

PHYSICAL ACTIVITY AND STUDENT PERCEPTIONS OF LEARNING AND
NUTRITION IN THE SCHOOL GARDEN

By

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(Under the Direction of David Knauff)

ABSTRACT

School gardens are increasingly popular, and have been shown to have numerous academic, emotional, and even nutritional benefits to students. This study seeks to address gaps in research in regards to physical activity and nutrition. While many studies have shown student increase in fruit and vegetable consumption, preference, and student willingness to try fruits and vegetable, not much is known about the student experience and perspective. A PhotoVoice project, and follow up student and teacher interviews were used to analyze what students perceive as important learning and doing activities in the garden, and special attention was given to how the food produced in the garden was discussed. The researcher found that teachers create a garden culture through modeling social ideals, and that student's view of food in the garden is defined through the lens of the school garden culture. A number of non-nutrition themes also emerged from the analysis. In addition to the PhotoVoice study, a

physical activity study using accelerometers was conducted to determine how school gardens impacted physical activity on school garden days compared to non-school garden days. PARAGON direct observation tool was also used to document student physical activity levels and movements. Researchers found that students increased their MVPA level by an average of 9.6 minutes on days participating in school garden activities. Overall, school gardens are a valuable tool for encouraging healthy eating and increasing physical activity within the school day.

INDEX WORDS: school gardens, PhotoVoice, vegetable preference, physical activity, accelerometry

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DEDICATION

For my precious daughters, Daisy and Sally

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Chapter 1: Review

School gardens are increasingly being used as an educational tool. They are utilized in a variety of subject areas, with a variety of curricula, at all grade levels, by teachers with a wide range of gardening experience, and with a multitude of anticipated learning outcomes. The following review will provide a brief description of school garden history, their current iterations, as well as what research shows about the value and limitations of school gardens. In addition, the case will be presented for the need to conduct qualitative research on student interaction with nutrition concepts in the school garden, as well as the need for research to better understand how school gardens influence physical activity within the school day.

History of School Gardens

Although school gardens are a growing trend, they are not a new concept. Many European philosophers and pedagogists promoted school gardens long before they took hold in the education system. Comenius, Rousseau, Pestalozzi, and Froebel all speak of the importance of children learning through experiencing nature. Because of those early works in the 1600s and 1700s, school gardens were mandatory in Prussia throughout the 1800s, though Froebel's work of developing and spreading kindergartens was crucial in spreading school gardens to the remainder of Europe (Subramaniam, 2002; Warsh, 2011).

The first era of school garden popularity in the U.S. existed from 1891-1920, and school gardens have cycled in and out of popularity with various educational, social,

and environmental movements since that time. The very first U.S school gardens were a result of nature study advocates, who saw the gardens as an extension of the classroom, an opportunity for moral development, and a method of instilling love of the land and of nature into rural youth. This group soon saw the benefits of school gardening for urban youth as well, and extended school gardens to city children to offer the same opportunities. From there the school garden idea was soon adopted and adapted by progressive reformists, who focused not only on education and moral growth, but gardens as a strategy to address social ills in urban, rather than rural areas (Subramaniam, 2002; Trelstad, 1997)

Accounts of programs during the Progressive Era (1890-1920) promoted school gardens for a myriad of reasons: creating a strong work-ethic, providing opportunity for income and subsistence, character development, city beautification, improved health, reduction of juvenile delinquency, and even the integration of immigrants into American society (Trelstad, 1997). Gardens of various sizes, scales, and impact levels were found throughout the nation, and became the basis for the School Garden Army during World War I (Trelstad, 1997).

The U.S. School Garden Army (USSGA) was directly responsible for the success of this first school garden movement in the U.S, but also played a part in its subsequent decline (Warsh, 2011). In response to the food crisis arising in Europe due to World War I, the U.S. Department of Agriculture (USDA), the national Board of Education, the War Department, and President Woodrow Wilson came together to fund and direct the U.S School Garden Army (USSGA) (Hayden-Smith, 2007). The USSGA was very successful, boasting 75,000 gardens involving over a million students by the end of the

war (Subramaniam, 2002; Hayden-Smith, 2007). In addition to continuing the Progressive Era values, the USSGA connected gardening with patriotism, asserting the importance of contributing to the war effort. One significant change that resulted from this transition was from the importance of the experience of gardening promoted by the progressives, to the emphasis on production needed for school gardens to stabilize the food economy (Hayden-Smith, 2007; Warsh, 2011).

Several factors contributed to the decline of the U.S school garden movement after World War I: the growing popularity of summer camps reduced the number of children available to work in the gardens, improved economic conditions and fewer immigrants following World War I reduced the need for reform that gardens addressed, and finally, the dismantling of the Home and Garden Department combined with the cessation of funding from the USDA for school gardens eliminated government support of school gardens (Hayden-Smith, 2007; Trelstad, 1997). Also, the emphasis on food production from the USSGA program made school gardens less meaningful after the war when additional food production was not needed, and the gardens were separated from Progressive Era values.

Production gardens saw a resurgence during the Great Depression and World War II, but school gardens never again reached the same level of popularity as they experienced during the Progressive Era and World War I. Since that time school gardens in the United States never completely disappeared, but rather garden popularity changed with educational and societal trends of the time including the “war on poverty” in the late 60’s and early 70’s, the environmental movement of the 70s, and

again in the early 90's during an educational shift towards innovative and experiential learning (Desmond, Grieshop, and Subramaniam, 2002).

School gardens have had seasons of popularity throughout many different historical contexts and have gained traction in society with just as many philosophical underpinnings. The only constant element of school gardens is that they are more than just gardens; gardens are a means of food production, but school gardens are tools for teaching, instilling values, creating community, and establishing societal norms. School gardens have a rare ability to become a space where all of these things can happen, and research shows us that they do achieve all of these, which is why new generations of educators and activists continue to choose to place value on using them in a school setting. A study commissioned by the United Nation's Food and Agriculture Organization and the International Institute for Educational Planning listed ten core areas of use for school gardens: academic skills, personal development, social and moral development, vocational skills, life skills, community development, food security, sustainable development, vocational education, and school grounds greening (Desmond, Grieshop, and Subramaniam, 2002). As a new era of school garden popularity emerges it is essential to look at the historical context of school gardens and realize the role current national and global issues, educational trends, and the values that both give rise to those, and are influenced by them, play in determining the focus and outcomes of school gardens.

School Gardens Today

School Garden Popularity

The current iteration of school gardens is quickly becoming a staple of the school environment. Although the number of school gardens in the United States is not known, there are several counts that collectively begin to show the scale of this trend.

Bridging the Gap, a research program of the Robert Wood Johnson Foundation conducted a survey of school administrators and found that in the 2012-2013 school year approximately 26.6% of public elementary schools have school gardens, and that the prevalence of school gardens has more than doubled since they began the study in 2006 (Turner, Sandoval, and Chaloupka, 2014).

The 2015 Farm to School Census reported over 7,000 school gardens (USDA, 2016). These show that not only are school gardens present within the nation's school systems, but that this movement is continuing to grow, and has yet to reach its height.

Characteristics of the Current School Garden Movement

The current interest in school gardens has been cited with several triggers, including educational trends towards experiential and problem-based learning, increased support of environmental education, the need to address childhood health concerns, and the local and sustainable food movements (Desmond, Grieshop, and Subramaniam, 2002; Blair, 2009; Williams and Dixon, 2013).

School gardens are often implemented with the goal of improving health and decreasing childhood obesity (Blair, 2009; Williams and Dixon, 2013). Gardening to promote healthy eating is an essential part of Michelle Obama's *Let's Move* campaign, and the mission statement of Alice Water's Edible Schoolyard, another national school

garden movement, seeks not only to create an “interactive classroom,” but also to “transform the health and values of every child in America.” (*Let’s Move*; The Edible Schoolyard Project, 2016). Many groups that offer grants for school gardens, including the Captain Planet Foundation and the Whole Kids Foundation, and USDA Farm to School program, offer funding for schools to not only put school gardens into place, but also to promote fruit and vegetable consumption (USDA Food and Nutrition Service, 2016; Whole Kids Foundation, 2016; Captain Planet Foundation, 2016).

Although tied closely to health promotion, current food movements have also played a role in school gardens (Williams and Dixon, 2013). Many schools participate in Farm to School programs that provide students with fresh, local food. In addition to changing what’s on the cafeteria menu, these programs also often promote agricultural literacy through school gardens. Both the rising childhood obesity epidemic and increased concern about modern food movement have been cited as reasons for the rise in these programs (Bagdonis, Hinrichs, and Schafft, 2009). Many gardens desire to connect students with the food chain and to teach students where food comes from, specifically out of concern for environmental, social, and health outcomes that result from our modern food system. The outcomes of the modern food movement are increased interest in organic, sustainable, and local agriculture as evidenced by the plethora of farmers markets, community-supported agriculture, and even the popularity of books like Carlo Petrini’s “Slow Food Nation” and the many books written by journalist and food activist Michael Pollan (Petrini, 2013; Pollan, 2006; Pollan, 2007; Pollan, 2008). It follows that many school gardens have threads connecting to this series of movements.

Benefits of School Gardens

There is a growing body of evidence supporting many positive impacts of garden-based learning, including greater academic achievement, personal development, community development, and better nutrition.

A number of studies have shown an increase in general academic achievement in school gardens. In a 2013 paper by Williams and Dixon, the authors found that, of forty studies measuring the impact of school gardens in relation to academic achievement, 83% showed improvement in academic outcomes, but jumped to 93% for those analyzing the impact to science education. Beyond the tangible improved test scores and general understanding, students who participate in school garden activities have also been found to demonstrate more frequent use of higher order thinking skills; gardens offer a myriad of opportunities for creating, planning, evaluating and problem solving. And while this is not necessarily different from other experiential learning outcomes, school gardening offers a greater opportunity for informal learning within the garden, which is not necessarily captured in the research (Blair, 2009).

School gardens have also been linked to personal development and community development including better emotion regulation, improved self-esteem, sense of self, sense of place, feelings of belonging, and pride in the school garden (Miller, 2007; Blair, 2009).

A number of school garden studies have focused on the impact that school gardens make to student nutrition. These studies have demonstrated that school gardens have a number of positive effects. A meta-analysis of 11 separate studies concluded that school garden participation could increase fruit and vegetable

consumption as well as create a willingness in students to try fruits and vegetables (F&V). Other reported benefits include increased preference, increased ability to identify, and consumption of a larger variety of fruits and vegetables, as well as greater likelihood of students choosing vegetables in the school cafeteria. Multiple methods have been used to collect this data, including 24 hour recall, food diaries, pre- and post-intervention tests, taste tests, and cafeteria observations (Robinson-O'Brien, Story, and Heim, 2009).

Students in school gardens may also be influencing F&V consumption in the home. A 2011 study analyzed the parent perspective on a garden-based nutrition program offered at a YMCA summer camp and found a significant increase in both students requesting F&V at home, and the availability of fruits and vegetables in the home (Heim et al., 2011).

School Garden's Impact on Nutrition

Value of Fruit and Vegetable Consumption

Although there are many factors leading to the rise of the modern school garden movement, and many documented benefits, the following review will focus primarily on how and why participation in school gardens impacts student nutrition.

The primary influence of school gardens on nutrition is the promotion of F&V consumption. Eating F&V has long been associated with a healthy diet, and they are rich sources of a variety of nutrients and minerals. Diets high in F&V are also important to healthy weight maintenance (Rolls, Ello-Martin, and Tohill, 2004). In addition to weight maintenance, high consumption of F&V can also result in weight loss (Rolls et al., 2004). F&V have high water contents, and as a result are foods with a relatively low

energy density, and when eaten in high, or even recommended portions, can reduce overall calorie intake. F&V are also high in fiber which leads to high satiety, which can also reduce calorie intake (Rolls et al., 2004). Beyond being a source of low calorie nutrition, F&V have also been linked to cancer, stroke, and hypertension prevention (Van Duyn, M.A.S., and Pivonka, 2000).

The role of F&V in weight management is of particular benefit amidst the increase in childhood obesity that has occurred over the past several decades. An estimated 17% of youth in the US are obese (Ogden, Carroll, Kit, and Flegal, 2014). With this increase in obesity and the consequential rise in co-morbidities such as diabetes and high cholesterol, there is an immediate need for new approaches to increasing F&V consumption (Deckelbaum and Williams, 2001).

Beyond the immediate health benefits, inadequate F&V consumption is associated with poor academic achievement, weight dissatisfaction, and low family connectedness in youth (Neumark-Sztainer, Story, Resnick, and Blum, et al. 1996).

Research Outcomes

School gardens have been implemented often with the goal of changing student eating behavior and exposing them to or even providing them with, fresh F&V. Studies on the impact of school gardens on student nutrition primarily focus on reported changes in consumption and preference.

Multiple studies have shown an increase in F&V consumption after exposure to school gardens. Two large meta-analyses of school garden nutrition research have been completed. One analyzed 11 studies and found gardens to have the potential to increase F&V consumption (Robinson-O'Brien et. al 2009). A second meta-analysis of

20 studies used a vote-counting analysis that also showed a significant increase in vegetable consumption post intervention; this study showed that while not every school garden nutrition intervention study showed a significant difference in consumption, that the general trend among all the studies was overwhelmingly significant (Langellotto and Gupta, 2012).

Increase in preference for vegetables has been shown post intervention for middle school students (Ratcliffe et al., 2011). 4th grade students in a garden-enhanced nutrition program were found more likely to choose vegetables from the cafeteria than students just exposed to nutrition curriculum (Morris and Zidenberg-Cherr, 2002). LA Sprouts garden-based nutrition intervention also found positive increased vegetable preference for students participating in the program (Gatto, Ventura, Cook, Gyllenhammer, and Davis, 2012).

