

**AN EVALUATION REVIEW:  
IMPROVING THE DIETS AND MINDS OF SCHOOL-AGED YOUTH  
THROUGH  
GARDENING- AND COOKING-ENHANCED NUTRITION EDUCATION**

by  
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First Reader

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Second Reader

**Abstract**

This paper provides an evaluation review of gardening- and cooking-enhanced nutrition education programs for a community organization in Durham, North Carolina: Durham Public Schools' Hub Farm. The review will outline the need for gardening- and cooking-enhanced nutrition education programs in relation to children's dietary patterns, and review three promising models from different organizations across the country, including an additional program description of the Hub Farm's "Seed to Belly" model. Finally, this paper will provide concrete recommendations for the Hub Farm, including recommendations around program and evaluation design, expected outcomes, measurement and more comprehensive school health models. The hope is that these recommendations will inform curriculum and program design, in order to ensure program effectiveness for school-aged youth in Durham.

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## **Background**

Over the past few decades, the United States has struggled to combat the negative impacts of an obesogenic environment, one where the majority of Americans have poor dietary patterns and low rates of physical activity.<sup>1</sup> Other factors, including the food and physical activity environment, lack of education and skills, and food marketing contribute to unhealthy eating and poor health outcomes for adults and children alike.<sup>1</sup> The impacts of this environment, and the resulting poor dietary patterns, are perhaps most strikingly seen in the rising rates of obesity, type 2 diabetes and other chronic diseases the U.S. population continues to experience; it is estimated that over half of Americans (roughly 117 million) have preventable chronic disease, many of which are related to eating patterns and lack of physical activity.<sup>1</sup> The Centers for Disease Control and Prevention (CDC) estimates that over 35% of adults in the U.S. are obese, and 60% of adults are considered overweight.<sup>2</sup> Amongst school-aged children, the trend towards obesity increases with age; over 8% of children age 2-5 years are obese, compared to over 17% of children 6-11 years, and over 20% of children 12-19 years.<sup>2</sup> Childhood obesity has been linked to poor dietary patterns, and is known to cause cardiovascular disease, type 2 diabetes mellitus, asthma and psychological problems.<sup>2</sup> In addition, childhood obesity has been known to carry into adulthood.<sup>3</sup> For these children, the consequences of not eating healthfully extend beyond discussions of obesity; studies have found that children's diets can impact their cognitive functioning, behavior and academic performance,<sup>4,5</sup> all of which can change the course of their futures.

An important determinant of children's dietary patterns is fruit and vegetable (FV) consumption. The Dietary Guidelines for Americans recommends a diet rich in fresh fruit and vegetables, along with whole grains and low-fat dairy products for people age two and older.<sup>i</sup> Additionally, the evidence-based, "My Plate" tool recommends that half of our plate at every meal is fruit and vegetables. Nationwide in the U.S., as is the case in many Western countries, children and adolescents are not eating the recommended levels of fruit and vegetables.<sup>6</sup> Knowledge of, willingness to try, and preferences for FV have been linked to increased FV consumption,<sup>7-8</sup> and increases in FV intake is known to play a role in preventing obesity, along with cardiac disease, cancers and other chronic conditions.<sup>9</sup> Additionally, children's self-efficacy skills and food asking behaviors, have been known to play an important role in determining dietary patterns.<sup>8</sup> Many studies have shown that food preferences established during childhood roll over into adolescence, and then predict food choices in adulthood; this makes establishing healthy dietary patterns early in childhood extremely important.<sup>6</sup>

### ***Disparities***

Many striking health disparities exist related to dietary patterns and consumption of FV. Factors such as socioeconomic status (SES), parental education level, and race/ethnicity have been known to predict fruit and vegetable intake, along with other food-related predictors such as preference for FV.<sup>6,10</sup> We see these disparities mirrored in rates of chronic disease; nationally, rates of obesity and chronic disease are higher

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<sup>i</sup> Defined as: "The Dietary Guidelines for Americans recommend a diet rich in fruits and vegetables, whole grains, and fat-free and low-fat dairy products for persons aged 2 years and older. The guidelines also recommend that children, adolescents, and adults limit intake of solid fats (major sources of saturated and trans fatty acids), cholesterol, sodium, added sugars, and refined grains."  
<http://www.cdc.gov/healthyschools/nutrition/facts.htm>

amongst certain racial/ethnic groups, namely Black and Latino populations.<sup>11</sup> Similarly, communities in low-income areas are disproportionately affected by food deserts and have a greater likelihood of negative diet-related health outcomes including obesity and other chronic diseases.<sup>12</sup>

Regionally, we see higher levels of chronic disease such as obesity and type 2 diabetes in the Southeastern United States; in North Carolina (NC), over 40% of adults are obese (2014).<sup>13</sup> Obesity rates remain high at 16.1% for 10-17 year olds, which puts the state rank at the 18<sup>th</sup> highest in the nation; the state has the 7<sup>th</sup> highest rate (15.4%) of obesity for low-income children 2-4 years old.<sup>13</sup>

It is also important to recognize that these same groups experience many other types of health and education disparities. Though academic achievement is impacted by a *wide* variety of social factors, it is worth noting that Black, Latino and low-income populations experience disparities in educational attainment, often characterized by lower standardized test scores and higher high-school drop-out rates.<sup>14</sup> While these phenomena are by no means the result of poor dietary patterns, it makes prioritizing the health of these populations all the more important and urgent.<sup>14</sup>

While a multifaceted approach, one that touches on all levels of the socioecological framework, is needed to address these complex problems, this paper will focus on interventions at the individual level, aimed at improving the “education and skills” gap that exists for students in many disparate communities, in order to promote healthful eating and living. Specifically, gardening- and cooking-enhanced nutrition education programs for school-aged youth, aimed at improving knowledge, attitudes, preferences, and on building self-efficacy and asking skills, will be reviewed.

### **Gardening- and Cooking-Enhanced Nutrition Education**

School-based nutrition education programs are thought to be one method of combatting the negative effects associated with the unhealthy diets of school-aged children by targeting nutrition behavior change.<sup>15</sup> The Southern Regional Nutrition Education and Obesity Prevention Center of Excellence has identified comprehensive nutrition education programs occurring in a single setting, and school nutrition programs to promote healthy eating, as effective strategies for changing children's dietary patterns.<sup>16</sup> While the literature on the effectiveness of these types of programs is scant, certain interventions have proven to be impactful in key areas: cooking education and garden-based learning interventions.

