sociodemographic variables, eating out (breakfast, lunch and/or dinner) came the closest to significance. Even though they did not rise to the level of significance, it does fit that they were close as the more students tend to eat away from home, the more likely they are to have at least some food waiting in the fridge that never gets eaten. Overall, the various Curriculum activities had a positive effect. This fits with the understanding that objective environmental knowledge can be divided into three dimensions: system knowledge (knowing what), action-related knowledge (knowing how) and effectiveness knowledge (knowing when and why). It would appear that all three are needed in order to move people into actually acting on the desired behavior, and college students have very little accurate objective knowledge, system or action or effectiveness, about food waste. By utilizing the Curriculum Strategy, along with the physical collection of their own food waste, the present research touched
on all aspects that could help move the needle forward in awareness of and action towards decreasing personal food waste.

Strengths

A strength of this study is that there have been few studies on food waste aimed at consumers and very few aimed at college students and of those on college students even fewer have been in the classroom setting. With consumers being a main reason for food waste and food waste being a main cause of methane gas, ways to control this are needed. Dovetailing with the need to reduce consumer food waste is the desire from many allied health organizations to find ways to include sustainability issues in the classroom where their future members are being educated.

This research fits neatly within these areas of need as it studies consumers, college students, and ways to train future allied health professionals in the sustainability issue of food waste. At the time of the research in the fall of 2021, as far as the PI is aware, this was the first time to use the validated REFRESH survey in America. The model of Motivation – Ability – Opportunity focuses on consumer food waste from several different angles, all of which are important for explaining how food ends up in the trash. Other methods, such as the Theory of Planned Behavior and the Social Practice Theory do not look at both the Individual level and the Social level and both of these levels are part of the explanation.

Physically collecting food waste is seldom done on larger samples. The logistics of it are difficult. By using a simple ‘kitchen caddy’ method, this research was able to collect food waste two different sessions of three days each from 174 students. Trialing this method is one of the best strengths of this study.
Limitations

This research project does have many limitations. It was very useful to collect food waste, but the students live in so many different food scenario’s such as living at home with a parent who cooks for them to being part of a fraternity or sorority and eating their meals at the house to having a meal plan and eating at the dining halls to being on their own for shopping and preparing food. Each of these scenarios is likely to generate different amounts of food waste. The Greek houses provide three meals a day, fully prepared. The student can pick up their food waste from any portion they did not eat, but separating out the food preparation waste such as carrot peels or ends, or other bits and pieces that result as the cook cooks is not very functional. A somewhat similar situation arises when a set of four roommates cook together, and the student would have to estimate a fourth of the kitchen waste to place in their bag. Another roommate issue can arise when someone helpfully throws out the bag that was sitting in the refrigerator. Those eating in the dining hall have no way to collect kitchen waste. A situation this research ran into was that the second collection was to occur the week before Thanksgiving, but it became apparent that in the week before Thanksgiving week a number of students were already heading home and consequently had cleaned out their refrigerator. Once this became clear, the PI moved the second collection to the week after Thanksgiving. Also, a variety of food waste was collected that was not on the list such as one bag had old meat in it, and another had many orange peels. Social desirability bias was certainly a possible reason for the FW to be reduced in the post-collection. It is possible that simply collecting their own personal food waste was enough of a trigger to make some positive changes in the motivation areas without the need for lectures/discussion.
It was assumed that the students did their own work for the Discussion Post, but it was certainly possible that they found a way to get around that. This would lead to them not receiving any motivating influence from researching the Discussion. If they did the Replies, then at least they hopefully read others reports. It is the PIs experience though that the Discussion Posts are written by the student, and they do read two other reports in order to make their Replies. This was before the era, though, of Chat GPT, so how that will work in future Discussions is up in the air. There was no way to separate the effect of the Discussion from the effects of the rest of the intervention. We also were unable to separate out the System versus Action lectures to see if one of these led to more results than the others.