Beyond consumption and preference, nutrition intervention studies have also looked at a variety of other indicators. Students participating in school gardens have been found to have a greater willingness to try F&V after garden exposure (Robinson-O'Brien et al., 2009; Ratcliffe et al., 2011; Morgan et al. 2010). School gardeners were also more likely to have tried and eaten a greater variety of vegetables within the past month compared to non-school gardening students (Ratcliffe et al., 2011). Students enrolled in school garden programs were also better able to identify F&V (Ratcliffe et al., 2011; Morgan et al., 2010), had increased knowledge about F&V (Langellotto and Gupta, 2012; Morris and Zidenberg-Cherr 2002), and had overall better attitudes and perceptions in regards to eating F&V (Gatto et al., 2012).

Examining the Need for a Qualitative Assessment of Nutrition Outcomes

Despite the growing evidence that school gardens can positively impact student F&V consumption and preference, and their attitudes and motivation surrounding F&V consumption, there is a need for a qualitative assessment analyzing nutrition outcomes. School gardens are incredibly diverse, and can have a range of desired outcomes, among which changes in dietary habits and nutrition education is only one (Subramaniam, 2002). However, it seems probable that repeated exposure to F&V in a garden setting could influence attitudes, motivation, and perhaps even preference and consumption, even if students were not engaging in a nutrition curriculum. Can positive nutrition outcomes be seen on some level for school gardens that are not used to focus on nutrition?

The studies conducted up to this point have overwhelmingly been nutrition intervention studies, where student school garden participants are administered pre and post evaluations, in between which a certain curriculum, usually a combination of nutrition and garden science, is taught over a specific time frame. And while these studies have cumulatively provided evidence that school gardens can indeed change attitudes and behaviors, they are not indicative of real world conditions. In analyzing 9 commonly cited studies that measure various effects of garden-based nutrition education within the school day, three used existing school gardens, two put gardens into place at the schools for the study, and four were unclear if the gardens they used existed before the study. For those that did use pre-existing school gardens, there is no mention of how the gardens were utilized prior to the study. And while in three of these studies the teachers involved either collaborated with researchers or developed curriculum themselves, it is not clear if teachers continued using curriculum after the

studies, or if the programs addressed content they were responsible for teaching (Morris and Zidenberg-Cherr, 2002; Ratcliffe et al., 2011; Parmer et al., 2009; Gibbs et al., 2013; Morgan et al. 2010; Cason, 1999; Lineberger and Zajicek, 2000; Morris, Neustadter, and Zidenberg-Cherr, 2001; McAleese and Rankin, 2007). In essence, these studies are valuable in showing that school gardens can have an impact, but are not analyzing the impact in real-world garden programs. Likewise, they are documenting change, but do not attempt to determine what component of the intervention is specifically causing these changes in school garden participants.

Nutrition education is also only one of many reasons school gardens may be implemented. In the public school context it is essential for gardens to have strong academic connections. While studies have looked at a myriad of outcomes as a result of garden-based-learning, school gardens must have a positive effect on academic outcomes to remain relevant in the public school system (Williams and Dixon, 2013). The 2001 No Child Left Behind Act has led to an increase in standards-based curriculum, standardized tests, and academic accountability in public school systems, which can limit instruction in areas outside of the core academic areas (Hamilton, Stecher, Marsh, McCombs, Robyn, 2007). In fact, the reported median time spent in nutrition and dietary education in elementary schools is only 3.4 hours for the entire school year (Kann, Telljohann, and Wooley, 2007). In Georgia, nutrition education for elementary students is only a small component of health education. There are no standards that are specific to nutrition concepts, but are rather vague with suggested elements such as “design a meal using the food guide pyramid” (which is no longer a part of the US Dietary Guidelines) and “predict the short and long term effects of health

choices on the multiple dimensions of health” (Georgia Department of Education (DOE), 2009a ; Georgia Department of Education, 2009b). The Georgia DOE Website is also unclear regarding who is responsible for teaching health standards. This limited statewide focus on nutrition education implies that gardens with a focus on core academic areas would be much more relevant to Georgia public schools.

The first part of this study aims to address these issues by answering two main questions; the first step is to determine whether or not students 1) are associating nutrition messages and behaviors with general garden-based learning and 2) to determine student perspectives on interactions with vegetables in the gardens and how the school garden has influenced their attitudes and behaviors towards vegetable consumption. Not only do these questions need to be answered, but they also need to be answered within garden programs that are already established and whose primary objective is standards-based academic learning, specifically for core academic areas. A qualitative study is the best way to gain a broad understanding of student perceptions, without limiting or guiding student responses. Also, while fruit consumption has also been studied within the context of school gardens, due to the difficulty of production of some fruit crops and seasonality of others, many school gardens do not include fruit crops. To best coincide with student garden experiences, this study will focus only on vegetables.

There are several theories that could explain why academic learning in the garden may influence attitudes and behaviors towards vegetable consumption in the absence of formal nutrition education. The most relevant in terms of this study are explained by Social Cognitive Theory (SCT) and the experiential learning theory.

Nutrition interventions have been found to be most successful when based on a theoretical framework (Lytle, 1994). And while garden-based-learning programs are all unique, there are general constructs that apply broadly to these programs. SCT is commonly used as a theoretical framework for explaining the impact of school gardens (Ratcliffe et al., 2011; Morris et al., 2001; Morris and Zidenberg-Cherr, 2002; Morgan et al. 2010; Morris et al., 2000). SCT posits that the interaction of cognitive, environmental, and behavioral factors lead to behaviors of an individual (Bandura, 1998; Bandura, 1986; Reynolds et al., 1999).

School gardens could influence cognition surrounding vegetable consumption by increasing awareness of vegetables through the garden experience. Studies have shown that multiple exposures to new foods are essential for changing both preference and consumption, as well as that preference is perhaps the most important factor influencing F&V consumption (Wardle et al., 2003a; Wardle et al., 2003b; Taylor, Evers, and McKenna, 2005; Rasmussen et al. 2006). Increased familiarity with vegetables as a result of garden experience could be a factor in outcomes that have already been identified in garden nutrition studies, such as willingness to try and ability to identify F&V (Morgan et al., 2010; Ratcliffe et al., 2011; Robinson-O'Brien et al., 2009).

The learning environment created by the garden is also important. Children learn attitudes and behaviors that adults model in the garden. Parental modeling of F&V consumption is an important factor in youth vegetable consumption (Rasmussen et al. 2006; Taylor et al., 2005; Blanchette and Brug 2005). There is less evidence on the influence of teacher modeling. However, an analysis of schools teaching sustainability found modeling was a common theme in student learning, and this type of learning

seems particularly relevant to the school garden (Higgs and McMillan, 2006). The social cognitive model of F&V consumption in elementary school children posits modeling as a path to increased F&V consumption, and while the researchers did not find a significant relationship, they did find a correlation between modeling and consumption (Reynolds et al. 1999).

Modeling is also important in the behavioral realm to build self-efficacy. Bandura relates a number of ways in which self-efficacy is built, including mastery experiences, such as a child successfully growing and or preparing vegetables, and social modeling, such as seeing other children or adults gardening (Bandura, 1986; Bandura, 1998). Self-efficacy is an important factor for vegetable consumption in adults (Shaikh, Yaroch, Nebeling, Yeh, Resnicow, 2008). Formative garden experiences could very well play a part in establishing both gardening and efficacy for preparing and eating vegetables.

In some school gardens, where students take home fresh produce, increased availability of vegetables may be a significant environmental factor. For youth in particular, availability is an important component of consumption (Rasmussen et al., 2006; Shaikh et al., 2008; Taylor et al, 2005). Because youth are most likely not responsible for making purchase decisions, having access to F&V can be an enhancing or limiting factor in F&V consumption. A literature review focusing on ages 6-18 found that availability is a leading factor for youth consumption (Rasmussen et al., 2006; Shaikh et al., 2008); another study found that availability and preference were “most consistently and positively” related to consumption (Blanchette and Brug 2005).

School policies can also influence consumption, and school is an ideal environment to influence F&V preference and consumption (Taylor et. al, 2005). A

review of small school-based interventions aimed at increasing F&V consumption showed significant changes in consumption had the following characteristics: interactive food activities, social support, family and community involvement, and policies that support healthy eating (Gortmaker, Peterson, Wiecha, Sobol, Dixit, Fox, and Laird, 1999). All of these characteristics can be implemented in school gardens.

Experiential Learning

While SCT is commonly used to explain nutrition outcomes, the experiential learning model is also relevant in terms of garden-based-learning in core academic areas. Experiential learning theory as described by Kolb, which is based on earlier work by Dewey, Lewin, and Piaget, discusses the value of combining classroom learning with hands-on learning experiences in increasing learning outcomes (Kolb, 2014). Experiential learning is at the heart of school garden's academic connection, and experiential learning has shown improvements in science skills in garden-based learning classrooms (Blair, 2009; Williams and Dixon 2013; Mabie and Baker 1996). However, the hands-on component of gardening may be an important aspect of changes in attitude and behavior toward fruit and vegetable consumption (Kolb, 2014), though this specific connection has not been researched.

Impact of School Gardens on Physical Activity

If school gardens are being implemented as a means of promoting F&V consumption as a way to improve overall health and mitigate the obesity epidemic, then physical activity in the garden should also be considered.

There are multiple health benefits associated with physical activity including better musculoskeletal health, cardiovascular health, reduced adiposity, and improved

mental health. Generally, 60 minutes a day of moderate physical activity is recommended for youth, but additional health benefits can be seen from vigorous activity (Janssen and LeBlanc, 2010). Despite this, many youth have relatively sedentary lifestyles (Steele, Van Sluijs, Sharp, Landbaugh, Ekelund, and Griffin, 2010; Matthews, Chen, Freedson, Buchowski, Beech, Pate, Troiano, 2008). Physical activity can be used to prevent and address obesity by increasing energy use (Baranowski, Mendlein, Resnicow, Frank, Cullen, Baranowski, 2000). Preventing obesity for youth is not only important for children's current health, it could also affect their lifelong health outcomes (Baranowski et al., 2000).

Youth spend a significant portion of their time in school, making school a relevant vehicle for promoting physical activity (Nettlefold et al., 2011). Several studies have shown that physical activity during the school day can even increase academic achievement (Mahar, 2011; Rasberry, Lee, Robin, Laris, Russell, Coyle, Nihiser, 2011). Although physical education classes and recess can contribute to overall physical activity, they do not provide adequate daily physical activity (Nettlefold et al, 2011; Kahan, 2008; Ridgers, Timperio, Crawford, and Salmon et al., 2011). There is a need for other ways to increase physical activity within the school day.

Gardening can be an important part of achieving recommended levels of physical activity. Gardening and yard work are the top two reported leisure time physical activity choices in adults (Crespo, Keteyian, Heath, and Sempos, 1996). In a study with older adults, active gardeners not only met physical activity recommendations through gardening, they also had significantly better health outcomes than non-gardeners of the same age (Park, Shoemaker, and Haub, 2009). In an energy expenditure study with

youth, several specific garden tasks (transplanting, weeding, cultivating, and raking) were shown to achieve moderate physical activity levels, suggesting gardening is a relevant source of physical activity for youth as well as adults (Domenghini, 2011).

While there is an abundance of research on school garden nutrition outcomes, there has been markedly little research on how school gardens may impact physical activity within the school day. One after-school garden-based-learning intervention with a focus on increasing nutrition and physical activity found a significant increase in students reporting that they were physically active every day in a post-intervention questionnaire. In that study, Domenghini (2011) implemented an accelerometer study in which garden-club participants had significantly higher moderate and vigorous physical activity, as well as significantly lower sedentary time, during the time spent in the garden compared to the rest of their day.

Meyers and Wells (2015) recently created and validated PARAGON (Physical Activity Research & Assessment Tool for Garden Observation) to assess physical activity in the garden. For this direct observation tool, researchers observe students for 15 seconds, followed by 15 seconds of coding for five behaviors: activity level, garden tasks, motions, associations, and interactions. However, this tool has yet to be used in a school garden study outside of the initial research group.

There is a profound need for understanding how school gardens contribute to physical activity in children. As school gardens become increasingly popular, it is worthwhile to determine if these programs can significantly impact physical activity levels of children within the school day. While school garden programs alone may not address the obesity epidemic, or fulfill weekly physical activity requirements, it is

possible that they can be a component of a multi-pronged approach within schools for addressing health and wellness. This study seeks to fill the void in school garden physical activity research by comparing physical activity levels on gardening and non-gardening days within the school setting. In addition, this study will use multiple measures for determining physical activity during the gardening class. As one of the first studies of its kind, this study will be an important contribution to the knowledge of the benefits of school gardening programs.

In conclusion, this study intends to address the lack of understanding of how students perceive learning in the school garden, and how vegetable preference and nutrition concepts are situated in that learning context. While multiple studies have looked at preference and consumption at a quantitative level, this study will consider the issue from a qualitative stance. Additionally, this study seeks to determine how school garden participation influences physical activity during the school day compared to non-garden days. Both studies will also focus on documenting how students experience school gardens in existing settings, rather than what outcomes are possible by implementing an intervention study.

References

- Bagdonis, J. M., Hinrichs, C. C., & Schafft, K. A. (2009). The emergence and framing of farm-to-school initiatives: civic engagement, health and local agriculture. *Agriculture and Human Values*, 26(1-2), 107-119.
- Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and health*, 13(4), 623-649.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.
- Baranowski, T., Mendlein, J., Resnicow, K., Frank, E., Cullen, K. W., & Baranowski, J. (2000). Physical activity and nutrition in children and youth: an overview of obesity prevention. *Preventive Medicine*, 31(2), S1-S10.
- Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education*, 40(2), 15-38.
- Blanchette, L., & Brug, J. (2005). Determinants of fruit and vegetable consumption among 6–12 year old children and effective interventions to increase consumption. *Journal of human nutrition and dietetics*, 18(6), 431-443.
- Captain Planet Foundation. 2016. Project Learning Garden. Retrieved from [://captainplanetfoundation.org/learning-garden/](http://captainplanetfoundation.org/learning-garden/)
- Cason, K. L. (1999). Children are “growing healthy” in South Carolina. *Journal of nutrition Education*, 31(4), 235-236.
- Crespo, C. J., Keteyian, S. J., Heath, G. W., & Sempos, C. T. (1996). Leisure-time physical activity among US adults: results from the Third National Health and Nutrition Examination Survey. *Archives of internal medicine*, 156(1), 93-98.
- Deckelbaum, R. J., & Williams, C. L. (2001). Childhood obesity: the health issue. *Obesity research*, 9(S11), 239S-243S.