#### ***Cooking education***

Another common approach to changing dietary patterns and promoting healthful eating amongst people of all ages is through cooking programs.<sup>17</sup> The literature on these types of programs suggests that cooking programs can positively impact children's "food-related preferences, attitudes and behaviors."<sup>17</sup> Additionally, some evidence suggests that children are more willing to try a new food if they have grown or cooked it themselves.<sup>17</sup> The literature also indicates that children's attitudes towards cooking significantly increase post-cooking intervention.<sup>17</sup> Many cooking programs do, however, vary by type and length. Programs examined in one CDC systematic review, ranged in length from two sessions to regular sessions over two years; these programs' impact on the aforementioned outcomes also varied.<sup>17</sup> The authors noted that program length and

type, as well as the differing evaluation methods, made it difficult to establish “best practices” for these programs.

### ***Garden-based learning***

Similarly, garden-based learning has been known to have an effect on: overall academic achievement, improvements in life skills, self-esteem, social skills and behavior, and understanding of agriculture and the environment.<sup>18</sup> Additionally, it has proven to positively impact knowledge of nutrition, food preferences, and the consumption of fruit and vegetables.<sup>18</sup> A variety of studies have shown that school garden initiatives have positively impacted students’ science achievement and food behaviors.<sup>19-21</sup> Additionally, place-based learning (occurring in the community) that is focused on local ecology, has also resulted in improvements in student academic achievement, including reductions in unsatisfactory standardized test scores in variety of subjects, as one low-income Black community in Louisiana experienced.<sup>20</sup>

The combination of cooking-enhanced nutrition education with garden-based learning is one innovative approach to health education that has gained popularity in recent years.<sup>21</sup> While the existing body of literature on these types of programs is limited, studies have demonstrated that some interventions can be effective in improving a variety of outcomes for children. The conceptual models from two gardening- and cooking-enhanced nutrition education program (see Appendix A) describe the ways in which these types of interventions are thought to affect individual-level behavior change. A number of previous studies examining nutrition education interventions with a gardening component have demonstrated an impact on FV knowledge, preferences, willingness to taste, attitudes, self-efficacy and some have been able to measure increases in intake.<sup>3</sup>



<sup>21,22</sup> One review of garden-based nutrition education programs highlighted a need for more studies and more rigorously designed evaluations in order to contribute to the promising literature on these types of interventions, and to showcase the many important impacts they may have on the dietary patterns and learning environment for youth.<sup>21</sup> In the following section, select gardening- and cooking-enhanced nutrition education interventions will be reviewed and their outcomes discussed. Programs were chosen based on criteria including: similarity to Hub Farm's model and target population, diversity in evaluation design, and year published (with newer studies included).

### **Program Reviews:**

#### ***LA Sprouts***

LA Sprouts is a 12-week gardening- and cooking-enhanced nutrition education program, specifically geared towards Latino youth, in Los Angeles, California. This program has gone through numerous evaluation iterations and has shown promising results in certain outcome areas. The intervention is based on general Social Cognitive Theory (SCT), which is commonly used to explain adult behaviors, including dietary behaviors. While SCT has been used to explain children's dietary behaviors, the literature on the effectiveness of using this theory to describe the behaviors of children is somewhat inconclusive.<sup>8,23</sup> Additionally, this intervention is based on Self-Determination Theory (SDT) which ascertains that each person has three basic psychological needs: competence, relatedness, and autonomy; a key principal being that change comes with increased autonomy and perceived competence and is more sustainable due to the intrinsic nature of the change.<sup>8</sup> This program uses these theories to explain the dietary

behaviors of children, linking personal behaviors such as self-efficacy, preferences and outcome expectations, to increases in fruit and vegetable intake.<sup>8</sup>

The initial 2011 pilot study for this program was a quasi-experimental intervention study; 104 fourth and fifth grade students at one public elementary school in Los Angeles Unified School District participated, all were enrolled in afterschool care programs. This school was selected due to its close proximity to a community garden, and because 94% of students qualified for free or reduced-lunch. Forty of these students participated in the intervention program, 77 did not. The curriculum consisted of a 12-week cooking- and gardening-enhanced education program (See Appendix B for a more detailed description). Additionally, parents of LA Sprouts participants were also offered three nutrition/gardening/cooking classes at the elementary school, around pick-up time.<sup>24</sup> At the end of the study, the control subjects and their families were offered a comprehensive nutrition/cooking/gardening workshop as an “abbreviated delayed intervention.” Researchers collected data and administered pre-and post-tests one week before and one week after the program.

*Measurement:*

<i>Demographics:</i> Age, ethnicity, SES was measured by asking parents’ education level, use of a computer at home, mother’s ownership of a car.
<i>Acculturation:</i> Acculturation, Habits and Interests Multicultural Scale for Adolescents was used (AHIMSA). Validated for Latino youth.
<i>Motivation for Healthy Eating:</i> Motivation for Healthy Behaving Measure, from the Treatment and Self-Regulation Questionnaire. Validated in a pediatric population, adapted for use to measure motivation to eat fruits and vegetables; 17 items; 2 subscales: Autonomous/intrinsic motivation, controlled/extrinsic motivation.
<i>School Performance:</i> School Engagement Questionnaire – validated 15 question instrument, asks students to rate items on a 5-point scale. Subscales: Behavioral, Emotional and Cognitive Engagement. The scale has met and exceeded the criterion for reliability measured by Cronbach’s alphas.

<i>Attitudes about, preferences for, and self-efficacy to eat and cook FV:</i> Combined measure assessing attitudes about, preferences for, perceptions and self-efficacy to eat and cook FV – modified from validated questionnaires used in pediatric population. See Appendix C for a more detailed description.
<i>Anthropometrics:</i> Height, Total body fat % (Tanita Body Fat Analyzer), Age and sex-specific BMI percentiles were used, Waist circumference, Blood pressure.
<i>Dietary Intake:</i> 2007 Block Food Screeners for Ages 2-17, 41 items ask about food eaten yesterday. Designed for self-administration with support from teacher or parent if needed; take approximately 10-12 minutes to complete.