Implications for Research and Practice

When this research was conducted in the fall of 2021, there had been very few studies aimed at reducing food waste in college students in the United States, and actually not very many intervention studies aimed at anyone in the United States. Europe was well ahead of us in concern about food waste and the need to work with consumers to lower it. REFRESH had validated and utilized the survey on thousands of people in various countries in Europe. With NASEM also recommending the MAO Framework, it was a good opportunity to bring this to America.

The survey itself was easy enough to place into Qualtrics and to add my own sociodemographic questions to. The date-label questions were added from Dr. Visschers, a long-time European researcher. My only concern with the survey is that students might have rushed through and not truly paid attention to the nuances of the questions. In the instructions, the respondent was cautioned to consider each question well and not rush. They were warned that
many of the questions could sound close to each other, and they needed to be carefully considered. Even so, the time taken was quite quick in many cases, and there is the chance that the subtle differences and/or those that were the reverse of each other may not have been caught. An example would be “Most people important to me support me if I do not throw away food” and ‘Most people important to me expect me to not throw away food.’ A student could wonder what ‘support’ means and quite possibly at their house food being thrown away is seldom discussed. Students might very well make a quick guess at what the point of the question was and answer without more thought. A suggestion for the future would be to practice this type of survey in class to get them acclimated to answering these types of questions. A survey from another type of environmental study, such as turning off lights, would be a good choice as the questions would be set-up fairly similarly.

Trialing the kitchen caddy method of collecting and measuring food waste in a large college class was a useful purpose of this study. Collecting food waste is obviously a messy project for both the respondent and the researcher. The alternate though of simply asking respondents to guesstimate how much they waste is not particularly accurate. Memory is relied on when looking back over the week. Also, social desirability bias is quite strong and results have been found to under-estimate FW by a large amount.\textsuperscript{113,120}

The caddy method has only been used a small number of times, so the knowledge about how well it works is very limited. This study adds to this knowledge base of a method that has several advantages of being quite simple, easy enough for the respondents to do, and at the least a way to estimate the relative amount of total food waste in a HH with the added benefit of visually impressing the respondent. If using this method in a future study, improvements would be to give the students more detailed instructions or more visual instructions as to what to
include and what not to include with the goal of making what is collected more consistent.

Another improvement would be to understand better the various food provisioning scenarios typically found in students and then to have a set of instructions for each of the usals, such as, those eating at a Greek House would be instructed to only collect what was on their plate when eating there and not try to collect waste from the kitchen, someone who cooks for themselves would also collect their own kitchen waste, etc. This would not be close to a complete collection for many, but it would standardize the pre- to post- amount for each individual student and would overall make for a more accurate pre- post-.

Originally, one of the goals was to open the individual bags of waste after weighing and dump the contents into a large garbage container. This container would be weighed before and after and this data along with a picture of the large amount of waste would be shared with class. This did not work as the food waste came in over a week’s time and the PI weighed the bags most late afternoons. If the old food had been dumped at the end of each day, where would the container have been stored in the meantime? The food bags were zipped shut and could be stored in the walk-in refrigerator. A large, not well sealed, garbage container would not belong in the refrigerator and by the end of the week would have been quite smelly. Also, more thought should have gone into what to do with the food waste before this started. This had not been planned out as it should have been. The farm on campus might have been able to take the waste with earlier arrangements. With the whole project about how we want to keep food out of the landfills, placing it in the garbage was not a choice. As it turned out, the food ended up back at the PIs house, and each bag was opened and dumped into a deep hole in the ground to make compost.

The Discussion Post was a basic way to encourage student connections with others who were also thinking about food waste. A big improvement would be if a true blog could be
arranged. Generation Z are digital natives. A set of blogs through the semester whereby the student tracks their food waste journey by means of a combination of visuals, thoughts, and recordings would be much more engaging for each student to do and for students as they peruse and respond to each other's contribution. Students could be very inventive, and this inventiveness could grab attention to the bigger purpose of why we are trying to reduce food waste and how every consumer can do their part in this. There might also be a way then to isolate the effectiveness of this method.