- Desmond, D., Grieshop, J., & Subramaniam, A. (2002). Revisiting garden based learning in basic education: Philosophical roots, historical foundations, best practices and products, impacts, outcomes, and future directions. *Food and Agriculture Organization*, 59-59.
- Domenghini, C. M. (2011). *Physical activity and curriculum development of an after-school gardening program for youth health* (Doctoral dissertation, Kansas State University).
- Gatto, N. M., Ventura, E. E., Cook, L. T., Gyllenhammer, L. E., & Davis, J. N. (2012). LA Sprouts: a garden-based nutrition intervention pilot program influences motivation and preferences for fruits and vegetables in Latino youth. *Journal of the Academy of Nutrition and Dietetics*, 112(6), 913-920.
- Georgia Department of Education. 2009, May 18. Georgia Performance Standards. Retrieved From https://www.georgiastandards.org/Standards/Georgia%20Performance%20Standards/2_Health_Education.pdf
- Georgia Department of Education. 2009, May 18. Georgia Performance Standards: 4th Grade. Retrieved from https://www.georgiastandards.org/Standards/Georgia%20Performance%20Standards/4_Health_Education.pdf
- Gibbs, L., Staiger, P. K., Johnson, B., Block, K., Macfarlane, S., Gold, L., ... & Ukoumunne, O. (2013). Expanding children's food experiences: the impact of a school-based kitchen garden program. *Journal of nutrition education and behavior*, 45(2), 137-146.
- Gortmaker, S. L., Peterson, K., Wiecha, J., Sobol, A. M., Dixit, S., Fox, M. K., & Laird, N. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Archives of pediatrics & adolescent medicine*, 153(4), 409-418.
- Hamilton, L. S., Stecher, B. M., Marsh, J. A., McCombs, J. S., & Robyn, A. (2007). *Standards-based accountability under No Child Left Behind: Experiences of teachers and administrators in three states*. Rand Corporation.

- Hayden-Smith, R. (2007). "Soldiers of the Soil": The work of the United States School Garden Army during World War I. *Applied Environmental Education and Communication*, 6(1), 19-29.
- Heim, S., Bauer, K. W., Stang, J., & Ireland, M. (2011). Can a community-based intervention improve the home food environment? Parental perspectives of the influence of the delicious and nutritious garden. *Journal of nutrition education and behavior*, 43(2), 130-134.
- Higgs, A. L., & McMillan, V. M. (2006). Teaching through modeling: Four schools' experiences in sustainability education. *The Journal of Environmental Education*, 38(1), 39-53.
- Janssen, I., & LeBlanc, A. G. (2010). Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral nutrition and physical activity*, 7(40), 1-16.
- Kahan, D. (2008). Recess, extracurricular activities, and active classrooms: Means for increasing elementary school students' physical activity. *Journal of Physical Education, Recreation & Dance*, 79(2), 26-39.
- Kann, L., Telljohann, S. K., & Wooley, S. F. (2007). Health education: Results from the school health policies and programs study 2006. *Journal of school health*, 77(8), 408-434.
- Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. FT press.
- Langellotto, G. A., & Gupta, A. (2012). Gardening increases vegetable consumption in school-aged children: A meta-analytical synthesis. *HortTechnology*, 22(4), 430-445.
- Let's Move. Gardening Guide. Retrieved from <http://www.letsmove.gov/gardening-guide>
- Lineberger, S. E., & Zajicek, J. M. (2000). School gardens: Can a hands-on teaching tool affect students' attitudes and behaviors regarding fruit and vegetables?. *HortTechnology*, 10(3), 593-597.
- Lytle, L. A. (1994). Nutrition Education for School-Aged Children: A Review of Research.

- Mabie, R., & Baker, M. (1996). A comparison of experiential instructional strategies upon the science process skills of urban elementary students. *Journal of Agricultural Education*, 37, 1-7.
- Mahar, M. T. (2011). Impact of short bouts of physical activity on attention-to-task in elementary school children. *Preventive medicine*, 52, S60-S64.
- Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., & Troiano, R. P. (2008). Amount of time spent in sedentary behaviors in the United States, 2003–2004. *American journal of epidemiology*, 167(7), 875-881.
- McAleese, J. D., & Rankin, L. L. (2007). Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *Journal of the American Dietetic Association*, 107(4), 662-665.
- Miller, D. L. (2007). The seeds of learning: Young children develop important skills through their gardening activities at a Midwestern early education program. *Applied Environmental Education and Communication*, 6(1), 49-66.
- Miller, D. L. (2007). The seeds of learning: Young children develop important skills through their gardening activities at a Midwestern early education program. *Applied Environmental Education and Communication*, 6(1), 49-66.
- Morgan, P. J., Warren, J. M., Lubans, D. R., Saunders, K. L., Quick, G. I., & Collins, C. E. (2010). The impact of nutrition education with and without a school garden on knowledge, vegetable intake and preferences and quality of school life among primary-school students. *Public health nutrition*, 13(11), 1931-1940.
- Morris, J. L., & Zidenberg-Cherr, S. (2002). Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables. *Journal of the Academy of Nutrition and Dietetics*, 102(1), 91.
- Morris, J., Briggs, M., & Zidenberg-Cherr, S. (2000). School-based gardens can teach kids healthier eating habits. *California Agriculture*, 54(5), 40-46.

- Morris, J., Neustadter, A., & Zidenberg-Cherr, S. (2001). First-grade gardeners more likely to taste vegetables. *California Agriculture*, 55(1), 43-46.
- Myers, B., & Wells, N. (2015). Children's physical activity while gardening: development of a valid and reliable direct observation tool. *J Phys Act Health*.
- Nettlefold, L., McKay, H. A., Warburton, D. E. R., McGuire, K. A., Bredin, S. S. D., & Naylor, P. J. (2011). The challenge of low physical activity during the school day: at recess, lunch and in physical education. *British Journal of Sports Medicine*, 45(10), 813-819.
- Neumark-Sztainer, D., Story, M., Resnick, M. D., & Blum, R. W. (1996). Correlates of inadequate fruit and vegetable consumption among adolescents. *Preventive medicine*, 25(5), 497-505.
- Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Jama*, 311(8), 806-814.
- Park, S. A., Shoemaker, C. A., & Haub, M. D. (2009). Physical and psychological health conditions of older adults classified as gardeners or nongardeners. *HortScience*, 44(1), 206-210.
- Parmer, S. M., Salisbury-Glennon, J., Shannon, D., & Struempfer, B. (2009). School gardens: an experiential learning approach for a nutrition education program to increase fruit and vegetable knowledge, preference, and consumption among second-grade students. *Journal of nutrition education and behavior*, 41(3), 212-217.
- Petrini, C. (2013). *Slow food nation: Why our food should be good, clean, and fair*. Rizzoli Publications.
- Pollan, M. (2008). *In defense of food: An eater's manifesto*. Penguin.
- Pollan, M. (2006). *The omnivore's dilemma: A natural history of four meals*. Penguin.
- Pollan, M. (2007). *Second nature: a gardener's education*. Grove/Atlantic, Inc.

- Raspberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. *Preventive medicine*, 52, S10-S20.
- Rasmussen, M., Krølner, R., Klepp, K. I., Lytle, L., Brug, J., Bere, E., & Due, P. (2006). Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *International Journal of Behavioral Nutrition and Physical Activity*, 3(1), 22.
- Ratcliffe, M. M., Merrigan, K. A., Rogers, B. L., & Goldberg, J. P. (2011). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health promotion practice*, 12(1), 36-43.
- Reynolds, K. D., Hinton, A. W., Shewchuk, R. M., & Hickey, C. A. (1999). Social cognitive model of fruit and vegetable consumption in elementary school children. *Journal of Nutrition Education*, 31(1), 23-30.
- Ridgers, N. D., Timperio, A., Crawford, D., & Salmon, J. (2011). Five-year changes in school recess and lunchtime and the contribution to children's daily physical activity. *British journal of sports medicine*, bjsports84921.
- Robinson-O'Brien, R., Story, M., & Heim, S. (2009). Impact of garden-based youth nutrition intervention programs: a review. *Journal of the American Dietetic Association*, 109(2), 273-280.
- Rolls, B. J., Ello-Martin, J. A., & Tohill, B. C. (2004). What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management?. *Nutrition reviews*, 62(1), 1-17.
- Shaikh, A. R., Yaroch, A. L., Nebeling, L., Yeh, M. C., & Resnicow, K. (2008). Psychosocial predictors of fruit and vegetable consumption in adults: a review of the literature. *American journal of preventive medicine*, 34(6), 535-543.

- Steele, R. M., Van Sluijs, E. M., Sharp, S. J., Landsbaugh, J. R., Ekelund, U., & Griffin, S. J. (2010). An investigation of patterns of children's sedentary and vigorous physical activity throughout the week. *Int J Behav Nutr Phys Act*, 7(1), 88.
- Subramaniam, A. (2002). Garden-based learning in basic education: A historical review. *Monograph, Centre for Youth Development, University of California*. 12pp.
- Taylor, J. P., Evers, S., & McKenna, M. (2005). Determinants of healthy eating in children and youth. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique*, S20-S26.
- The Edible Schoolyard Project. (2016). Our Work. Retrieved from <http://edibleschoolyard.org/our-work>
- Trelstad, B. (1997). Little machines in their gardens: a history of school gardens in America, 1891 to 1920. *Landscape Journal*, 16(2), 161-173.
- Turner, L., A. Sandoval, and FJ Chaloupka. (2014). School Garden Programs are on the Rise in US Public Elementary Schools, but are Less Common in Schools with Economically Disadvantaged Student Populations - *A BTG Research Brief*. Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago.
- US Department of Health and Human Services, & US Department of Health and Human Services. (2008). Physical activity guidelines for Americans.
- USDA Food and Nutrition Service. (2016, March 16). Community Food Systems. Retrieved from <http://www.fns.usda.gov/farmtoschool/farm-school>
- USDA. (2016). School Gardens: Using Gardens to Grow Healthy Habits in Cafeterias, Classrooms and Communities. Retrieved from http://www.fns.usda.gov/sites/default/files/f2s/FactSheet_School_Gardens.pdf

- Van Duyn, M. A. S., & Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. *Journal of the American Dietetic Association*, 100(12), 1511-1521.
- Wardle, J., Cooke, L. J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite*, 40(2), 155-162.
- Wardle, J., Herrera, M. L., Cooke, L., & Gibson, E. L. (2003). Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. *European journal of clinical nutrition*, 57(2), 341-348.
- Warsh, M. (2011). Cultivating citizens: The children's school farm in new york city, 1902–1931. *Buildings & Landscapes: Journal of the Vernacular Architecture Forum* (Vol. 18, No. 1, pp. 64-89). University of Minnesota Press.
- Whole Kids Foundation. (2016). Schools. Retrieved from <https://www.wholekidsfoundation.org/index.php/schools/school-garden-grant-program>
- Williams, D. R., & Dixon, P. S. (2013). Impact of garden-based learning on academic outcomes in schools synthesis of research between 1990 and 2010. *Review of Educational Research*, 0034654313475824.

Chapter 2: PhotoVoice in the School Garden Classroom: codifying learning experiences and the meaning of food in the school garden

Literature Review

School gardens have recently experienced a surge in popularity, and are now a feature in approximately 26.6% of public elementary schools in the US (Turner, Sandoval, & Chaloupka, 2014). While their prominence may have grown in recent years, school gardens are not a new concept; their popularity has risen and fallen in the US since the late 1800s in association with various educational, social, and environmental movements (Desmond, Grieshop, & Subramaniam, 2002; Subramaniam, 2002). More often than not, school gardens are about much more than just food production, and have been used over the years to improve academic skills, encourage personal, social, and moral development, teach vocational and life skills, develop community, increase food security, promote environmental learning and sustainable development, and improve aesthetics of school grounds (Desmond et al., 2002; Trelstad, 1997; Blair, 2009).

The current iteration of school gardens has been primarily associated with experiential learning, environmental learning and awareness, and increasingly with a focus on health and nutrition (Desmond et al., 2002; Williams & Dixon, 2013).

With 17% of US youth characterized as obese, it is no surprise that promoting healthy eating through gardening has gained traction as a movement (Ogden, Carroll, Kit, & Flegal, 2014). Gardening to promote healthy eating is an essential part of Michelle

Obama's *Let's Move* campaign, and the mission statement of Alice Water's Edible Schoolyard, another national school garden movement, seeks not only to create an "interactive classroom," but also to "transform the health and values of every child in America." (*Let's Move*, 2016; The Edible Schoolyard Project, 2016).

School gardens have the potential to promote health and support healthy weight maintenance and obesity prevention by encouraging fruit and vegetable consumption. F&V are high in nutrition, low in energy density, and have been linked to prevention of several chronic diseases (Rolls, Ello-Martin, & Tohill, 2004; Van Duyn, Mary Ann S & Pivonka, 2000).

Multiple studies have shown an increase in vegetable consumption after exposure to nutrition education through school gardening. One meta analysis of 11 studies, found school gardens interventions increase vegetable consumption in youth by (Robinson-O'Brien, Story, & Heim, 2009b). A second meta-analysis of 20 studies used a vote counting analysis that also showed a significant difference in vegetable consumption in youth; this study showed that while not every school garden nutrition intervention study showed a significant difference in consumption, that the general trend among all the studies was overwhelmingly significant (Langellotto & Gupta, 2012).

Beyond consumption nutrition intervention studies have also looked at a variety of other indicators. Students participating in school gardens have been found to have a greater preference for fruits and vegetables (F&V) and a greater willingness to try fruits and vegetables (Robinson-O'Brien, Story, & Heim, 2009b; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011a; Morgan, Warren, Lubans, Saunders, Quick, & Collins, 2010a). Student enrolled in school garden programs were also better able to identify F&V

(Ratcliffe et al., 2011; Morgan, Warren, Lubans, Saunders, Quick, & Collins, 2010a), had increased knowledge about F&V (J. L. Morris & Zidenberg-Cherr, 2002a; Langellotto & Gupta, 2012), had eaten a greater variety of fruits and vegetables within the past month, and had overall better attitudes and perceptions in regards to eating F&V (Gatto, Ventura, Cook, Gyllenhammer, & Davis, 2012).