*Results:*

2011
<ul style="list-style-type: none"> <li>- Increased dietary fiber intake (particularly in the overweight subgroup)</li> <li>- Decreased diastolic blood pressure</li> <li>- Reduction in BMI (for overweight subgroup)</li> <li>- Less weight gain (for overweight subgroup)</li> </ul>
2012
<ul style="list-style-type: none"> <li>- Improved preferences for vegetables, even higher among the obese/overweight subgroup, and even higher in the female subgroup.</li> <li>- Participants responded with higher values on all questions assessing attitudes and perceptions, did not hold significance after adjustment for multiple comparisons.</li> <li>- Participants had a greater increase in self-efficacy, though not statistically significant.</li> <li>- Post hoc analyses: reductions in weight were associated with increase in preferences for vegetables and fiber from fruit.</li> </ul>
2015 (RCT)
<ul style="list-style-type: none"> <li>- Increased identification of vegetables</li> <li>- Increased knowledge of gardening and nutrition</li> <li>- More likely to garden at home</li> </ul>

Two studies used the pilot study data to assess a variety of different outcomes (in 2011 and 2012). Outcomes that were significantly impacted in the first study included: increased dietary fiber intake (particularly for the overweight/obese subgroup), decreased diastolic blood pressure, reduction in BMI for overweight subgroup, less weight gain for overweight subgroup. In the second study, significant outcomes included: preferences for

vegetables (particularly amongst the overweight/obese and female subgroups). Changes were also seen in attitudes and perceptions of FV, cooking, and gardening, and increases in self-efficacy, though these differences were not statistically significant after adjusting for multiple comparisons. In both studies, the impact of a short-term intervention (12 weeks) was most noticeable in the overweight/obese subgroups, arguably the most at-risk subgroup in the study. Strengths of these studies include a quasi-experimental design, and the relatively low-cost and feasibility of pilot studies. Limitations include less rigorous designs and convenience samples that may be subject to biases. Since this initial pilot evaluation, LA Sprouts has undergone a Randomized Control Trial (RCT) evaluation (2015). This more rigorous study yielded promising results; LA Sprouts participants improved in the areas of identification of vegetables, knowledge of gardening and nutrition, and were more likely to garden at home.<sup>8</sup> This program shows promising results for impacting many determinants of dietary behaviors.

### ***Idaho Schools – Nutrition in the Garden Program***

This 2007 study, conducted by McAleese and Rankin, attempted to evaluate the impact of a 12-week gardening-enhanced nutrition education intervention amongst 6<sup>th</sup> graders in Southeast Idaho middle schools.<sup>21</sup> The study used a nonequivalent control group design, schools were selected as convenience samples, the control and first experimental group were randomly assigned, while the second experimental group was chosen based on garden availability;<sup>15</sup> 99 sixth graders participated. In this study, researchers attempted to isolate how impactful the *gardening* aspect of this intervention was on adolescents' FV consumption by evaluating three groups; one received no nutrition education, one received basic nutrition education, and one received gardening-

and cooking-enhanced nutrition education. The nutrition curriculum used in both experimental schools was the “Nutrition in the Garden” curriculum developed and validated by Lineberger and Zajicek.<sup>15</sup> This study does not cite a behavioral theory upon which the intervention is based. It does, however, mention evidence in the literature that supports the positive impact garden-based learning has on promoting healthful eating through improving FV knowledge, preferences, and attitudes. The primary expected outcome of this study was that students receiving garden-enhanced nutrition education would increase their FV consumption more than those receiving the same nutrition education without a gardening component.

Students participating in the study completed three validated consecutive 24-hour recall food workbooks in class before the intervention began, and post-intervention. The results of this study showed the highest increase in daily intake of fruits and vegetables amongst those participating in the nutrition education + gardening intervention. Additionally, students in this group had significantly higher increases in dietary fiber, vitamin A and vitamin C intake. Strengths of this study included the pilot intervention quasi-experimental design, with two experimental groups; this allowed for the researchers to specifically assess the impact of the gardening aspect of the curriculum. Additionally, this study was able to demonstrate a significant increase in FV consumption, using dietary fiber intake as a proxy, and increases in Vitamins A and C. Limitations include the lack of randomization, which makes this a less rigorous design than an RCT, and the validity of the three 24-hour food recall workbooks (compared to a validated FFQ) since these workbooks have not been assessed in the literature.

*Measurement:*

- Three 24-hour food recall workbooks completed pre- and post-intervention

*Results:*

- Increase in daily intake of FV highest in the nutrition + garden program
- Increases in fiber intake
- Increases in Vitamin A, Vitamin C

***YMCA – Delicious and Nutritious Garden***

A 2009 study by Heim et al looked at the effectiveness of the *Delicious and Nutrition Garden* intervention, delivered to students attending a YMCA summer camp to 4<sup>th</sup> to 6<sup>th</sup> grade children.<sup>25</sup> The program curriculum involved a 12-week gardening- and cooking-enhanced curriculum, consisting of twice weekly visits to the garden. Weekly activities included: FV taste tests, preparation of fruit and vegetable meals and snacks, lessons based on evidence-based nutrition standards, and recipes and newsletters sent home to families. This program was based on Social Cognitive Theory and key principles of experiential learning. The primary expected outcomes were increased participant satisfaction from baseline to post-test, increased FV exposure, preferences, self-efficacy, asking behavior, and availability of FV at home. This intervention aimed to provide children with multiple exposures to less common FVs, as the literature suggests that it takes anywhere from 5-10 exposures in order to increase children's acceptance of new foods. Additionally, this program sought to build on previous studies findings' that described the impact that children's preferences and asking behavior can have on the home food environment. This study subsequently asked about the availability of FV in the home in a pre- and post-parent survey.

A convenience sample of n=93 students was selected and, since this was a pilot study, a pre-post test design was used. Measures for the pre-post student tests, and parent surveys were developed and adapted based on studies by Domel, Neumark-Sztainer, and Haines,<sup>ii</sup> and were reviewed by registered dietitians for approval. Results from this study demonstrated high levels of enjoyment for taste-testing FV, preparing FV, working in the garden, and learning about FV. Additionally, there were significant increases in the number of FV ever eaten, preference for vegetables, and in FV asking behavior. Strengths of this study included the process evaluation questions about participant satisfaction, outcome questions based on validated scales, and the relatively low-cost, pilot evaluation design. Limitations include the small sample size, the convenience sample, and non-experimental design.