The three PP lectures were well received, but three is too many for most college classes. A suggestion would be to greatly shorten the section on Food Systems and mostly use a few slides on Food Systems to set up the rest of the slide set on FW and Actions to reduce food waste. This would be appropriate for a 50 minute class. Then, a week later, have the Breakout Groups, or in-class groups, the Action II Lecture, whereby the students test out what they recall from the week before and work together to manipulate the PP. A PP that students can use as a group activity to physically move parts around is the idea of the PI in her own classes. The PI needed something to engage her online classes with and that students could work on together. The PI has used this method a number of times now for group practice towards an exam. It does need to be well explained ahead of starting and doing a sample slide together in the class meeting before would help. This way explanations on the day of are cut to a minimum. There will always be some students who do not participate in such activities, and the Lecturer will simply have to hope the student picks up some of the information.

Overall, if the above is used in college classes for beginning the process of allied health students learning about sustainability/food waste then it is suggested to cut the Lectures down to two with the second one being the group activity. The information in the first Lecture will prime
the students to be interested in food sustainability for future classes where more specific information will be learned. The group activity PP is a good way to practice skills and should encourage interest also. A Blog post done two – three times in a semester exhibiting the students take on reducing food waste would be much preferential to a Discussion post. Collecting the FW as done in this project is a good use of time and should be more organized than it was this round.

For future studies in this area, a qualitative study to see how food fits into a student’s life would be useful. Student’s only have so much control over their food lives. Some have little funds and so have to be very cautious. Others spend many dollars on eating at restaurants and the portions are what the restaurant gives whether you can eat all that or not. Many have minimal food provisioning skills. Finding out more about just what concerns students and their food provisioning methods would be an excellent next research project. Boulet, Hoek, and Raven, 2021, developed a framework that “recognizes the nested relationships between different context (or levels) and their associated factors.” This framework is based on the social ecological model (SEM) and shows the nested relationship between the individual and the rings of influence expanding out. These researchers conducted a study using a video elicitation method. Study subjects (13) used their phone camera to take videos related to one of the following activities: unpacking a food shopping trip, cooking a main meal, or cleaning up after a meal. They would then watch the recording and make comments. College students would find a similar research focused on food waste an engaging activity, and from this more can be learned about the many factors in a student’s life that play into food being wasted.
CHAPTER SIX: CONCLUSION

In order to find a way to begin incorporating sustainability issues into allied health students learning experiences in a way that would easily fit into the curriculum an intervention using the Framework of Motivation – Ability – Opportunity was conducted in a college level Fundamentals of Nutrition course. A survey based on the constructs of MAO was delivered in the early weeks of the class. The students collected their personal food waste for three days in the first part of the semester. A set of curriculum activities was deployed in the middle weeks. These included a lecture on Food Systems, a lecture on Actions to Reduce Food Waste, and a class group activity to practice what was learned in the Actions lecture. The students then engaged in a Discussion in which each student researched an aspect of food waste. Food waste was again collected for three days, and the survey was repeated. The purpose of these activities was to increase the students’ motivation and their abilities and their opportunities to reduce their personal food waste. The intervention successfully reduced students' personal food waste and increased their Motivation and their Ability.
Appendix A: IRB Approval from University of Florida
Appendix B: IRB Approval from University of North Florida

From: Rahim-Williams, Bridgett <bridgett rahimwilliams@unf.edu>
Sent: Wednesday, September 1, 2021 2:19 PM
To: Brunng, Sarah <n00928320@unf.edu>
Cc: Esplique Bueno, Eva Rhonda <n00460586@unf.edu>
Subject: Exempt Study

Hi Sarah,

You are good to go because UF declared the research "Exempt.". Remember, we only needed the documents from UF for UNF records.

Please feel welcome to give us a call anytime you are waiting to hear back from us. My number is 904-620-2318. Eva's is 904-620-2318. Once your research was deemed exempt by UF, you were ready to begin. The "pending" status in IRBNet will be changed. Our apology in that you thought you still needed to wait to begin your research.