While clearly there is a need for nutrition education, and there is evidence that garden-based nutrition interventions are effective, it remains unclear how relevant that goal is within school systems or how able school systems are able to accommodate a garden focused on nutrition education. The 2001 No Child Left Behind Act has led to an increase in standards based curriculum, standardized tests, and academic accountability in public school systems, which can limit instruction in areas outside of the core academic areas (Hamilton, Stecher, Marsh, McCombs, & Robyn, 2007). As of 2006, the median time spent in nutrition and dietary education was only 3.4 hours in U.S. elementary schools at each grade level (Kann, Telljohann, & Wooley, 2007). For school gardens to maintain viability in public schools, it is necessary for them to have an academic impact (Williams & Dixon, 2013). And while nutrition education may indeed be a component of school gardens, it is unlikely that it is the focus for garden based-learning programs that operate within the school day.

Also, the studies conducted up to this point have overwhelmingly been nutrition intervention studies, where student school garden participants are administered pre and post evaluations, in between which a certain curriculum, taught over a specific time frame, is implemented. And while these studies have cumulatively provided evidence that school gardens can indeed change attitudes and behaviors, they are not indicative

of real world conditions. In analyzing 9 commonly cited studies that measured various effects of garden-based nutrition education within the school day, three used existing school gardens (McAleese & Rankin, 2007; Morris, Neustadter, & Zidenberg-Cherr, 2001; Gibbs et al., 2013) two put gardens into place at the schools for the study (Morgan, Warren, Lubans, Saunders, Quick, & Collins, 2010b; Cason, 1999), and four were unclear if the gardens they used existed before the study. For those that did use pre-existing school gardens, there is no mention of how the gardens were utilized prior to the study. And while in three of these studies the teachers involved either collaborated with researchers or developed curriculum themselves, it is not clear if teachers continued using curriculum after the studies, or if the programs addressed content they were responsible for teaching (Morris & Zidenberg-Cherr, 2002b; Parmer, Salisbury-Glennon, Shannon, & Struempfer, 2009; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011b; Lineberger and Zajicek, 2000). In essence, these studies are valuable in showing that school gardens can have an impact, but are not analyzing the impact in real-world garden programs.

Nutrition interventions have been found to be most successful when based on a theoretical framework (Lytle, 1994). And while garden-based-learning programs are all unique, there are general constructs that apply broadly to these programs. Social Cognitive Theory (SCT) is commonly used as a theoretical framework for explaining the impact of school gardens (Morris, Briggs, & Zidenberg-Cherr, 2000; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011; Morgan, Warren, Lubans, Saunders, Quick, & Collins, 2010b; J. L. Morris & Zidenberg-Cherr, 2002b; J. Morris et al., 2001). SCT posits that the interaction of cognitive, environmental, and behavioral factors lead to behaviors of

an individual (Bandura, 1986; Bandura, 1998; Reynolds, Hinton, Shewchuk, & Hickey, 1999). It is plausible that school gardens could provide an environment for modeling of attitudes towards vegetables, increasing children's exposure to vegetables, and providing a means of developing self-efficacy towards both gardening and vegetable consumption, even without a specific nutrition curriculum.

While SCT may be most relevant to nutrition outcomes, the experiential learning model is also relevant in terms of garden-based-learning in core academic areas. Experiential Learning Theory as described by Kolb, which is based on earlier work by Dewey, Lewin, and Piaget, discusses the value of combining classroom learning with hands-on learning experiences in increasing learning outcomes (Kolb, 2014). Experiential learning is at the heart of school garden's academic connection, and experiential learning has shown improvements in science skills in garden-based learning classrooms (Blair, 2009; Mabie & Baker, 1996; Williams & Dixon, 2013). However, the hands-on component of gardening may be an important aspect of changes in attitude and behavior toward fruit and vegetable consumption (O'Brien & Shoemaker, 2006), though this specific connection has not been researched.

The primary research goal for this study was to determine if students participating in school garden programs that have primarily an academic focus would associate nutrition messages with their learning experience. Student's perception of what they have learned is not a comprehensive view of what learning has actually taken place, however it does begin to show cognition surrounding garden experience and offers a sense of valuation students place on specific content areas in relation to the garden. To determine if students associate nutrition or health as areas of learning

through interaction with the garden, overall student perceptions of learning outcomes in the garden were identified.

The secondary objective for this study was to understand student's perceptions of vegetable exposure and experience in the context of the school garden to determine how, if at all, school gardens are affecting motivation, preference, or consumption of vegetables.

In conjunction with the research goals, a third goal was to create a research program that, to the greatest extent possible, complements rather than disrupts classroom or garden based learning opportunities. It is important that the teachers and school systems involved in this study find this research useful both to understanding impacts of the garden program for their students, as well as useful for enriching student development.

Methods

PhotoVoice

PhotoVoice is the primary methodology that was utilized for this study. PhotoVoice was first described by Caroline Wang and Mary Ann Burris as a public health participatory research method. They define PhotoVoice as “a process by which people identify, represent, and enhance their community through a specific photographic technique.” Feminist theory and the concept of critical consciousness provide an academic backdrop for this method and were key to Wang and Burris's decision to take documentary photography out of the hands of the researcher, and put it into the hands of the research participants. As a participatory research method, community members are given a voice to express their own understanding of

community strengths and concerns, rather than those ideas being constructed by the researcher themselves (Wang & Burris, 1997).

Photography projects have been used in previous studies to examine children's experience in school gardens. Sands and associates used PhotoVoice with 5th graders to document experiential learning in a school garden program (Sands, Reed, Harper, & Shar, 2009). Although they did find limitations in their project, the limitations listed were caused by planning and time constraints rather than appropriateness of the method. Otherwise, the researchers found PhotoVoice to be a valuable tool for working with youth in the garden, citing that PhotoVoice gave students the ability to express themselves visually, provided teachers an accurate feedback tool, and increased student feelings of appreciation for the garden work they were completing. Moore and associates (2015) also used photography and narrative writing to see what children thought was important in the garden and were able to use narratives to provide useful insight into the research topic. PhotoVoice was chosen for the current study as the most appropriate tool for understanding the perception of student learning in the garden for the following reasons:

1. Participatory asset mapping - Wang identified asset mapping as one of the primary uses for PhotoVoice (Wang, 1999). Though the topic used in this study was less broad than those identified and suggested in her work, this project uses mapping of learning and doing activities to understand student perceptions of the hierarchy of importance of what was learned and what tasks are completed in the garden. By using the combination of photos and narratives, the physical garden

landscape was layered with the mental learning landscape to better understand the interaction between the two.

2. Participatory evaluation - Wang also identified participatory evaluation as a key use for PhotoVoice (Wang, 1999). The current research is important to understand how knowledge, and specifically nutrition knowledge, is situated through the garden experience. And while this will be useful in understanding how gardens influence adoption for a myriad of factors surrounding vegetable consumption, it is also of immediate relevance to the teachers, school systems, and communities involved in the gardens. Student identification of what they have learned will assist teachers in evaluating how well they are meeting academic goals through the garden and assess student levels of understanding.

PhotoVoice is also a means of:

3. Engaging youth in creating knowledge - Historically school gardens have been a forum for discussion of progressive social issues. So often youth are being used to achieve change in the larger social context, yet rarely have they been called upon to add to the creation of knowledge surrounding the need for those changes. Wang lists five key concepts in PhotoVoice, with one of those being that “community people ought to engage in creating and defining the images that shape healthful public policy.” School gardens have become a part of public policy, making PhotoVoice methodology increasingly relevant and appropriate choice of research methodology (Wang, 1999).
4. Engaging youth in their learning process - PhotoVoice is particularly valuable as a pedagogical tool; it uses reflection to concrete learning, promotes critical

thinking skills, integrates technology, creates context for real-world writing skills, and ultimately engages students in their own learning process.

5. Grounding ideas in visual images - PhotoVoice, by using photos, group discussion and narrative writing, tethers learning concepts to photos of the physical spaces that aid in developing those specific concepts. While students may be able to describe many elements of learning relevant to the garden, it is important to tie learning specifically to that space.
6. Providing visual evidence for decision makers - Finally, PhotoVoice was chosen as a method because of its goal to reach policy makers (Wang and Burris, 1997). Policies impact the effectiveness of school gardens at the school, district, state, and national level. One goal of this project was to engage community stakeholders as well as those who are making decisions that impact how school gardens can be used and supported within school systems.

Interviews

Both teacher and student interviews were conducted as a follow-up to the PhotoVoice project. While the PhotoVoice portion of the study captured very broad information about student perception of learning in the garden, interview questions were developed to generate information about more specific questions. Interviews were only conducted at the Tupelo Ridge and Clover Valley schools (pseudonyms used to protect anonymity) because these garden programs were more well established.

Teacher interviews focused on motivation for using school gardens as part of the curriculum, academic and non-academic goals of the garden, learning strategies implemented and learning outcomes observed, and finally, the role of vegetable

gardens in nutrition outcomes. Teacher interviews were not part of the original research plan, but as data from the PhotoVoice portion of the project was analyzed, it became evident that taking a deeper look at teacher motivations and perceptions of the garden would be valuable in understanding student generated data.

Student interviews were focused primarily on garden experiences, especially with consuming vegetables grown in the garden, and their perception of eating vegetables in context with their larger food environment. Several questions pertained to student vegetable preference as well. Student and teacher interview protocols can be found in the appendix.

Research Protocol

Site Selection

Schools and classrooms participating in the study were selected on the following criteria: 1.) presence of an edible garden, 2.) regular use as a teaching tool during the school day, 3.) connection to core academic content, 4.) involved elementary school classrooms. 5.) researcher access to classrooms using the gardens. The three schools selected based on these criteria were Hawthorne Elementary School, Clover Valley Elementary School, and Tupelo Ridge Elementary School (pseudonyms used to maintain participant anonymity).

Demographic information was not identified as part of the study for individual participants; however, demographic and economic indicators for each school are listed in Table 1.

Table 1 Demographic and Economic Indicators for participating schools

Indicator	Hawthorne*	Clover Valley*	Tupelo Ridge*
% white	53	83	74
% black	36	3	8
% multiracial	5	5	4
% hispanic	5	4	13
% Asian	1	5	2
% eligible for free or reduced lunch	64	17	67
% of students with a disability	11.4	9.7	17.5
% of gifted students	5.6	14	7.5

(K-12 Public Schools Report Card, 2014)

*names changes to ensure anonymity

Participant Recruitment

At both Tupelo Ridge and Hawthorne Elementary School the school garden is a living laboratory for STEM (Science Technology Engineering and Math) enrichment classes. Multiple classes use the space and are taught by a science enrichment instructor. The STEM teachers at each school identified which classes would be best suited to participate in the study using their professional judgement. At Clover Valley Elementary the school garden is used by several teachers, but was established and is maintained by one 3rd grade teacher. Her homeroom class was invited to participate in this study.

After approval by all of the relevant school districts and/or principals as well as the study being approved by the University of Georgia Institutional Review Board, each

class was visited to explain the study, obtain student assent, and send home relevant parent consent forms. 100% of both Clover Valley and Tupelo Ridge, and 92% of the Hawthorne Elementary students participated in the study. Total enrollment in the study was 66 students, though only 64 completed the study because of a class enrollment change. This high enrollment level was essential in creating an understanding of the total class garden experience, rather than just the experience of a few select students.

Participant Training

Before beginning the research project all students were educated about the PhotoVoice process, photography ethics, and basic photography skills. After the initial introduction, they were given the prompts of 1.) What do you learn in the garden?; and 2.) What do you do in the garden?

An entire class period was devoted to introducing the prompts and providing scaffolding for the students to help them think through the photo taking process. Students co-created a chart where they verbally answered the prompts and provided examples of photos that answered the prompts. Students also drew pictures of the potential photos they may have taken during the project, and wrote short paragraphs describing how the drawings expressed what they were learning and doing in the garden. This offered students an opportunity to conceptualize photos that would answer the prompts without being guided to specific answers by either the researcher or classroom teacher. This also focused students on the purpose of the project, rather than just the initial excitement of using cameras in the garden space.

Data Collection

After training, digital cameras were left at each school for a portion of the fall semester. Thirty digital Nikon Coolpix L29 cameras were purchased for the project. Two, on occasion, three students shared each camera. To establish authorship of photos, students took photos of their name card before their series of photos each day data was collected. When photos were downloaded the photos appearing after the student's name were taken by that student, and for the most part this proved very effective. Because Tupelo Ridge participated in the pilot study where each student had their own camera, the students experienced confusion with the new system and there was a question of authorship of photos in the first few weeks. Students were easily able to distinguish their own photos however, but because of the initial question of authorship, the wish of the teacher to document further into the growing season, and inclement weather that kept students from fully participating in garden activities, the Tupelo Ridge classroom later received a full set of cameras, and were given several additional weeks to take photos. The other teachers felt they were able to accurately capture the garden experience and collect data within a month, and did not ask for additional time with the cameras. The frequency and duration of time students were allowed to take photos in the school garden was decided by the classroom teacher.

Student Data Analysis

After the photos were developed, each student received a packet of their printed photographs. Students were asked to select one photo to talk about during a small group discussion that they would also write a narrative about later. Five to eight students at a time participated in small group discussions with each student in the study

participating. Discussions were facilitated by the researcher and audio-recorded. Students were asked to 1.) Describe what was happening in the photo/or what the photo was of and 2.) to tell the group how that related to what they were learning or doing in the garden. After each student presented their photo, the students organized photos based on the dialogue surrounding them, and assigned a category for each group of photos. Students were very effective at making decisions as a group, but when conflict or obvious stalemates occurred, the researcher stepped in and facilitated decision making. Likewise, when students became unfocused, or began grouping photos merely by content of the photo, rather than student's responses of why they took the picture, the researcher reiterated the goal of the group discussion.