*Measurement:*

Process

7 questions - asked children about their personal level of enjoyment for each intervention activity on a Likert-scale and included 4 open-ended questions.

Outcome

*FV Exposure*

Assessed by asking participants if they have ever eaten 11 specific vegetables, and 5 specific fruits (Yes/No).

*Preferences*

3 scales created including items taste-tested and grown in the garden: 11-item vegetable, 5-item fruit, 8-item snack scale. The FV scales were created based on scales developed by Domel and colleagues; these scales appeared in many studies reviewed.<sup>25</sup>

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<sup>ii</sup> D. Neumark-Sztainer, M. Wall, C. Perry, M. Story. Correlates of fruit and vegetable intake among adolescents: Findings from project EAT. *Prev Med*, 37 (2003), pp. 198–208; J. Haines, D. Neumark-Sztainer, C.L. Perry, P.J. Hannan, M.L. Levine, M. Story. V.I.K. (very important kids): A school-based program to reduce teasing and risk for weight-related disorders. *Health Educ Res*, 21 (2006), pp. 884–895; S.B. Domel, W.O. Thomson, H.C. Davis, T. Baranowski, S.B. Leonard, J. Baranowski. Psychosocial predictors of fruit and vegetable consumption among elementary school children. *Health Educ Res*, 11 (1996), pp. 299–308; S.B. Domel, T. Baranowski, H. Davis, S.B. Leonard, P. Riley, J. Baranowski. Measuring fruit and vegetable preferences among 4th- and 5th-grade students. *Prev Med*, 22 (1993), pp. 866–879.

*Self-Efficacy*

Assessed with a 5-item scale including questions such as “How sure are you that you could eat fruit as a snack when you’re hungry?”

*Asking Behavior*

Assessed using a 7-item scale asking “In the last week did you ask someone in your family to...”

*Home Availability*

Assessed using a 7-item scale in the child survey by asking “How often are the following true? (ex: In my home there are cut up FV...etc.)

*Demographics*

Measured age, grade level, sex, race/ethnicity – assessed in the parent survey.

*Results:*

**Process:**

High levels of enjoyment in the intervention activities

- Most children (97.8%) enjoyed taste-testing fruits and vegetables
- Children enjoyed preparing fruit and vegetable snacks (93.4%)
- Children enjoyed working in their garden (95.6%)
- Children enjoyed learning about fruit and vegetables (91.3%)

**Short-term Outcomes:**

- Increase in the number of fruits and vegetables ever eaten
- Increase in vegetable preferences
- Increase in fruit and vegetable asking behavior at home

**DPS Hub Farm – Seed to Belly and DINE**

The Durham Public Schools Hub Farm was founded in 2012 as a centrally located 30-acre farm 30-acre outdoor learning lab (with a ~1 acre production garden, 2 ponds and surrounding forests) where students can “learn about food production and land stewardship through hands-on, experiential learning.”<sup>26</sup> The mission of the Hub Farm is to bridge the knowledge gap between where and/or how food is grown and the food children see in the kitchen on their plates. One of their main initiatives is the Seed to Belly (STB) program, which offers gardening- and cooking-enhanced nutrition



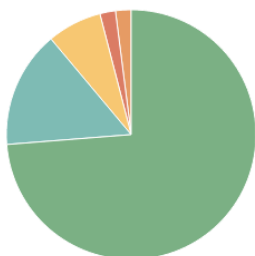
education. The Hub Farm offers this program in collaboration with Durham's Innovative Nutrition Education (DINE) for eligible schools (those that have 50% or more students receiving free/reduce price lunch), and on their own for ineligible schools. DINE is a school and community-based nutrition education program that is funded by the Supplemental Nutrition Assistance Program (SNAP) via SNAP-Ed, and by the Durham County Health Department.<sup>27</sup> The ultimate goal of the STB program is to improve children's nutrition and overall health in Durham County, NC, where 32.0% and 11.0% of high school students were considered overweight and obese, respectively.<sup>28</sup> Currently, the program runs year-round (although it is visited less frequently in the summer and winter). Participation in the program is currently teacher-driven; classroom teachers can arrange to bring their classes out to the farm where the STB programming takes place.

The program is promoted to all elementary and middle schools in the DPS system, however, schools that attend most regularly are located within close proximity to the farm. Eno Valley Elementary School participates in STB programming frequently. Over 80% of students at Eno Valley are Black, 15% are Latino and over 90% receive either free or reduced-price lunch (see Figure 1), making this a program that serves the youth groups who are experiencing aforementioned disparities in FV consumption and poor health outcomes resulting from dietary patterns at a national level.

Students begin their time on the farm harvesting from the farm's planting fields. Then, students become farmer-chefs, learning what food grows during which seasons in NC and how to harvest foods straight from the earth. In collaboration with the DINE team, students receive a lesson in nutrition and healthy eating, and then cook a healthful dish as a team, learning essential cooking skills like chopping, measuring, and

collaboration. Finally, students taste the food together and take home recipes and ingredients to share with their families. An additional part of this program is the Nature’s

### Student diversity



	This school	State average
Black	73%	26%
Hispanic	15%	14%
White	7%	52%
Asian	2%	3%
Two or more races	2%	4%
American Indian	0%	1%
Pacific Islander	0%	0%

Source: [See notes](#)

### Students by group

	This school	State average
Female	48%	49%
Male	52%	51%
Students participating in a free or reduced-price lunch program	94%	56%

Source: [See notes](#)

**Figure 1.** Student Demographics: Eno Valley Elementary School, Durham, NC  
<http://www.greatschools.org/north-carolina/durham/621-Eno-Valley-Elementary/details/#Enrollment>

Accompaniment, where students spend time in nature, exploring the Hub Farm and surrounding forest area. This seeks to promote physical activity and appreciation of nature. See Appendix D for a more detailed program outline. Currently, the STB program is working on collecting monitoring data but does not evaluate the larger impact of the program on student outcomes.