Let us know if you have additional questions.

Kind regards,

Bridgett

Bridgett Rahim-Williams, PhD, MPH, MA
Interim Assistant Director, Research Integrity
Office of Research and Sponsored Programs
University of North Florida
Jacksonville, FL 32224

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Main: (904) 620-2455
Fax: (904) 620-2457
Web: https://www.unf.edu/research/

"Research for research's sake: contributions to science. Research to solve a human problem: priceless"
Appendix C: Consent Form

RESEARCH PARTICIPANT INFORMED CONSENT FORM

Please read this document carefully before you decide to participate in this research study. Your participation is voluntary, and you can decline to participate, or withdraw consent at any time, with no consequences.

Study Title:
Curriculum Strategy to Increase College Student’s Motivation, Ability and Opportunity Resulting in Reduction in Wasted Food

Person(s) conducting the research:
Principal Investigator: Sarah Brunnig, skbrunnig@ufl.edu, 386-748-0175

Purpose of the research study:
The purpose of this study is to determine if a set of curriculum activities will increase student’s motivation and/or ability and/or opportunities to reduce personal food waste

What you will be asked to do in the study:
Students will participate in required graded class activities including lectures, discussion post, surveys and collecting of personal food waste. Students will have the option of opting out of having their survey data and food waste data included in the research statistics.

Time required:
All the activities are part of the course grading.

Risks and benefits:
There are no risks or discomforts anticipated
There are no direct benefits of participation for you

Alternatives to participating in the study:
If you choose to not have your data from the survey or collection of your personal food waste included in the research statistics, then you simply will not opt-in at the end of this consent form or inform me later at any time till the end of class. This will in no way affect your grade.
Confidentiality:

The Researcher would like to use the data generated from the survey and the collection of food waste for this research study. Your identity will be kept confidential to the extent provided by law. Your name will be removed from any data used for publication or presentations.

Compensation:

There is no compensation for participation

Source(s) of funding for the research:

This study requires no funding

May the researcher(s) benefit from the research?

The Researcher may benefit professionally if the results of the study are presented at meetings or in scientific journals.

Withdrawal from the study:

You are free to withdraw your consent for your data to be used in the research statistics at any time without consequence and your data will be discarded. On the survey, you can decline to answer any question you do not wish to answer. The researcher could choose to not use your data on the basis of it being incomplete.

If you wish to discuss the information above or any discomforts you may experience, please ask questions now or contact one of the research team members listed at the top of this form.

If you have any questions regarding your rights as a research subject, please contact the Institutional Review Board (IRB02) office (University of Florida; PO Box 100173; Gainesville, FL 32610; (352) 392-0433 or irb2@ufl.edu.)

See below for Agreement and Signature lines
Agreement:

I have read the procedure described above.

Yes, I voluntarily agree that you can use my data in the research study

_________________________________________________
Participant Name

_________________________________________________
Participant Signature  Date
Appendix D: Email giving permission to use Survey

Timmermans, Toine <toine.timmermans@wur.nl>
To:

Dear Sarah,

Thanks for your email. Happy to read you find the REFRESH methodology useful. You have full permission to use and further build on those (with reference).
Looking forward to receive the results.

Best regards,

Toine

-----Oorspronkelijk bericht-----
Van: Sarah Brunnig <noreply-website@wur.nl>
Verzonden: zondag 29 augustus 2021 01:59
Aan: Timmermans, Toine <toine.timmermans@wur.nl>
Onderwerp: Question via WUR.nl
Appendix E: Food Waste Collection Instructions

Food Waste Instructions:

We are now ready to move on to the Food Waste Project. Each of you should have the eight freezer bags provided by your Instructor. The reason you need to use the instructor provided bags is because the weight of the bag will be a known quantity and allow for that weight to be removed from the total of the bag containing food waste. You will likely only need three bags this first round, but you were provided eight in order to have enough for the second round late in the semester and to have a few extra in case needed. Your last name, first name should be on each bag. That will be quite important when turning them in.