In addition to group coding of photos, students also wrote guided narratives, free writes, and captions about their favorite and most meaningful photos. Students at Clover Valley and Tupelo Ridge schools chose their own pseudonyms to maintain anonymity. Hawthorne students were randomly assigned pseudonyms.

Student and Teacher Interviews

All interviews took place after completion of the PhotoVoice project. Nine students at each school participated in the interviews. Students were selected by classroom teachers, and were interviewed in groups of three at a time. All interviews were audio recorded and later transcribed. The primary school garden teacher at each school was also interviewed and audio recorded. Names of the teachers have been changed to protect their anonymity.

Data Analysis

For the final analysis student narratives were coded. After an original open, inductive coding, data was organized into themes through concept mapping. All materials were then recoded with the emerging themes to elucidate common threads in student learning, and learning subgroups were defined as needed, as well as themes not directly related to student learning. Other data, such as student codes developed during group discussion, student created anchor charts, and field observations, were used to further support the thematic analysis. Student interviews and teacher interviews were also coded, but as separate data sets from the PhotoVoice project. Themes were identified for each question as well as for the entire interview.

Results

Student Narratives

Four major themes developed across analysis of each school. These were science learning, garden skills and tasks, the garden as food, and personal growth.

Science Learning

Science learning themes were prominent at both Clover Valley and Tupelo Ridge schools. At Clover Valley, science learning could be divided into two main categories, plant science and ecology. Plant science was a very small theme and included plant needs. Ecological learning themes revolved almost entirely around discussion of caterpillars and butterflies, and could be clearly separated into sub-themes of habitats, life cycles, and pollination. Students showed a clear understanding of ecological interactions in the garden. For example; “In the school garden we plant flowers that attract pollinators like the Gulf Fritillary” and “I like butterflies because they help pollinate flowers. This photo makes me feel happy because all the flowers we planted are being

pollinated by pollinators.” The interdependence of species within an ecosystem is an important ecological concept, and while students are not directly identifying this concept within their writing, description of specific ecological relationships was common.

Species identification was also not discussed by students in the context of learning. However, identifying specific species located within their photos and providing information regarding those species was present in the majority of student narratives. Nineteen plant and animal species were identified in student narratives, with several, such as the Gulf Fritillary, Yellow Swallowtail, and general “caterpillar,” repeated multiple times.

Student coded science learning themes were markedly similar to the researcher’s interpretations of their data, though in some cases somewhat less specific, and included “nutrients,” “life cycles,” “pollinators,” “butterfly,” and “caterpillar/larvae.”

Tupelo Ridge students on the other hand, had less of a focus on ecological concepts, and instead focused on plant science, specifically plant needs. Students most often listed water and sunlight as plant needs, but soil, space, food (nutrients/fertilizer), air, and the correct season were also listed, which shows an advanced understanding of plant needs for this age group. One student even gave a brief description of photosynthesis; “Did you know the leaves on a plant collect sunlight to make sugar?”. Plants whose needs were met were identified as “healthy” and “in good shape,” and students cautioned that forgetting to water would result in plants that are “brown and rotten,” which shows understanding of cause and effect between what happens when plant needs are met, as opposed to when plant needs are ignored.

No specific science content theme emerged from analysis of Hawthorne Elementary student narratives. However, observing plant growth was an overwhelmingly dominant motif within their writing. Perhaps because these students, unlike students at the other schools in this study, had the opportunity to plant the very first seeds in their elementary school garden that was established in the semester of this study, they display more joy and excitement over seeing the changes that occur, as seeds germinate, and as the weeks go by grow larger and larger until time for harvest. This is shown in a quote by Jamal who writes, "This is a photo of a seed. The seed is what we planted to see how the plants do in a month and they grew and grew into green leaves.... I took this photo because I want to see when the seeds grow big and see how much it grew. This photo makes me feel excited because I got to see how they grew larger. From seeds to collard greens." It is likely that with continued exposure to the school garden, these students' ability to describe learning in the garden would change over time. However, It is important to note that after their first few visits to the garden, observation emerged as a theme. Observation is an important science skill as well as "Habits of Mind" standard for Georgia science curriculum, and is important not just for learning about science, but in the creation of science knowledge. Many gardeners can testify to the joy and satisfaction of watching a plant grow from seed, and these students clearly express their excitement at the progress of these seeds. And while students did not specifically talk about plant life cycles, they are learning about life cycles through observing plant growth. They also seem to have somewhat of a focus on the gardening process. When coding, all groups here instinctively began to put their photos into a

chronological order based on the process of gardening, following the garden from soil preparation, to planting, and documenting plant growth.

Garden Tasks and Skills

Students at all three schools identified multiple garden tasks completed in the school garden. In total, 61 references were made to specific gardening tasks, though general mentions of “taking care of plants” and “helping plants grow” were not included in this count. Overwhelmingly, students at all school listed planting as a garden activity, with students writing about planting 23 separate times. Harvesting was the second most listed garden skill with 10 distinct references, but was only mentioned at Clover Valley and Tupelo Ridge. However, when the photos were taken at Hawthorne, the plants were not ready for harvest, so that is not entirely surprising, but students did anticipate “picking” as a future activity. Preparing the seedbed (referenced 7 times), which was described as tilling, smoothing soil, and shoveling, was a close second to planting at Hawthorne, but was not listed at either of the other schools. Weeding as a garden skill was listed at all three schools. Watering was described at Tupelo Ridge and Clover Valley, however the Hawthorne garden has limited access to water, so students may not be involved in watering. Less frequently mentioned garden tasks were fertilizing and measuring at Hawthorne, deadheading and playing with chickens at Clover Valley, and a general description of transplanting at Tupelo Ridge.

Tupelo Ridge students also had a small subset of cooking skills that were found within the discourse of garden tasks and skills. These skills include food preparation tasks such as washing, cutting, and “making food”. Eating the vegetables was also referenced in conjunction with these tasks. While students at other schools did

reference either cooking or eating, it was in other contexts with the exception of one Clover Valley student who listed cooking as a garden task.

The School Garden as Food

A number of food, eating and health related themes emerged during analysis, although at each school the role of the garden as a source of food emerged in different forms.

At Hawthorne Elementary, many students wrote about anticipating eating the collards they grew. For example, “I also think our school garden is well growing and it is healthy and it will be good to eat when we eat it.”, “This photo makes me happy because it’s something we can eat.”, and “ I think my health would be happy to have some good veggies in my belly.” This anticipation was a prominent theme of Hawthorne student’s narratives, and the expected future experience of eating the collards was overwhelmingly positive. These students are excited about tasting the veggies, rather than fruits, of their labor.

Tupelo Ridge students on the other hand, centered their writing around eating, and in particular, healthy eating. Much of the writing that mentioned vegetables growing in the garden also referenced those vegetables as food. For example, Dorothy writes “In the garden we grow healthy stuff like broccoli” and later reiterates “In the garden we grow plants and healthy food”. Students commonly even referred to garden plants as food, rather than something that would be made into food. Ninjaboy3 phrases this concisely saying “In the garden we plant food.” Heather elaborates more expressing “I think our school garden is wonderful because we have a lot of food in the garden that is healthy and there are pretty plants”. Not only do students reference healthy food, they reference both eating and enjoying vegetables. There is also an understanding of how

healthy eating influences overall health. Bandit writes extensively about healthy eating; “You need to be healthy so you can live a long life. This picture is about growing and eating. Vegetables are very good for you. You need a garden so you can grow vegetables so you can be healthy.”. Nature Girl goes so far as to actually include a recipe for turnip fries in her narrative about the photo of a turnip plant she took. There is clear evidence at Tupelo Ridge Elementary School that students are not only associating the garden produce as food, but they are identifying these foods as healthy, and describing an appreciation for eating vegetables.

Finally, Clover Valley students identified food from the garden as a means of helping others; “In the school garden we plant plants to grow plants that we give to families that don't have enough food.” Not only do students acknowledge where the vegetables they grow and harvest go, they take pride in it, are empowered by the act of giving to others. Blue Night Hawk begins by describing his photo of a piece of garden art; “The tiles say ‘Gardening with a Purpose.’...This photo makes me happy because I always garden with a purpose to help those in need.” The Red Fire-Breathing Dragon says “It makes me feel awesome inside because I am helping families in need.” Every student who wrote about the purpose of the garden did more than just describe the process of harvesting, food preparation, and donation; they took ownership. Students consistently used phrases such as “we grow”, “we give”, “we...feed our families”, and “/ am helping”. Clover Valley students did not mention eating vegetables or personal health within their narratives, but it is evident from their writing that they have passionately embraced the garden mission of providing for the hungry.

Personal Growth

There were a number of unanticipated themes that arose that center around what could be characterized as personal growth, work ethic, or even character development. These themes most often illustrate attitudes of work and care that are cultivated in the garden environment, but also extend to self-efficacy, and various forms of pride.

“Working Hard”, “Giving Care”, and “Helping in the Garden” were all distinct themes based on the language around the central personal growth theme, but all approached the same ideas that gardening is hard work, takes a lot of effort, and care is needed to provide for plants and animals in the garden. Awesomest Person in the World at Clover Valley writes “I think our school garden is awesome because we work hard to keep it in good condition.” Students understand that for a garden to be successful it takes the combined effort of all, as demonstrated in this quote by Rebecca at Hawthorne Elementary; “I think our school garden is going to be good because everyone works together. Students also realize that this is part of the learning they do in the garden. Earthworm at Clover Valley writes “I took this photo because our class learns how to take care of our animals and water, feed, and play with the animals.” Similarly another student at Hawthorne says “We learn...how we can help our garden grow.”

Closely related to the themes of “Working Hard”, “Giving Care”, and “Helping in the Garden” is “Pride in Accomplishment”. More than just describing hard work, students took pride in the effort and care they have expended to achieve a thriving garden and wanted that to show in their photos. Several students described the reason for choosing a particular photo to write about because they felt it represented the work

put into the garden. One such student wrote “ I choose this photo because I thought it would stand for how much we work and harvest in the garden”.

There were many other examples of pride among student narratives. In particular at Clover Valley, students demonstrated pride for the mission of the garden. For Hawthorne student's pride was most often displayed in their desire to share their garden experience with others. Like students at Clover Valley, these students also write about wanting others to know that they are good workers, but they also describe wanting others to see photos of their garden, and even being able to teach others how to garden by taking photos of each step in the gardening process. Students at all schools demonstrate pride in their school garden by use of positive descriptors in regards to the school garden. Awesome, amazing, beautiful, wonderful, great, cool, good, special, and fun are all used to describe the school garden. Agatha at Clover Valley says “Our garden is the best garden in the world and I love our garden”.

Another theme worth mentioning is the increase in self-efficacy Hawthorne students demonstrated surrounding their ability and identify as gardeners. Comments like “This photo makes me feel happy because it makes me think I know how to plant.” exemplify this concept. Because of their school garden experience, these students feel more comfortable and confident as gardeners.

One theme that was unexpected, but pleasantly surprising was student empowerment through the PhotoVoice process, which was evident at all three schools. During the course of the project it was clear that students were excited to receive their developed photos. They eagerly opened their photo packets and spread their art over their desks, analyzing each photo, and showing each other, their teachers, and the

researcher their best work. Nevertheless, it was still surprising to see this emerge so strongly in student narratives. Some students expressed a desire for others to know the work that went into taking the photos, and deciding which photos to take. Others expressed pleasure at the beauty in their photos and the outcome of their own artistic vision. Still others wrote about choosing to take a particular photo to share particular garden knowledge or skills with others. Overall this was a very powerful theme within student narratives, and shows the importance of participatory research and the value of self-expression. Here are a few student quotes that demonstrate the empowering effect of the PhotoVoice project:

“This photo makes me feel amazing because I worked hard to focus it on one thing.” - Awesomest Person in the World

“This photo makes me feel happy because I know I took it.” - Grealishes

“This photo makes me feel like a good photo taker and that I am serious when I take my photos” - Paxton

“This photo makes me feel happy because the shading is so pretty” - Brianna

“When others see my photo, I want them to feel good about themselves too. Just how I feel about myself.” - Shawna

“This photo is like my favorite out of all the photos because it really looks like an ants life or maybe a spider’s life. It is cool how I like my photo so much.” - Brooke

Teacher Interviews

Motivation and Student Learning Experience Themes

Teachers at Clover Valley Elementary School and Tupelo Ridge Elementary School were interviewed regarding program goals, perceived outcomes, and academic strategies used. While this generated a variety of interesting and valuable themes, the

ones relevant to this particular study relate to teacher's motivations and the student learning experience they aim to create through the gardens.

For student photos and narratives, many themes revolved around specific content. For teacher interviews however, the learning process emerged as a primary academic focus. Both teachers described the academic value of the garden in terms of teaching problem-solving and communications skills and as a place where students could learn with real-world, concrete examples.

Another important theme for both teachers was life skills, though the teacher at Tupelo Ridge was reluctant to use that phrase, and focused more on students being able to help themselves. Every class period he tells students that their mind is a garden, where they can choose to plant useful or beautiful things, or let weeds take over; he wants to empower students to make good choices for their minds and bodies. Mrs. McGregor talked about life skills in two primary contexts. One was teaching students the intrinsic value of hard work and effort, and how taking care in the work they do can create positive outcomes...like their beautiful garden and the families they provide food for. This is especially relevant, because this was also an important theme throughout her student's narratives. She also discussed life skills in the sense that knowing how to use tools, build things, and grow things, and to think through the gardening process is just as valuable as academic knowledge.

What was most interesting in the teacher interviews, is their responses to the very first question asked, which was "Why did you decide to start a school garden?". In both cases the answers the teachers provided correspond with emergent student themes revolving around the garden as food.

Mrs. McGregor wanted a garden with a mission and a purpose beyond food production, of wanting to give back to the community. Her goal was not only to address hunger in the community, but to also teach students that they can contribute, that they can make a difference. This sense of purpose was profoundly reflected in student narratives, where helping others through gardening was a primary theme.