The DINE program exists separately from the Hub Farm and the STB program, and serves many at-risk schools across the DPS system. DINE uses an eight-lesson “in-house” curriculum that is based on the U.S. dietary guidelines and on MyPlate standards; there are currently three different curricula, one for K/1<sup>st</sup>, one for 2<sup>nd</sup>/3<sup>rd</sup> and one for

4<sup>th</sup>/5<sup>th</sup> grade.<sup>27</sup> Each lesson includes taste tests, educational reinforcements, and student/parent handouts as well. Other components of DINE include a school wellness program in which nutritionists serve on wellness committees and the Smart Steps walking program. Additionally, DINE offers some afterschool programming which varies by school. The DINE team does evaluate (both process and outcome evaluations) the eight-session nutrition lessons they provide to students in the classroom. Currently, DINE uses a pre- and post-test model to evaluate student knowledge of food groups, preferences for FV, willingness to try new foods; the tests vary by grade-level curricula. The 2<sup>nd</sup>/3<sup>rd</sup> grade test asks students to recall the type of milk, amount of vegetables, and amount of fruit, unhealthy snacks, sugary beverages they ate yesterday. The test for the 4<sup>th</sup>/5<sup>th</sup> grade students also includes information about reading food labels, and asks students how often they read them. These pre-tests are sent out in the Fall before classes begin, and the post-tests are sent out in the Spring. Additionally, a parent pre- and post-survey is sent out in the Fall and Spring.<sup>27</sup> To the author's knowledge, neither Seed to Belly nor DINE programs have been evaluated as part of an academic research study.

### **Summary of Opportunities for Development, Evaluation Designs, and Tools for**

#### **Hub Farm**

##### ***Opportunities for Development***

Recommendations for the Hub Farm's Seed to Belly program include suggestions for program and evaluation design and measurement tools, many of which could "seed" opportunities for grant or development-based funding, or possibly other academic research. See Figure 2 for a full list of recommendations from this review, and others

adapted from a 2009 systematic review of garden-based nutrition intervention programs by Robinson-O'Brien et al. One commonality amongst effective programs that are similar to STB, was a length of 12 weeks (or a full semester). This seems to be the amount of time (or “dose”) needed to make a true impact on the participating children; many of the programs had weekly, or twice weekly garden visits during the intervention. Another recommendation for Hub Farm would be to document and standardize the curricula and compare (both DINE curricula and their own) to those that have been proven to be evidence-based. When choosing outcomes to measure, Hub Farm should consider focusing on the outcomes that have been significant in similar programs, often the determinants of dietary behavior; one outcome that was consistently higher in intervention groups across the different types of studies reviewed was increased preferences for vegetables. A complete list of significant outcomes is listed in Appendix C.

**Planning:**

- Include a needs assessment to determine what specific schools, and student populations are experiencing in DPS.
- Involve a variety of stakeholders to ensure the intervention is interdisciplinary and touches on all levels of the socioecological framework.
- Ground the intervention in theory – how is this program expected to change behavior? What theory is it based on?
- Use both quantitative and qualitative (interviews, focus groups) to guide planning.
- Document and standardize all curricula before evaluation begins – Determine how many in-class DINE sessions and how many STB sessions students will receive.
- Interventions should be ~12 weeks long.

**Study Design & Evaluation Methodology:**

- Convene a workgroup to determine evaluation design and methodology.
- Use previously validated tools, such as those listed in Appendix C, and/or pilot test tools with a small group prior to use in the evaluation. If creating new tools, use validated tools and adapt to fit program needs.

- Include large sample sizes to account for variation by sex, race/ethnicity, and other demographic categories.
- Evaluate the independent effects of the *garden-enhanced* nutrition education program vs. traditional nutrition education.
- Evaluate which aspects of the gardening process were most beneficial/impactful.
- Use control groups who do not receive the intervention; if possible do a Randomized Control Trial (RCT) with many groups receiving each condition (6 groups per condition is ideal).
- Longitudinal research or impact evaluations to see if the changes remain or have changed after time has passed, are beneficial.

Outcome Measures:

- Evaluate the determinants of dietary behavior change, as well as dietary intake and other health-related factors.
- Evaluate which aspect of the gardening intervention is most critical: planting, harvesting, food preparation, nutrition-education lesson.

Sustainability:

- Determine the “facilitators” and “barriers” to long-term sustainability.
- Collect process evaluation data (about how the program is being implemented) for documentation and future iterations of the program.
- Encourage the linkage of school subjects/learning objectives to the garden education and assess and monitor outcomes.

**Figure 2.** Recommendations for designing, implementing and evaluating gardening- and cooking-enhanced nutrition education programs for youth. *Adapted from: “Impact of Garden-Based Youth Nutrition Intervention Programs: A Review.”*<sup>21</sup>

### ***Expected Outcomes***

- Increase in exposure to FV
- Increase in vegetable preferences
- Increase in positive attitudes and perceptions about FV
- Increase in self-efficacy, specifically FV asking behavior
- Increase in dietary fiber intake