First the timing of bringing in the bags will be explained, then the basics of what to collect will be described, and lastly how to bring in will be explained.

Timing:

The object is to collect your personal food waste, both from home or eating out, over a three-day time period and to bring in the three bags during the week from Sept 20 – Sept 24. This allows all this next week – Sept 13 – Sept 17 through the weekend and into the following week to collect three days. How to choose these days? First consider seriously as to which day during the week of Sept 20 – 24 you will be able to come to my office and schedule that on your calendar so as to remember. Then work backwards from that day to set three good days that will work. The days do not have to be consecutive but should represent ordinary days for you. It will be better to aim for earlier in that week to bring in the bags rather than later in the week. That way if you miss your day, you still have several other days in the week to come by.

- It will help to mark these days on your calendar and also place alarms/notifications on your phone such as just before each normal mealtime as a reminder to do this.
- Carry a bag with you through the day so as to easily collect items as you are out and about. If you want to be safer, then double bag while it is in your backpack.
- Importantly, if you routinely do a refrigerator clean-out about once a week or so, then aim to include that day in your three days.
- The bags can be kept in your refrigerator – well sealed – and so you can collect on some days and then bring them in a few days later.
- Looking ahead to our second time of this towards the end of the semester, please remember what types of days you used and use those same types of days again for consistency.

What to include?

- Collect from home, restaurants, snacks, etc.
- In the interest of food safety, we will NOT collect meat, seafood, or bones – except as stated below. This will greatly cut down on any contamination/smell concerns.
- All other food that could be eaten is what is to be collected.
- Mixed dishes and casseroles that contain meat…. If meat/seafood is mixed throughout and not easy to separate, then collect and make sure it stays in the fridge till brought in.
- Cooked eggs can be collected, but not egg-shells.
- Bits removed from produce as you are preparing meals such as ends of celery or asparagus or strawberry tops - collect
  - Use your judgment such as if you cut very close to the strawberry top so that there is almost no berry left then do not collect, but if you are like most people and cut off a fair amount of berry, then collect.
  - Many peels such as potato or apple can be eaten so collect.
- Inedible items like banana peels and watermelon rind, do not collect, but if there are still useable bits of watermelon clinging to the rind then scoop those out and collect.
- Items that you would normally feed an animal or put in a compost pile – collect.
- Table scraps of meals not eaten which you are not saving for another meal – collect.
  - And this includes parts of meals eaten out that you were going to throw away or send back to the kitchen uneaten – collect.
- Leftovers in your fridge that you did not eat and are going to throw out – collect.
- If unsure, then more collecting is better than less.
- If anyone is looking at you oddly, just say you have an odd professor who wants you to collect food waste for a class project.

You will have to make some judgment calls. If you live in a house with others, you can ask for whomever is prepping the food to put the items to be thrown out in a bowl, and you will take out your ‘portion.’ You can then be in charge of your own leftovers from your meal as to whether it goes in the fridge for another meal, maybe tomorrow’s lunch, or it goes in your collection bag.

Keep your collection bags well marked, and if you share a fridge, make sure they have a Hands-Off sign on them, so no one comes along and throws them out!!

Please try and be consistent and remember your decisions later in the semester when we do this again.

**Bringing In:**

Bring in your 3 bags of food one of the days Monday through Friday of Sept 20 – 24. Come to the same office where you picked up the freezer bags. Hopefully, this time it won’t be hard to find. As you enter, there is a small kitchen on the left with a round table. I will have that set up for receiving the bags of food.

- Please make sure your last name, first name is on each of the three bags. Please bring in three bags, even if by some very unusual, but possible, chance you had no food waste on one day.
- When there, use the sharpie to mark #1, #2 and #3 on the bags, or do that at home.
- If you are going to need another bag for our next round you can pick up one more.
- Initial by your name to show you were there, just like when picking up the bags.

Thank you for your cooperation in this Class Project.
Appendix F: Discussion Instructions

Discussion Two

Our standard for the Main Post is to write > 300 words (not including title or references) and then to reply with full comments (~100 0 words) to at least two others. You will need three references as explained below and these will need to be properly in-text cited and a reference list using any system such as AMA and APA.