On the other hand, Mr. Green started a school garden as a component of the larger Farm to School program. He connects science concepts from seed to table, and in the process teaches students where their food comes from. He does not teach nutrition in a way that would be recognizable in the realm of nutrition education, but does talk about growing and eating healthy vegetables. He ties this into science standards by asking questions (he's a big fan of the Socratic method) that allow students to make connections for example, between rocks and minerals they have studied, to nutrients plants take up from the soil, and ultimately to eating minerals by eating vegetables from their garden.

Beyond the classroom, many Farm to School components are also visible at a school wide level. A professional chef comes in once a week to work with the Tupelo Ridge cafeteria to increase tasty and healthy choices. Tupelo Ridge Elementary School (TRES) is part of the Georgia Feed my School week program, where one week a year everything on the cafeteria menu is grown or produced in Georgia. Mr. Green also organized a Taste of Tupelo Ridge event for students and parents featuring local chefs and their take on kid-friendly seasonal vegetable recipes. Even the hallways have been decorated with student work describing their favorite veggies on researcher visits to the school.

Both teachers felt that students were more open to trying vegetables because of the school garden experience, citing both increased exposure or “immersion” into vegetables and the desire to eat what they had produced. Both teachers also cook with vegetables from the program. Tupelo Ridge students have prepared vegetables in the classroom and have also had chefs visit and prepare seasonal vegetables for them. Clover Valley students have a cooking club that meets once a week to prepare meals for local families in need, but students are also given the opportunity to try F&V from the garden. However, vegetables as a source of nutrition or way to improve student health was not a major theme in Mrs. McGregor’s interview. Likewise, while CVES students frequently brought up growing food to provide for those in need, growing and eating vegetables to be healthy was only mentioned once.

Both teachers have clear academic and personal growth goals for their students, but what really seems to influence student response to the vegetables they are growing is the driving force behind why these teachers decided to begin a garden-based-learning program. There was no doubt in the interviews that these gardens were an important part of the academic curriculum, and that students were learning necessary content through the lens of experiential and problem-based learning. However, the other social goals that are important to these teachers are interwoven through the rhetoric and discussion in the garden, and are ultimately influencing how students perceive food in the garden. This is further supported by results from student interviews

Student Interviews

Nine students at both Clover Valley and Tupelo Ridge also participated in an interview about their experience with the school garden, eating vegetables from the

garden and how that compared to other experiences with eating vegetables, preference for vegetables, and their perception of changes of preference because of the school garden. In total there were nine questions (some with multiple sub questions), but a few stood out as particularly informative as I coded the interviews.

What is the purpose of the school garden... why is there a garden at your school?

All nine Clover Valley students identified feeding families and ending childhood hunger as the purpose of their garden, aligning with themes from PhotoVoice narratives and the teacher interview. TRES students had somewhat more varied answers, and did include an acknowledgement of learning goals, but the majority of the students thought the purpose of the garden was to have healthy food, or food to eat in general. Overall, students' views of the purpose of the garden seemed to be based in the outcome of the food grown in the garden, which is determined by teacher-set parameters for the garden program.

Have you ever tried the vegetables that you've grown at school?

Again, answers between the schools were highly varied. All students from TRES could identify one or more vegetables that they had tried, and most students enjoyed the vegetables, though that response was not unanimous, and some students reported liking some vegetables and not others. CVES students, although the teacher reported they had tried vegetables in the garden, were uncertain of having tried garden vegetables, and this question always resulted in a discussion amongst research participants, trying to recall if they had in fact tried anything. Some students thought maybe vegetables were eaten if there were leftovers in cooking club, but zucchini bread

was the only definite use of a vegetable listed, though making fig jam from garden figs and trying pink lemonade raspberries were both fruits that were mentioned.

As a follow-up to this question, the researcher asked students that reported trying garden vegetables if they would like to eat more vegetables from the garden. All TRES students, even ones who reported not liking the vegetables they had tried from the garden, wanted to try more.

Do you think participating in the school garden has made you like eating vegetables more, less, or the same?

This was the last question asked about vegetables. Slightly more students at Tupelo Ridge said the school garden made them like garden vegetables more, though an equal number of CVES students said that they liked vegetables the same, as reported liking them more, and one student reported liking them less. No Tupelo Ridge students reported liking vegetables less, though one student liked them the same, and one was unsure. One Tupelo Ridge student volunteered “I like vegetables better than junk food.”

More important than the response to this question, were the answers given to why their preference had changed. Though there was no clear trend in responses from Clover Valley students, the majority of TRES students reported that they liked vegetables more because of being able to try different vegetables from the garden; wanting and enjoying “trying” the garden vegetables came up multiple times during the interview. Some students said they like school garden vegetables more because they were “yummy” or “healthy.”

One other important theme that emerged, was a strong student preference for either raw or cooked vegetables. Liking or disliking one of the other came up in

discussion multiple times at each school, and frequently multiple times within an interview. This could be important for research regarding nutrition in the school garden in the future.

Discussion and Conclusions

Nutrition Outcomes

Teachers create a garden culture through modelling societal ideals

The main purpose of this study was to determine if students perceived nutrition learning as an outcome of garden-based-learning experiences where science content was the academic focus. Based on evidence from student coding, narratives, and interviews, teacher interviews, and field observations, it seems evident that students are thinking about garden vegetables as a source of healthy food if it is a clear goal of the school garden teacher, though specific nutrition content does not have to be center to the curriculum.

At Tupelo Ridge Elementary School, the garden teacher identified Farm to School programming as the basis for creating the garden. As the science lab teacher, the academic justification for his program is to enhance science learning, and content does focus on science, not nutrition standards. However, the way he frames discussion about the garden, links science learning to eating, and incorporates eating experiences with students, in conjunction with a school atmosphere that promotes Farm to School learning, is increasing student's exposure to the concept of eating vegetables for health. Student's did not identify any specific nutrition content in relation to the garden, but spoke frequently about "growing food" and "eating healthy vegetables."

Similarly, Hawthorne students, who knew the collards they were growing would be served in the cafeteria, eagerly anticipated the harvest of the vegetables, and the expectation was that they would be both tasty and nutritious. The garden teacher, also a science enhancement teacher, listed nutrition as a focus for the garden, though over the course of the project, students did not document any specific nutrition content. Unlike the other two programs which were well established, this program was only in its first semester. It seems likely this theme would further develop as students gained more experience in the program.

On the other hand, at Clover Valley Elementary, which has a remarkable school garden program in which students grow food to serve to needy families in the school community, students did not discuss vegetables as a source of food for themselves, but rather discussed growing food to help others. The classroom teacher there briefly mentioned nutrition in her interview, however, it was not a recurrent theme within the interview, like the service component of the garden was. Even though many students in her class participated in an after school cooking club, where they had hands on instruction for preparing garden vegetables, their perception of learning in the garden that centered around food was all about giving. Clover Valley students had difficulty remembering if they had even tried vegetables from the garden, though their teacher mentioned they had several opportunities to taste the vegetables and overall seemed to enjoy the experience.

It seems that specific nutrition knowledge or content surrounding school gardens is not as important as how teachers frame the purpose of the garden. In both the teacher and student interviews at Tupelo Ridge, the garden as a source of food, and

specifically healthy food, was the main reason identified for why the garden was put into place. At Clover Valley, the teacher, and all the students interviewed, identified the garden as a means to address hunger issues in the community. These social goals that extend beyond the academic content are woven through the entire garden experience, and that immersion in a particular garden culture changes how students perceive learning in the garden. This supports social cognitive theory, and particularly the value of social modeling in learning.

As teachers are modeling certain behaviors and attitudes toward the garden, student's are adopting these views, which was strongly demonstrated in student narratives. This is particularly noticeable at Clover Valley and Tupelo Ridge Elementary where teacher interviews align strongly with student narrative themes, especially in the context of how food is viewed. This was also noticeable in personal growth themes at Clover Valley, and to some extent at Tupelo Ridge, though the connection there was not as defined. What will be most important to long term changes in attitude and potential subsequent changes in consumption, is how strong these teacher influences remain after students leave their respective garden programs.

Students identify opportunities to try new vegetables as an important part of change in vegetable preference

Nutrition themes emerged at both Tupelo Ridge and Hawthorne Elementary School. However, student narratives did not convey changes surrounding nutrition attitudes to any degree that would support thematic analysis of why those changes were occurring. Student interviews however, did demonstrate a specific trend around the experience of sampling food from the garden. When asked if they liked vegetables more, less, or the same after participating in the garden experience, most students

answered more, and overwhelmingly students identified being able to try new vegetables as the reason why this change was occurring. The experience of “trying” vegetables was important to the garden experience. Students also related that sometimes vegetables they ate from the garden program were prepared in different ways than they were at home. Differences in tasting vegetables raw versus cooked was also mentioned numerous times in the context of garden produce eating experiences. Even students who reported not liking the vegetables they tried in the school garden wanted to eat more food harvested from the garden in the future.

While many of the interview questions did ask students about the experience of eating food from the garden, this theme was evident in more general garden questions as well, such as the student’s favorite part of the garden experience. This fits closely with prior school garden research that shows students who participate in gardens display a willingness to try new vegetables (Robinson-O'Brien et al., 2009). Nutrition research has shown that multiple exposures to vegetables can change preferences (Wardle et al., 2003); based on student feedback, the garden seems a particularly useful venue for those multiple exposures since students are eager to try more, even if they did not identify as liking vegetables previously tasted. This evidence could support either the social cognitive theory or experiential learning theory, though it does not align with one overwhelmingly more or the other. Students did not however, identify growing their own vegetables as a reason for wanting to eat them, though that could be the result of how interview questions were phrased. That particular hypothesis has enough anecdotal support that it deserves further research.

Other Outcomes

Mixed methods studies may further research on school gardens and environmental learning

At Clover Valley ecological content themes were prominent, especially surrounding learning about pollinators. While conservation was not an emergent theme during the PhotoVoice project, observations during follow-up school visits to conduct student interviews as well as the teacher interview from that program, suggest that academic learning about specific species in the garden was beginning to transfer to an environmental appreciation and understanding for the need for environmental conservation. At these times, student had begun work on a STEM Problem Based Learning Project where students chose as a class to focus on monarch conservation, and were in the process of conducting research to create a monarch habitat, and were also writing a grant and raising money for this purpose. School gardens are thought by many environmental educators to be a valuable resource to teach ecology and environmental ethics. However, research has not effectively captured changes in environmental attitudes as a result of garden experience (Blair, 2009). This study was not aimed at looking specifically at environmental outcomes, but data generated in the process suggests that a qualitative study could be used to understand how students view gardens as part of the environment and could also inform the use of quantitative analysis, such as survey content.

Questioning the critique of school gardens' role in cultivating neoliberalism

There is an ongoing debate in the social sciences regarding the type of citizens that school gardens create, and a concern that these programs, along with other alternative food movements, are encouraging neoliberalist values (Allen & Guthman,

2006; Hayes-Conroy, 2010; McClintock, 2014; Pudup, 2008). Neoliberalism refers to a “market-driven ideology, through emphasis on such principles as volunteerism, individualism, personal responsibility, and consumer choice.” (Hayes-Conroy, 2010). Personal growth themes surrounding hard-work and the results of that hard-work emerged from analysis of student narratives at Tupelo Ridge and Hawthorne Elementary schools. While these could certainly fit into the neoliberalist critique, are these not important life skills? The youth that wrote about working hard were proud of the products of their labor, and not only of the outcomes, but of the care and effort that they had put in to achieve those outcomes. Furthermore, students at Clover Valley elementary also displayed a profound sense of compassion towards those in need, and a sense of concern for the community. These students are not teaching the poor to garden, they are simply working to meet a need in their community. All of the work that they were so proud of was going to benefit others not themselves. It is important to note that school gardens have the capacity to develop many characteristics within the youth working in these programs, and how and what shapes children into the adults they will one day become is much more complex than ideology behind market theories. While this paper was not designed as a critique of the critiques of school gardens, findings showed the example of Clover Valley as a particularly good example of a program that defies this particular concern.

Appropriateness of PhotoVoice as a Methodology and Pedagogy with Elementary Students

PhotoVoice has been noted for its value in creating a critical pedagogy in older grades and college students (Chio & Fandt, 2007; Cook & Buck, 2010; Cook & Quigley, 2013). It has not been well documented for pedagogy in elementary students, though in this study the researcher found it particularly useful in evaluating student learning in

such a way that also met teacher goals for academic development. PhotoVoice is much more about empowering the participants. However, if teachers do not find it to be a useful tool, there is little chance for it being implemented into the classroom. Developing problem-solving and critical thinking skills were identified as the overarching academic goals of the garden program; PhotoVoice is an extension of these goals. Students need to reflect and think critically about how to answer the PhotoVoice prompts. Teamwork and problem-solving was especially important in the group coding stage. In addition, PhotoVoice creates the opportunity for art and technology integration, a writing skills focus, and the very act of reflection was an integral part of experiential learning and may have confirmed learning experiences (Kolb, 2014). Overall, PhotoVoice could be a valuable teaching tool and aligned very well with the learning environment in place in the garden programs that were a part of this study.

PhotoVoice also enabled students to take ownership of their learning. It gave them a voice to express to their teachers and the community what components of learning they identified as important. This is particularly notable in the difference in answers generated by the in class activity where students were asked to list examples of concepts learned through garden experiences, and the actual themes generated by the PhotoVoice project. The class activity resulted in answers that were much more varied, and much more indicative of the total learning experience in the garden, whereas the learning themes that emerged from the PhotoVoice project were much more specific, because students were choosing the pieces of learning that had value to them.

The PhotoVoice project was also a source of empowerment to the students, unexpectedly to the extent that it emerged as a theme in data analysis. Student photo exhibits, which were not a source of data for this study, but were included in the IRB as part of the research process, were used at two of the three schools and seemed to strengthen this component of the project. Both Clover Valley and Tupelo Ridge Elementary sponsored events to display student photos and narratives to the community, as sharing results with stakeholders is an important component of the PhotoVoice methodology. Although this portion was not necessary from a research perspective, it was immensely valuable to the students involved.

Elementary students are developmentally capable of completing the PhotoVoice process, though they may need additional support and training in certain components, such as group coding. Overall, student-generated codes were incredibly similar to the codes developed by the researcher (keeping in mind that they coded photos and the dialogue around those photos, and the researcher coded narratives generated by the photos). Table 2 shows a comparison of student and researcher codes. This exemplifies the potential for increased use of this method with elementary students.