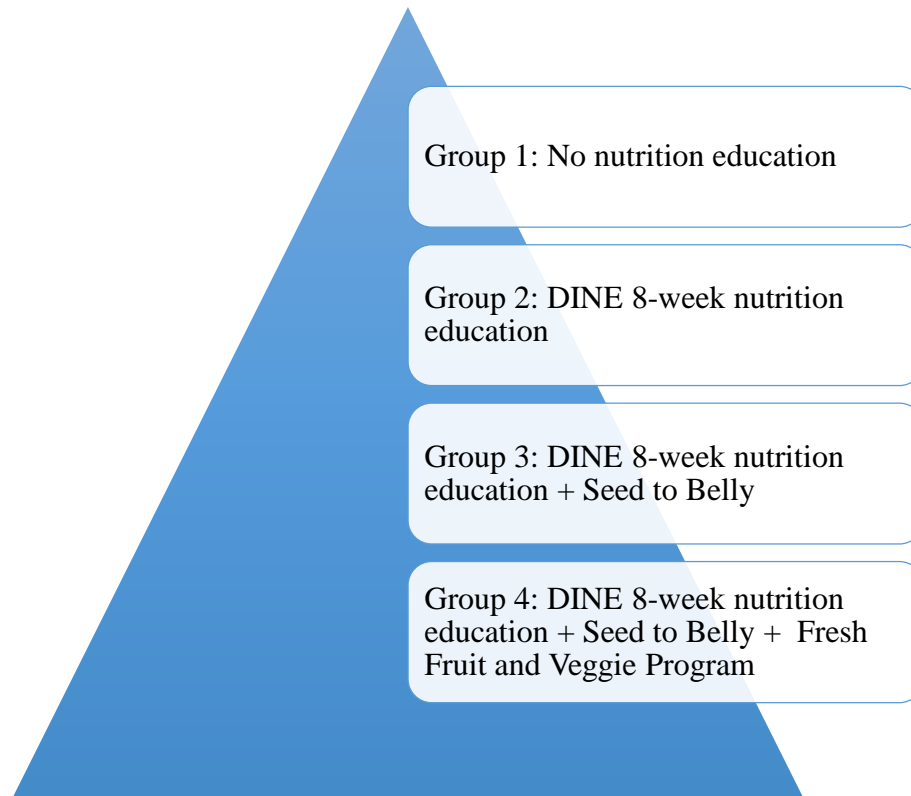
### ***Evaluation design***

It is important to note that programs included in this review were comprised of both *multi-session* nutrition education, and cooking and gardening education, therefore

the following recommendations are for the STB program in collaboration with DINE. Since STB will be evaluated for the first time, a pilot intervention design is suggested. This might include a program design similar to the YMCA *Delicious and Nutritious Gardens* evaluation that consisted of a process evaluation to capture the popularity/enjoyment of the program, and a simple outcome evaluation measuring knowledge, attitudes, and preferences for fruit and vegetables. A mix of quantitative and qualitative methods is suggested; as the YMCA program demonstrated, qualitative data regarding students' experiences and enjoyment yielded or provided useful information. If this pilot study yields promising results, a next step in evaluation design might be to consider a more rigorous study design. A quasi-experimental or randomized control trial (RCT) would both be adequate options, with the RCT providing a more rigorous assessment as subjects would be randomized into different control or experimental groups (which helps limit selection bias). If choosing one of these options, the YMCA program and the 2011 and 2012 LA Sprouts studies are models of quasi-experimental designs, and the 2015 LA Sprouts study is a good example of a RCT.

An ideal design, after the initial pilot study, might be comparable to the Idaho schools model described previously, consisting of three groups (one control and two experimental). The control group would have no nutrition education intervention, and researchers would need to ensure that there were no other competing efforts happening in the classroom or school. The first experimental group would receive the 8-week in-class DINE nutrition education only, and the third group would receive DINE nutrition education, complimented with multiple visits to the Hub Farm for the STB gardening, cooking and physical activity lessons. An additional experimental group could receive

DINE, Hub Farm, and an existing intervention the “Fresh Fruit and Veggie Program” that brings fresh fruit and vegetables to school cafeterias; this intervention would go beyond the scope of individual dietary behaviors and begin to address some of the issues around *access* to fresh FV, discussed in more detail in the recommendations and conclusions section. See Figure 3 for a sample of an ideal quasi-experimental design.



**Figure 3.** Sample quasi-experimental evaluation design for Hub Farm.

### ***Measurement***

In the majority of gardening and cooking-enhanced nutrition education programs reviewed, a validated pre- and post-test was administered to students to measure preferences, attitudes, self-efficacy and perceptions about FV, cooking, and gardening (determinants of dietary behavior). See Appendix C for a more detailed description of these measures. For the programs that measured food intake, a validated Food Frequency

Questionnaire was used to assess FV intake; tools mentioned in this review include the 2007 Food Screeners Questionnaire for Ages 2-17, and a three-part food recall workbook developed by Barbara Jendrysik. In a review of food frequency questionnaires, one study found that the most valid tools “did not assess portion size, measured a shorter time span (i.e., previous day/week), was of medium length (i.e., similar to 20-60 items), and was not administered to the child’s parents.”<sup>29</sup> While it would still be helpful to include parent surveys, they should focus on the food environment, child asking behaviors, rather than on recalling their child’s diet. One option for the Hub Farm could be to collaborate with DINE to use and adapt their existing evaluation tools (pre- and post- student tests and parent surveys). In all cases, it would be vital to standardize the number of visits to Hub Farm, and the Seed to Belly curriculum for the students receiving STB w/DINE, *and* to incorporate questions related to cooking and gardening into the assessments (see Appendix C for sample questions).

### ***Comprehensive School Health model***

It is important to consider the literature that suggests that more comprehensive models, touching on environmental and policy changes, may be more effective in helping children achieve healthful diets than nutrition education programs alone. Other evidence-based strategies identified by the Southern Regional Nutrition Education and Obesity Prevention Center for Excellence include: changing access and availability to favor healthy foods, increasing use and purchasing of food from local farms, and community-wide campaigns.<sup>16</sup> One such community-wide campaign is the Comprehensive School Health (CSH) model. This model has been recognized as a “best practice” and has been successfully adapted into programs such as the evidence-based 2-year APPLE Schools



program in Alberta, Canada, which targets socioeconomically disadvantaged schools.<sup>30</sup> Participating schools take part in school, home and community level environmental changes aimed at improving children's eating behaviors and levels of physical activity, such as: nutrition lessons for students and parents, cooking clubs, nutrition and physical activity policies, school breakfast programs, community gardens, and many other events.<sup>30</sup> Results included: "APPLE Schools have increased student's vegetable and fruit intake by 10%. The students are 35% more active and are 40% less likely to be obese."<sup>31</sup> This type of comprehensive program might be a future goal for Durham Public Schools, in collaboration with Hub Farm and the DINE team.

## **Conclusions**

In conclusion, gardening- and cooking- enhanced nutrition education programs may have the ability to make an important impact on children's dietary behaviors. The DPS Hub Farm's Seed to Belly program represents one innovative program that may have the ability to change the health and education trajectory for many students in the Durham Public Schools system. A well-designed evaluation might be a first step in determining precisely how effective this program has been with the children and adolescents in the DPS system. By addressing dietary behaviors at the individual level, these types of programs may serve as *one part* of a multilevel intervention to help reduce the risk of many problematic outcomes associated with poor diets such as: overweight and obesity, type 2 diabetes, and a variety of cognitive and academic concerns. It is important to note, however, that many studies suggest that interventions targeting individual-level, social-cognitive variables alone, may not have a lasting impact on

improving children's dietary behaviors.<sup>23,30</sup> This program has the potential to make higher level change, particularly if they move towards an intervention that incorporates many levels of the socioecological framework, such as environmental and policy changes that might address some of the social determinants behind these nutrition-related health outcomes. The DPS Hub Farm has already begun to forge important partnerships with groups such as DINE and other county health department sectors; collaboration with these groups has the potential to yield very impactful results.