The Rubric for Discussion Posts can be found in the upper right corner by clicking on the three dots.

Individual Topics on Food Waste

For this Discussion you will be researching a topic related to food waste and explaining it to your fellow Discussion Group classmates. You can pick any topic that impacts on food waste. Our Food System Lecture had a number of possible topics. Our lecture on Actions to prevent food waste did also. Possible topics are on a list that is in Module Two, and if you have another idea, then run that by TA Taylor or me.

You will find at least one Research or Review Article on your topic in a proper scientific journal. You will have at least two other references that can include more Research/Review or can be a quality website or information from an organization or a magazine/newspaper article. There are now many governments and organizations working in this space, so many reports, etc are available. These are called Gray Literature, and I find these reports/working papers quite useful. The purpose is to explain one area of the issue of Food Waste to your fellow students. Write in an appropriate way as to consumers with a college-level interest. Your three references will need to be properly in-text cited and a reference list given using any system such as AMA and APA.
Appendix G: Survey

Block 14

Introduction:
Welcome to our Class Survey for this semester. Please take your time to fill it out carefully as we would like to have good, useful data to come out of this survey. Working at a reasonable pace should have you done with it in about 10 minutes. The survey opens with some basic demographic questions, including your name. No name or other identifying details will be kept with the combined data, but it is needed on your survey.

Some of the questions will feel like they are asking close to the same thing, and they are, so read each one carefully. Watch the wording and the direction of the question/answers as some will be positive and some will be negative. You can also go back to a question to change the answer.

As a group of college students, you have many different variations of living and food arrangements such as dorm rooms but no cooking, to some cooking but mostly meal plans, to living at home and cooking regularly. Please respond to the survey with what seems to be the most reasonable answer given your typical arrangements, such as for the question about making a list for shopping, but you rarely shop for food, then think back to the last time you did shop and if you made a list. Questions relating to eating and leftovers can also refer to meals eaten out at dining halls or restaurants and leftovers brought back from a meal. Also answer honestly, not what you think you 'should' answer.

Please be sure to look back and make sure you have answered every question as missing data causes many problems with surveys making the results of less value. You are now ready to click Next and take the survey. Thank you.
Ms. Brummig
<table>
<thead>
<tr>
<th>Construct and Dimension</th>
<th>Questions</th>
</tr>
</thead>
</table>
| Food Waste Prevention Practices | I make a shopping list  
I plan what I am going to cook on each day of the week  
I make sure that food that is almost spoiled gets eaten first  
I plan the handling of food in my household  
I plan the buying and cooking of food |
| Planning of food shopping and use<sup>a</sup> | I buy products that I did not need  
I buy food that I had not planned to buy  
Regarding food, I consider myself an impulsive buyer |
| Overview of food in stock<sup>a</sup> | I know exactly what I have in stock  
I can see what I have in stock in one glance  
I make sure that food that needs to be eaten first lies in sight  
My shelves and/or fridge are organized |
| Impulse Buying<sup>a</sup> | I aim to not have any unnecessary leftovers  
I measure the ingredients of the meal  
I am precise in cooking the right quantities  
Before cooking, I think carefully about the quantities I need |
| Cooking precisely<sup>a</sup> | I finish my plate  
If I have put too much on my plate, I save the leftovers  
If I have cooked too much, I save the leftovers  
The leftovers I store, will be eaten  
All my prepared food will eventually be eaten (including leftovers)  
If I have leftovers on the plate or in the pan, then these will be saved |
| Using leftovers<sup>a</sup> | If I throw away food, then this is bad for the environment  
If I throw away food, then this has consequences for future generations  
If I throw away food, then this has consequences for less fortunate people  
If I throw away food, then this has consequences for the division of food across the world  
If I throw away food, then this has negative consequences |