Table 2 Comparison of Student Generated and Researcher Generated Codes

Theme groups	Student codes from group discussion and coding activity	Researcher codes from student narratives
Hawthorne Elementary School		
Science Learning	<ul style="list-style-type: none"> • What plants need • How fast they grow! • Growing Process • How big it is • How small it is 	<ul style="list-style-type: none"> • Observing Plant Growth

Garden Skills/Tasks	<ul style="list-style-type: none"> • Prepping Soil • Digging Process • Planting • Picking 	<ul style="list-style-type: none"> • Garden Skills/Tasks (Plant, Prepare seed bed, fertilize, weed, harvest, measure)
Garden as Food	<ul style="list-style-type: none"> • Picking 	<ul style="list-style-type: none"> • Anticipating Eating
Personal Growth	<ul style="list-style-type: none"> • Working Together 	<ul style="list-style-type: none"> • Working and Helping • Sharing the Garden Experience • Garden Efficacy
Clover Valley Elementary School		
Science Learning	<ul style="list-style-type: none"> • Nutrients • Life Cycles • Taking Care (chickens) • SwallowTail Caterpillars • Pollinators • Butterfly • Caterpillar/Larvae 	<ul style="list-style-type: none"> • Plant Needs • Habitat • Life Cycle • Pollinators • Species
Garden Skills/Tasks	<ul style="list-style-type: none"> • Planting • Work 	<ul style="list-style-type: none"> • Garden Skills/Tasks (plant, harvest, water, deadhead, play with chickens, pull weeds, cook)
Garden as Food	<ul style="list-style-type: none"> • Gardening with a Purpose 	<ul style="list-style-type: none"> • Helping Others
Personal Growth	<ul style="list-style-type: none"> • Taking Care (chickens) • Work 	<ul style="list-style-type: none"> • Giving Care/Working Hard • Pride in Accomplishment
Tupelo Ridge Elementary School		
Science Learning	<ul style="list-style-type: none"> • Soil and Plant • Water and Sun • Growing Group • Water Group • Decomposing Group • Plants Age/Flower's Life/ How Plants Grow 	<ul style="list-style-type: none"> • Plant Needs
Garden Skills/Tasks	<ul style="list-style-type: none"> • Eating and Picking • Growing Group 	<ul style="list-style-type: none"> • Garden Skills/Tasks (plant, harvest, weed, water) • Cooking Skills (food prep, washing produce, eat)
Garden as Food	<ul style="list-style-type: none"> • Eating and Picking 	<ul style="list-style-type: none"> • Healthy Eating
Personal Growth	<ul style="list-style-type: none"> • Eating and Picking 	<ul style="list-style-type: none"> • Healthy Eating

Strengths and Weaknesses of Study

Three schools participated in this study. However, none of them were urban schools, which is where many school gardens are concentrated. Rural and suburban schools may have different needs and resources. In the future, a similar study in an urban setting could be helpful.

A significant portion of time spent in classrooms in this study involved facilitating the PhotoVoice project. In retrospect, observing multiple class and garden experiences would have been immensely useful in situating data generated from this study. Also, because this study included multiple schools, there was a breadth, but limited depth of data at the student level. More time at each school could have remedied this.

Because teachers were so integral to this project, and on some levels could be considered co-facilitators, a brief training would have been valuable prior to the study to increase understanding of the methodology as well as discussing general principles of qualitative research. While prompting by teachers was not present in a level that affected student data, teachers needed to move beyond the role of teacher and into the perspective of a qualitative researcher in regards to assisting with this project both through facilitating space within class time for students to take photos as well as assisting students in the narrative writing.

Concerning reflexivity, the researcher is also a former teacher and supporter of agriculture education and garden-based-learning programs. While the researcher believes these experiences gave her insight that was valuable in coordinating and designing this study, she was also cognizant of her own biases and preconceived notions of the value of school gardens through data analysis and in making conclusions.

One strength of this study was the level of teacher engagement in the PhotoVoice projects, and the strength of their respective garden programs. Without the input of the teachers and their enthusiasm for the project, it would not have been possible. This was also reflected in the relatively high enrollment of the classes involved.

Another strength was including a range of schools and types of programs. This did limit the potential for depth at each individual site, but gave insight into how goals interwoven throughout the content created different school garden cultures and affected learning outcomes. Without multiple schools involved in the study this would not have been possible.

Next Steps

Future research is needed to clarify the role of modeling and school garden culture in forming student nutrition attitudes. Qualitative studies involving a greater emphasis on field observation to better understand and document how nutrition is contextualized in these classrooms would be particularly useful. However, a quantitative study comparing nutrition attitudes, preference, and consumption at baselines where students enter existing programs, and when those student exit programs is absolutely necessary to quantify changes existing programs are creating, and to look for actual changes in consumption. Other studies comparing various types of programs, including one year and multi-year exposures to garden learning are important. Also, analyzing school gardens with different core goals, and a particular emphasis in Farm to School programs would be beneficial to determine how differences in programs affect nutrition attitudes and consumption outcomes.

References

- Allen, P., & Guthman, J. (2006). From “old school” to “farm-to-school”: Neoliberalization from the ground up. *Agriculture and Human Values*, 23(4), 401-415.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.
- Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and Health*, 13(4), 623-649.
- Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education*, 40(2), 15-38.
- Cason, K. L. (1999). Children are “growing healthy” in south carolina. *Journal of Nutrition Education*, 31(4), 235-236.
- Chio, V. C., & Fandt, P. M. (2007). Photovoice in the diversity classroom: Engagement, voice, and the “eye/I” of the camera. *Journal of Management Education*, 31(4), 484-504.
- Cook, K., & Buck, G. (2010). Photovoice: A community-based socioscientific pedagogical tool. *Science Scope*, 33(7), 35-39.
- Cook, K., & Quigley, C. F. (2013). Connecting to our community: Utilizing photovoice as a pedagogical tool to connect college students to science. *International Journal of Environmental and Science Education*, 8(2)
- Desmond, D., Grieshop, J., & Subramaniam, A. (2002). Revisiting garden based learning in basic education: Philosophical roots, historical foundations, best practices and products, impacts, outcomes, and future directions. *Food and Agriculture Organization*, , 59-59.

- Gatto, N. M., Ventura, E. E., Cook, L. T., Gyllenhammer, L. E., & Davis, J. N. (2012). LA sprouts: A garden-based nutrition intervention pilot program influences motivation and preferences for fruits and vegetables in latino youth. *Journal of the Academy of Nutrition and Dietetics*, 112(6), 913-920.
- Gibbs, L., Staiger, P. K., Johnson, B., Block, K., Macfarlane, S., Gold, L., et al. (2013). Expanding children's food experiences: The impact of a school-based kitchen garden program. *Journal of Nutrition Education and Behavior*, 45(2), 137-146.
- Hamilton, L. S., Stecher, B. M., Marsh, J. A., McCombs, J. S., & Robyn, A. (2007). *Standards-based accountability under no child left behind: Experiences of teachers and administrators in three states* Rand Corporation.
- Hayes-Conroy, J. (2010). School gardens and 'actually existing' neoliberalism. *Humboldt Journal of Social Relations*, , 64-96.
- K-12 Public Schools Report Card: Indicators and Demographics. (2014). Student and School Demographics. Retrieved from <https://gaawards.gosa.ga.gov/analytics/saw.dll?dashboard>
- Kann, L., Telljohann, S. K., & Wooley, S. F. (2007). Health education: Results from the school health policies and programs study 2006. *Journal of School Health*, 77(8), 408-434.
- Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development* FT press.
- Langellotto, G. A., & Gupta, A. (2012). Gardening increases vegetable consumption in school-aged children: A meta-analytical synthesis. *Horttechnology*, 22(4), 430-445.
- Let's Move. *Gardening guide.*, 2016, from <http://www.letsmove.gov/gardening-guide>
- Lineberger, S. E., & Zajicek, J. M. (2000). School gardens: Can a hands-on teaching tool affect students' attitudes and behaviors regarding fruit and vegetables?. *HortTechnology*, 10(3), 593-597.
- Lytle, L. A. (1994). Nutrition education for school-aged children: A review of research.

- Mabie, R., & Baker, M. (1996). A comparison of experiential instructional strategies upon the science process skills of urban elementary students. *Journal of Agricultural Education*, , 1-7.
- McAleese, J. D., & Rankin, L. L. (2007). Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *Journal of the American Dietetic Association*, 107(4), 662-665.
- McClintock, N. (2014). Radical, reformist, and garden-variety neoliberal: Coming to terms with urban agriculture's contradictions. *Local Environment*, 19(2), 147-171.
- Moore, S. A., Wilson, J., Kelly-Richards, S., & Marston, S. A. (2015). School gardens as sites for forging progressive socioecological futures. *Annals of the Association of American Geographers*, 105(2), 407-415.
- Morgan, P. J., Warren, J. M., Lubans, D. R., Saunders, K. L., Quick, G. I., & Collins, C. E. (2010). The impact of nutrition education with and without a school garden on knowledge, vegetable intake and preferences and quality of school life among primary-school students. *Public Health Nutrition*, 13(11), 1931-1940.
- Morris, J. L., & Zidenberg-Cherr, S. (2002). Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables. *Journal of the Academy of Nutrition and Dietetics*, 102(1), 91.
- Morris, J., Briggs, M., & Zidenberg-Cherr, S. (2000). School-based gardens can teach kids healthier eating habits. *California Agriculture*, 54(5), 40-46.
- Morris, J., Neustadter, A., & Zidenberg-Cherr, S. (2001). First-grade gardeners more likely to taste vegetables. *California Agriculture*, 55(1), 43-46.
- O'Brien, S. A., & Shoemaker, C. A. (2006). An after-school gardening club to promote fruit and vegetable consumption among fourth grade students: The assessment of social cognitive theory constructs. *Horttechnology*, 16(1), 24-29.

- Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the united states, 2011-2012. *Jama*, 311(8), 806-814.
- Parmer, S. M., Salisbury-Glennon, J., Shannon, D., & Struempler, B. (2009). School gardens: An experiential learning approach for a nutrition education program to increase fruit and vegetable knowledge, preference, and consumption among second-grade students. *Journal of Nutrition Education and Behavior*, 41(3), 212-217.
- Pudup, M. B. (2008). It takes a garden: Cultivating citizen-subjects in organized garden projects. *Geoforum*, 39(3), 1228-1240.
- Ratcliffe, M. M., Merrigan, K. A., Rogers, B. L., & Goldberg, J. P. (2011). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice*, 12(1), 36-43.
- Reynolds, K. D., Hinton, A. W., Shewchuk, R. M., & Hickey, C. A. (1999). Social cognitive model of fruit and vegetable consumption in elementary school children. *Journal of Nutrition Education*, 31(1), 23-30.
- Robinson-O'Brien, R., Story, M., & Heim, S. (2009a). Impact of garden-based youth nutrition intervention programs: A review. *Journal of the American Dietetic Association*, 109(2), 273-280.
- Rolls, B. J., Ello-Martin, J. A., & Tohill, B. C. (2004). What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutrition Reviews*, 62(1), 1-17.
- Sands, C., Reed, L., Harper, K., & Shar, M. (2009). A photovoice participatory evaluation of a school gardening program through the eyes of fifth graders. *Practicing Anthropology*, 31(4), 15-20.
- Subramaniam, A. (2002). Garden-based learning in basic education: A historical review. *Monograph, Centre for Youth Development, University of California*. 12pp,

- The Edible Schoolyard Project. (2016). *Our work.*, 2016, from <http://edibleschoolyard.org/our-work>
- Trelstad, B. (1997). Little machines in their gardens: A history of school gardens in america, 1891 to 1920. *Landscape Journal*, 16(2), 161-173.
- Turner, L., Sandoval, A., & Chaloupka, F. (2014). *School garden programs are on the rise in US public elementary schools, but are less common in schools with economically disadvantaged student populations - A BTG research brief*. Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago.
- Van Duyn, Mary Ann S, & Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature. *Journal of the American Dietetic Association*, 100(12), 1511-1521.
- Wang, C. C. (1999). Photovoice: A participatory action research strategy applied to women's health. *Journal of Women's Health*, 8(2), 185-192.
- Wang, C., & Burris, M. A. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Education & Behavior : The Official Publication of the Society for Public Health Education*, 24(3), 369-387.
- Wardle, J., Cooke, L. J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite*, 40(2), 155-162.
- Wardle, J., Herrera, M. L., Cooke, L., & Gibson, E. L. (2003). Modifying children's food preferences: The effects of exposure and reward on acceptance of an unfamiliar vegetable. *European Journal of Clinical Nutrition*, 57(2), 341-348.
- Williams, D. R., & Dixon, P. S. (2013). Impact of garden-based learning on academic outcomes in schools synthesis of research between 1990 and 2010. *Review of Educational Research*, 0034654313475824.

Appendix

Student Interview Protocol

1. What is your favorite and least favorite thing about being in the school garden?
2. What is the purpose of the school garden; why is there are garden at your school?
3. Have you ever tried the vegetables that you've grown at school? (if not, go to four)
 - a. Can you tell me about that experience?
 - b. How did you like that vegetable compared to those you normally eat?
 - c. Do you want to eat more vegetables from the garden? Why?
4. Do you ever eat the same kind of vegetables that you grow in the garden at home?

(Yes or some)

 - a. Did you eat them at home before you grew them in the garden?
 - b. Do you eat them cooked the same way?
 - c. Are there any vegetables that grow in the garden that you would like to eat at home....are there any that you wish you didn't eat at home?

(no)

 - d. Are there any you would like to eat at home?
5. Overall do you like to eat most vegetables? Why or why not?
6. Do you think participating in the school garden has made you like eating vegetables more, less, or the same?
 - a. Why do you think that is?
7. Are there any photos from the PhotoVoice project that tie what we've talked about today?
8. What advice would you give to teachers who want to start school garden?
9. Is there anything else you think I need to know about the school garden or eating garden veggies?