While this approach is only one aspect of a solution to address a very complex problem, it is one that has the potential to be a part of a larger, more comprehensive community health movement for Durham's youth. This type of multi-faceted intervention is much needed to change the course of the future, particularly for those disparate youth living in Durham County, who are currently suffering from the consequences of the obesogenic environment in which they are immersed.

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## Appendix A

### *LA Sprouts Conceptual Model*

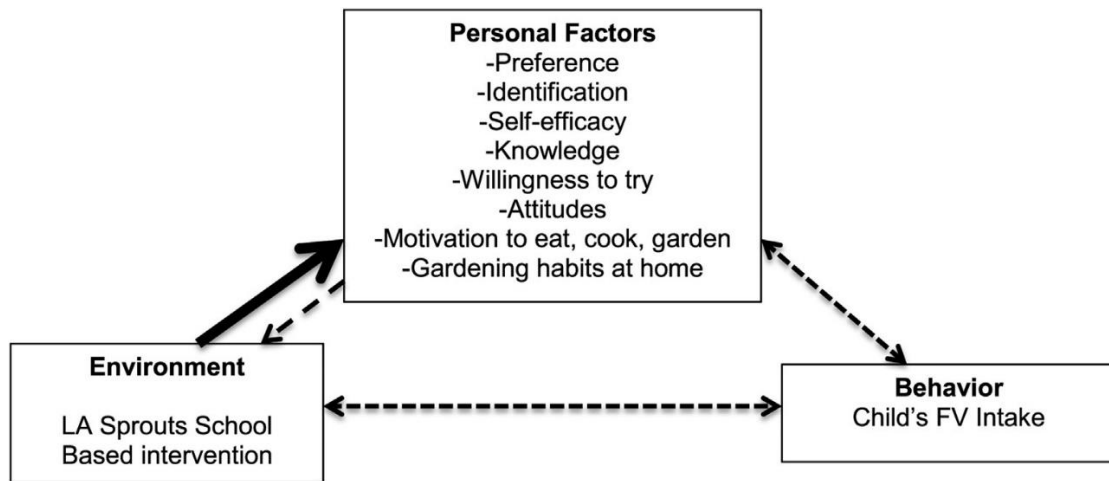


Figure 1. Conceptual framework of LA Sprouts. The solid arrow denotes the relationship for this data analysis. FV indicates fruit and vegetables.

Davis JN, Martinez LC, Spruijt-Metz D, Gatto NM. LA Sprouts: A 12-Week Gardening, Nutrition, and Cooking Randomized Control Trial Improves Determinants of Dietary Behaviors. *J Nutr Educ Behav*. 2016;48(1):2-11.e1. doi:10.1016/j.jneb.2015.08.009.

### YMCA Delicious and Nutritious Garden Conceptual Model

Variables	Description of Intervention Component
<ul style="list-style-type: none"> <li>● Food consumption habits</li> <li>● Tasting of fruits and vegetables</li> <li>● Ability/skill to prepare fruits and vegetables for meals/snacks</li> </ul>	<p><i>Behavioral Factors</i></p> <ol style="list-style-type: none"> <li>1. Gardening twice per week (planting, weeding, observing, harvesting)</li> <li>2. Weekly fruit and vegetable taste-testing</li> <li>3. Preparation of 12 fruit and vegetable recipes</li> <li>4. Children provided with a fruit and vegetable cookbook at the end of camp</li> </ol>
<ul style="list-style-type: none"> <li>● Self-efficacy <ul style="list-style-type: none"> <li>○ To try new fruits and vegetables when available</li> <li>○ To prepare healthy meals/snacks with fruits and vegetables</li> <li>○ To ask for fruits and vegetables at home</li> <li>○ Confidence to eat fruits and vegetables when other palatable foods are available</li> </ul> </li> <li>● Like/dislike for fruits and vegetables</li> <li>● Like/dislike for high-fat/high-sugar foods</li> </ul>	<p><i>Personal Factors</i></p> <ol style="list-style-type: none"> <li>1. Encouraged children to taste with all their senses</li> <li>2. Weekly discussion encouraged children to ask for the fruits and vegetables taste-tested, grown, and/or prepared</li> <li>3. Perceived ownership of the fruits and vegetables grown in the garden and the fruit and vegetable recipes prepared</li> <li>4. Children provided with a fruit and vegetable cookbook at the end of camp</li> <li>5. Children learned about: the origins of food, plant parts, the environment, nutrient needs of plants, and MyPyramid for Kids</li> <li>6. Children practiced setting goals and role-played ways to increase fruit and vegetable intake when presented with common barriers</li> </ol>
<ul style="list-style-type: none"> <li>● Availability of fruits and vegetables at camp and home</li> <li>● Accessibility of fruits and vegetables (eg, in child's reach on kitchen counter or cut up in refrigerator)</li> <li>● Availability and accessibility of high-fat/high-sugar foods at day camp and at home</li> <li>● Peers and family eat fruits and vegetables</li> <li>● Fruits and vegetables present at mealtime and for snacks</li> <li>● Parental support for fruit and vegetable consumption</li> <li>● Family ability to buy fruits and vegetables</li> </ul>	<p><i>Socioenvironmental Factors</i></p> <ol style="list-style-type: none"> <li>1. Children were mobilized as agents of change for their home food environment by sharing garden experiences and asking for fruits and vegetables at home</li> <li>2. Twelve opportunities to prepare a fruit and vegetable meal/snack (Two recipes were shared with younger campers to promote peer modeling of fruits and vegetables)</li> <li>3. Children brought home vegetables grown in their garden to be shared with family</li> <li>4. Weekly family newsletters: (a) summarized the week's activities; (b) provided helpful information to parents/primary caregivers to increase family's fruit and vegetable intake; (c) presented a take-home challenge (eg, find and eat a new vegetable at the farmers' market this weekend); (d) offered a simple fruit and vegetable recipe</li> </ol>

**Figure.** Behavioral, personal, and socio-environmental factors affecting fruit and vegetable behaviors of children with corresponding descriptions of the Delicious and Nutritious Garden intervention components.