<sup>a</sup>Van Geffen (REFRESH) unless otherwise stated
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>If I throw away less food, then I contribute to a better world</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If I throw away food, then this has financial consequences for my household</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **Attitude**        | *For me, throwing away food is:*  
*Throwing away food gives me a _____ feeling:* |                                                                                                        |
| **Social norm injunctive** | *Most people important to me disapprove of me throwing away food*  
*Most people important to me support me if I do not throw away food*  
*Most people important to me expect me to not throw away food* |                                                                                                        |
| **Social norm descriptive** | *Most people important to me throw away food regularly*  
*My neighbors and acquaintances throw away food regularly*  
*My friends throw away food regularly* |                                                                                                        |
| **ABILITY**         | **Skills**                                                                                             |
|                     | **Difficulty with assessing food safety**                                                              |
|                     | *I find it difficult to estimate if food is still safe to eat based on seeing, smelling, and/or tasting* |
|                     | *It is difficult to estimate if food is still safe to eat*                                             |
|                     | *Sometimes I do not know if food is still safe to eat*                                                 |
|                     | **Difficulty to cook creatively**                                                                     |
|                     | *I find it difficult to prepare a meal from (parts of) products I happen to still have at home*        |
|                     | *I find it difficult to prepare leftovers into new meals*                                             |
|                     | *I find it difficult to deviate from a (for me known) recipe*                                         |
|                     | *I leave food in the fridge for too long, because I do not know what to cook with it*                 |
|                     | **Difficulty to plan accurately**                                                                    |
|                     | *I find it difficult to estimate how much food I need to buy*                                         |
|                     | *I find it difficult to estimate how much food my household shall eat during the week*                |
|                     | *I find it difficult to estimate how much food I need to cook for a main meal*                         |
| I know the best was to keep fruit and vegetables fresh as long as possible |
| I know the best way to keep meat and fish fresh as long as possible |
| I know at which temperature I should keep the fridge to keep my food fresh as long as possible |
| I know how to keep products fresh as long as possible |

<table>
<thead>
<tr>
<th>Date-Label knowledge⁶</th>
<th>Visschers</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ‘use by’ date means that food products can become a health risk from this date on and should therefore no longer be consumed. *</td>
<td></td>
</tr>
<tr>
<td>Many retailers put the ‘sell-by’ date on easily perishable products so that they can sort them out in time.</td>
<td></td>
</tr>
<tr>
<td>The ‘best before’ date indicates how long a product will retain its specific characteristics (e.g. yogurt should remain creamy) when stored properly. Products can still be consumed for a longer time after this date.</td>
<td></td>
</tr>
</tbody>
</table>

**OPPORTUNITY**

**Time & Schedule**

<table>
<thead>
<tr>
<th>Prevalence of unforeseen events⁸</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sometimes I am too tired to prepare the meal for which I bought the products</td>
</tr>
<tr>
<td>Due to a busy schedule or last-minute plans, I sometimes do not prepare the meal for which I bought the products</td>
</tr>
<tr>
<td>Due to unexpected circumstances, I sometimes have food left over</td>
</tr>
<tr>
<td>Sometimes the meals during the week diverge from what I had planned</td>
</tr>
<tr>
<td>I often feel under time pressure in my day to day life</td>
</tr>
</tbody>
</table>

All items were answered on a 7-points scale.

⁶ Never– Rarely – Occasionally – Sometimes – Frequently – Usually - Every time
⁸ Strongly disagree - Disagree - Somewhat disagree - Neutral - Somewhat agree - Agree - Strongly agree
C₁ Very foolish – Foolish - Somewhat foolish Neutral - Somewhat wise - Wise -Very wise
C₂ Very irresponsible - Irresponsible - Somewhat irresponsible - Neutral - Somewhat responsible - Responsible - Very responsible
C₃ Very sad - Sad - Somewhat sad - Neutral - Somewhat happy – Happy - Very happy
C₄ Very guilty – Guilty - Somewhat guilty - Neutral - Somewhat indifferent – Indifferent - Very indifferent
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influences and interactions of household food waste through a video elicitation study. 