Heim S, Stang J, Ireland M. A garden pilot project enhances fruit and vegetable consumption among children. *J Am Diet Assoc.* 2009;109(7):1220-1226.  
doi:10.1016/j.jada.2009.04.009.

## Appendix B

### *LA Sprouts Curriculum*

45-minute interactive cooking & nutrition lesson <ul style="list-style-type: none"><li>- adapted from existing curriculum developed at USC</li><li>- Culturally relevant, seasonally available, local produce, whole grains &amp; low-sugar beverages</li><li>- Lead by a teacher: students work in groups to prepare recipes that emphasize FV</li><li>- Consume a meal family style with a table cloth, non-disposable plates and silverware (based on evidence)</li><li>- Conversational skills practiced</li></ul>
45-minute interactive gardening lesson <ul style="list-style-type: none"><li>- Bilingual Master Gardener from UC Cooperative Extension</li><li>- Two 6x12 raised beds dedicated to FV cultivation by LA Sprouts participants</li><li>- Hands on: planting, growing, maintaining, harvesting organic FV</li><li>- Identifying FV, seasonal crops, transplanting, recycling, compost, irrigation, mulching</li></ul>
Visits to farmer's markets 4x over 12 weeks <ul style="list-style-type: none"><li>- \$1 voucher to go towards buying FV to take home</li></ul>

Davis JN, Ventura EE, Cook LT, Gyllenhammer LE, Gatto NM. LA Sprouts: a gardening, nutrition, and cooking intervention for Latino youth improves diet and reduces obesity. *J Am Diet Assoc.* 2011;111(8):1224-1230. doi:10.1016/j.jada.2011.05.009.

## Appendix C

### *Review of Outcomes and Measures*

Program	Achieved Outcomes	Corresponding Measures
<b>LA Sprouts</b>	<p><u>2011 Study:</u>  Increased dietary fiber intake  - + overweight subgroup</p> <p>Decreased diastolic blood pressure</p> <p>Reduction in BMI (for overweight subgroup)  Less weight gain (for overweight subgroup)</p> <p><u>2012 Study:</u>  Preferences for Vegetables  - + overweight/obese subgroup  - + female subgroup</p> <p>Attitudes and perceptions  - veg from garden taste better than store, gardening is easy *not significant after adjusting for multiple comparisons</p> <p>Self-efficacy *not significant</p> <p><i>Reductions in weight were correlated with increase preferences for vegetables</i></p>	<p>2007 Food Screeners Questionnaire for Ages 2-17</p> <p>Blood pressure</p> <p>Anthropometrics – Height, weight</p> <p>Combined assessment using validated questionnaires developed for pediatric populations. Pre-test/post-test: 9 questions asked about enjoyment of eating common fruits, 11 about common vegetables – 5-point scale. 11 questions about self-efficacy to choose, eat, or cook FV – 5-point scale. 13 questions about attitudes, preferences, perceptions related to gardening and cooking – 7-point scale.</p>

	<p>(2012) and fiber from fruit (2011).  <u>2015 Study:</u>  Identification of vegetables Knowledge of gardening and nutrition</p> <p>More likely to garden at home</p>	
<b>Idaho Schools: Nutrition in the Garden</b>	<p>Increased servings of FV</p> <p>Increases in vitamin A, vitamin C, and fiber intake</p>	<p>3 food recall workbooks developed and validated by Barbara Jendrysik (pre and post intervention):</p> <ul style="list-style-type: none"> <li>- Diet Analysis Plus software program (version 6.1, 2004, Thomson Wadsworth, Atlanta, GA)</li> </ul>
<b>Delicious and Nutritious Garden – YMCA</b>	<p>High levels of participant satisfaction:</p> <ul style="list-style-type: none"> <li>- Enjoyed taste-testing FV</li> <li>- Enjoyed preparing FV</li> <li>- Enjoyed working in the garden</li> <li>- Enjoyed learning about FV</li> </ul> <p>Increase in the number of FV ever eaten</p> <p>Increase in vegetable preferences</p>	<p>Follow-up children’s survey completed during the last week of camp (adapted from resources listed in ii)</p> <p>11-item vegetable scale, 5-item fruit scale: “Have you ever eaten this food?” Yes/No</p> <p>3 scales: 11-item vegetable scale, 5-item fruit scale, 8-item snack scale.  Question in the FV scales: “What do you think about this food? 5-item Likert scale ranging from “I really do not like it!” to “I really like it a lot!” Questions in the snack scale asked them to choose between healthy and unhealthy snacks: “When I get home I would prefer to have...”<sup>7,32</sup></p>

	Increase in FV asking behavior	Assessed using a 7-item scale. Question: “In the last week, did you ask someone in your family to...” (ex: buy FV). Responses: Yes/No/I don’t have to ask, they already do this.  (All questions were adapted from resources listed in ii)
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## **Appendix D**

### ***Seed to Belly Program Outline***

- a. K-5 Seed to Belly:
  - 1.5-2-hour intensive
  - Teachers request through online form
    - Hub Farm works to find DINE dietician to lead “Making Food” session
  - Available September-end of November and March-June
  - Max number of students/session=50
  - Cost: \$5/DPS student, \$7/non-DPS student
- b. 6-8 Seed to Belly:
  - 1.5-2-hour intensive
  - Teachers request through online form
    - Hub Farm works to find DINE dietician to lead “Making Food” session
  - Available September-end of November and March-June
  - Max number of students/session=50
  - Cost: \$5/DPS student, \$7/non-DPS student

Below is a detailed outline of the hands-on education students receive during the 2-hour trip to the farm:

- a. Garden Discovery
  - Discover the full-circle pollinator cycle: from observing pollinators to tasting herbs
  - Get into production: plant it, nurture it, look how it grows
  - Harvest the ingredients necessary for making your meal
- b. Making Food (with DINE nutritionists/educators)
  - Nutrition lesson: what’s in it and why is it so good?
  - Learn the how-to’s: read the recipes and know your tools
  - Make it yummy! Students go to task preparing a menu item
  - Sharing the harvest: Once students have made the menu item, it’s time to taste
  - Extension: Upon return to the school students bring home a copy of the recipe they made to share with their families
- c. Nature’s Accompaniment
  - Forest, water and the ecosystem around us: listen, smell and see. Great for getting kids out of sun for a rotation.