Teacher Interview Protocol

Motivation

1. Why did you decide to start a school garden?
 - a. How long have you been teaching through gardening?
 - b. What kind of garden experience did you have when you started?

Academic Goals

2. What academic goals do you have for your school garden?
 - a. What strategies do you use to meet those goals
 - b. How do you integrate garden tasks with academic goals?
 - c. Can you name some specific learning objectives or standards that you taught during the PhotoVoice project?

Non-academic Goals

3. Are there other non-academic goals that are important to you?
 - a. Why do you think those are important - both personally and for students??
 - i. How do your personal beliefs play a role
 - b. Why did you decide to meet those goals with a garden?
 - c. What strategies do you use to meet those goals?
 - d. How do you balance academic needs and garden tasks with those goals?

Learning Strategies

4. What teaching strategies do you use in the garden?
 - a. Would you say that your teaching style in the garden is more formal, informal, or a combination of both?
 - i. can you provide some examples?
 - b. Do you use formal and informal teaching styles to teach different concepts?
 - i. can you provide some examples?

Learning Outcomes

5. What student outcomes are most important to you as a result of garden participation?
 - a. How do you evaluate student learning outcomes in the garden?
 - b. Based on your experience, what do you think the most prominent academic learning outcomes are for students participating in the garden?
 - c. Based on your experience, what, if any, non-academic learning outcomes are a result of garden participation?
 - i. Can you provide some examples that you've witnessed of this in the garden?

Vegetables

6. Why did you choose to establish a vegetable garden in particular?
 - a. How do you talk about food in the context of the garden, if at all?
 - b. How do your students react to the idea of eating vegetables from the garden?
 - c. Do you think gardening changes students motivation for eating vegetables, attitudes and knowledge about vegetables and nutrition, or their preference and consumption of vegetables?
 - i. Can you give some examples of how you've seen this?

Concluding

7. What would you say has been the biggest success with the school garden?
 - a. What advice would you give to someone starting a school garden?
 - b. Is there anything else you think I need to know about teaching with school gardens or school gardens and nutrition?

Chapter 3: The impact of school gardens on physical activity during the school day

Introduction

The number of school gardens in public elementary schools has doubled over the past ten years. Approximately 26.6% of elementary schools have a school garden on their campus (Turner, Sandoval, & Chaloupka, 2014). Learning gardens have long been a part of U.S school culture, but since the 1990s this learning tool has experienced a resurgence (Desmond, Grieshop, & Subramaniam, 2002). Generally, this trend has been linked to the growing popularity of experiential learning that took place during the early 90's, and more recently the focus of the school gardens has shifted towards nutrition and agricultural literacy in response to concerns with the modern food system and rising rates of childhood obesity (Desmond et al., 2002; Blair, 2009; Williams & Dixon, 2013).

A plethora of nutrition intervention studies have shown that school gardens can affect students' attitudes and behaviors in regards to fruit and vegetable consumption. Studies have found participation in school gardens increases students' consumption, preference, willingness to try new fruits and vegetables, ability to identify fruits and vegetables, and consumption of a wider variety of fruits and vegetables over the course of a month (Robinson-O'Brien, Story, & Heim, 2009; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011; Morgan, Warren, Luban, Saunders, Quick and Collins, 2010).

However, increasing fruit and vegetable consumption is only one of the ways the school gardening may affect student's health. Gardening has been identified as the

most common source of leisure time physical activity among U.S. adults, and is a good source of moderate physical activity in both youth and adults (Crespo, Keteyian, Heath, & Sempas, 1996; Park, Shoemaker, & Haub, 2009; Domenghini, 2011). Physical activity is an important part of a healthy lifestyle, with 60 minutes recommended daily for youth (US Department of Health and Human Services, 2008)

Despite this, relatively little research has been done on the implications of the school garden on physical activity in school children. An after-school nutrition and physical activity intervention found an increase in self-reported physical activity in a post-intervention survey (Domenghini, 2011). Domenghini also conducted an after-school garden-based nutrition intervention that included both an accelerometer and energy expenditure study. Results of that study concluded that students had a significant increase in moderate and vigorous activity in comparison to times of the day that they were not in garden club. The energy expenditure study analyzed several common garden tasks and found that transplanting, weeding, cultivating, and raking could all be classified as moderate physical activity tasks (Domenghini, 2011).

Recently Meyers created a direct observation tool to analyze five components of physical activity in the garden including activity level, garden tasks, motions, associations, and interactions. This tool has been validated, and was used in a 2014 intervention study at low-income elementary schools in New York (Myers & Wells, 2015; Wells, Meyers, and Henderson 2014). Researchers in that study used self-report data, accelerometry at intervention and nonintervention schools, and the Physical Activity and Research Assessment tool for Garden Observation (PARAGON) direct observation to compare indoor and outdoor lessons. They found through accelerometry that moderate

physical activity (MPA) increased 45% from baseline and moderate to vigorous physical activity (MVPA) increased 1.68%, both of which were significant differences in comparison to the nonintervention schools. PARAGON data from that study also showed that students participating in outdoor learning experiences moved more and engaged in less sedentary time.

The school garden could potentially be an important source of physical activity to school children. Many youth do not meet daily requirements for physical activity, and school is a prime location to promote physical activity (Matthews et al., 2008; Steele et al., 2010; Nettlefold et al., 2011). Physical education classes and recess may be limited and often do not provide adequate opportunities for physical activity (Kahan, 2008). On the other hand school gardens have been shown to increase academic achievement, especially in science, and have multiple other benefits that could help this type of program find traction in the public school system while simultaneously increasing physical activity (Williams & Dixon, 2013; Blair, 2009; Domenghini, 2011; Wells et al. 2014).

The objectives of this study were to 1.) determine if school gardens affect total moderate to vigorous physical activity on days where students participate in garden activities in comparison to school days where students do not participate in garden activities, and 2.) determine what specific movements and tasks were most common in school gardens in order to validate other movement data and provide a better understanding of what specific tasks are leading to an increase in physical activity.

Materials and Methods

Participants

Classrooms at four schools participated in the study, for a total of 77 students. Schools and classes were chosen based on the presence of an existing vegetable garden program, regular teacher use of the garden space, and permission of schools and teachers. The study was comprised of a 1st, 2nd, 3rd, and 4th grade classroom, with ages ranging from 6-10. After approval by all of the relevant school districts and/or principals as well as the study being approved by the University of Georgia Institutional Review Board, each class was visited to explain the study, obtain student assent, and send home relevant parent forms. 87.5% of eligible students participated in the study. The majority of students identified as white (68.1%). Other groups represented included black/African American (16.7%), biracial/multiracial (12.5%), hispanic (1.4%), and asian (1.4%).

Because this study focused on already existing programs, there was a high degree of variability among the school gardens. Garden programs encompassed a range of teacher gardening experience, academic goals, and facilities. Teachers primarily identified science as the main subject taught in the garden but math, language arts, social studies, and art were also identified. Teachers identified providing hands-on and real-world learning experiences as overarching academic goals at every school except School 2. Teachers in schools 1, 2, and 4 stated that time spent in the garden depended both on the season and units being studied.

Table 1 Characteristics of School Garden Programs

Garden Characteristics	School 1	School 2	School 3	School 4
Grade involved in study	3rd	1st	2nd	4th
Years teacher has taught using the garden	5	2	7	1
Class type	homeroom	homeroom	Science enrichment	Science enrichment
Number of raised beds	19	4	24	4
Number of crops grown (end of study)	11	6	12	1
Garden features	greenhouse, compost bins, chicken coop, tool shed, rain barrels	none	greenhouse, compost bin, rain barrels, tool shed	none

Accelerometer Measurement

The Actigraph GT3X (Actigraph, Pensacola, FL) was used to objectively measure the physical activity levels of children during the school day. This is a small (3.8 x 3.7 x 1.8 cm), light weight (27 gm) device that uses a triaxial accelerometer to measure body motion on three axes at a rate of 30 times per second and sums and stores these body accelerations, or activity counts, over a user specified time interval, or epochs. For this study, a 10-second epoch length was used to accurately classify the intensity of activities performed during short bursts, as is typical of children in this age range (Welk, Corbin, & Dale, 2000). Activity counts were downloaded and analyzed using proprietary software provided by the manufacturer.

Students wore accelerometers for a total of six school days, three on “garden days” and three on “non-garden days.” The measurements were divided into three separate rounds of data collection approximately one month apart over the fall growing season for the data to potentially reflect a greater variety of garden tasks. Each round of data collection consisted of one consecutive garden day and one non-garden day. On the first day of the two-day measurement period, researchers assisted putting monitors on students. Teachers collected the devices at the end of the day and assisted students with putting them on the following day, once again collecting them at the end of day two. The actigraph was attached to an adjustable elastic belt, and the monitor was positioned at the midaxillary line of the right hip. Research personnel and teachers kept records of times students wore the accelerometers, and made notes of any absences or early withdrawals during the school day.

Direct Observation

PARAGON is a momentary time-sampling direct observation tool developed to assess the activities of children while gardening (Myers & Wells, 2015). For this study, students were observed in 16-minute time intervals in which each trained research assistant observed 2 subjects on a 15-second observe/record rotation (combined to make a 30 second epoch), for a total of 4 minutes of observation per subject or 16 total epochs for each student. Reliability and validity of PARAGON has been previously established (Myers & Wells, 2015). PARAGON consists of five parts: 1) physical activity level; 2) garden tasks; 3) garden motions; 4) social associations; and 5) interactions. Because objectives of the current study include the determination of how school garden participation affected physical activity throughout the school day, only parts one through

three were utilized. Physical activity level codes consist of standing, lying, sitting, kneeling, squatting, and vigorous activity. Garden task codes include resting/observing, non-garden activities, weeding, digging, harvesting, carrying, and cleaning. Garden motion codes were gripping, bending, stretching, no motions, pushing/pulling, and lifting.

Research assistants underwent a vigorous one-week training prior to implementing PARAGON in the field. Training consisted of memorizing coding schemes and correctly coding still images and videos until >80% inter-observer agreement was achieved.

Direct observation was concurrent with accelerometer data collection. Each classroom was observed three times, once on each garden day in the study. Two to three observers were present each day. Research assistants observed 2 students each day, though a researcher on some days observed additional students.

Results and Discussion

Accelerometer Measurement

A t-test performed on the cumulative measurement of the non-garden days compared to the garden days showed a significant increase in physical activity during garden days. Over the entire study compared to non-garden days, on garden days students' sedentary time (SED) was reduced 15.5%, light physical activity (LPA) increased 13.3%, moderate physical activity (MPA) increased 40%, vigorous physical activity (VPA) increased 60%, and combined moderate to vigorous activity (MVPA) increased 45.7% on average. On average, total time for combined MVPA during the

school day increased by 9.4 minutes (table 2). Sedentary time decreased 46.6 minutes on average.

Data was also analyzed separately for each school. A paired t-test comparison showed a significant statistical difference between each physical activity category on non-garden and garden days, except for SED and LPA at School 3. School 1 had the greatest increase in MVPA, gaining an average of 13 additional minutes of MVPA on garden days (table 2). School 3 had the smallest increase at 6.9 minutes a day. Generally, there were much larger decreases in sedentary time rather than increases in MVPA at the schools where there was a significant difference in SED, with the greatest decrease in School 1 at 76 minutes, and the smallest decrease at School 4 at 41.7 minutes.

table 2. Comparison of physical activity in non-garden and garden days

PA Level	Total			School 1			School 2			School 3			School 4		
	NGD	GD	DIFF	NGD	GD	DIFF	NGD	GD	DIFF	NGD	GD	DIFF	NGD	GD	DIFF
SED	315.6	269.0	-46.6*	297.1	221.1	-76*	309.8	239.8	70.0*	275.9	268.3	-7.6	403.8	362	-41.7*
LPA	127.1	142.7	15.6*	132.0	152.4	20.4*	131.8	150.7	18.9*	126.8	138.1	11.3	110.1	125	14.9*
MPA	14.9	21.2	6.3*	15.8	25.0	9.2*	16.0	22.3	6.3*	14.8	19.1	4.3*	11.7	16.8	5.1*
VPA	6.2	9.4	3.2*	5.2	9.0	3.8	6.1	9.4	3.3*	10.2	12.8	2.6*	4.0	7.4	3.4*
MVPA	21.2	30.6	9.4*	21.0	34.0	13.0*	22.1	31.8	9.7*	25.0	31.9	6.9*	15.8	24	8.6*

* P<.05

NGD = non-garden day

GD = garden day

DIFF= difference

Especially in comparison to other physical activity (PA) intervention studies, school gardening may be an effective way to increase MVPA during the school day. Two commonly studied methods of increasing PA during the school day are aimed at increasing PA during physical education (PE) classes and at recess. In a recent review

of the effects of PA interventions on increasing PA during recess, no intervention strategy was found to conclusively increase PA (Parrish, Okely, Stanley, & Ridgers, 2013). An analysis of PE interventions reported an average 24% increase in MVPA, although it does not give a comparison for how many additional minutes of MVPA students received (Lonsdale et al., 2013). Maybe the most significant review is a meta-analysis of PA interventions geared toward youth including 30 separate studies and representing 14,326 participants that measured on average only a four minute increase in total MVPA compared to the pre-intervention measurement (Metcalf, Henley, & Wilkin, 2012).

The overall impact that additional minutes of MVPA gained at schools participating in school garden activities studied in this research, however, depended largely on the program. For both School 3 and School 4 in this study, the school garden is part of a science enrichment course that students attend once a week. Over the course of the year, that could potentially translate to approximately 5.8 additional hours of MVPA. In contrast, garden-based-learning programs in Schools 1 and 2 are part of the student's homeroom class. Both of these teachers reported using the garden multiple times each week, which could significantly increase the contribution to student's weekly accumulation of MVPA compared to use of the school garden in science enrichment courses.

The increase in MVPA may not be as important as the decrease in sedentary behaviors observed. Recent trends in research suggest that separate from MVPA, long periods of time spent in sedentary behavior can be detrimental to health, and that interrupting long periods of sitting, like those students experience in the school day, can

improve health outcomes (Katzmarzyk 2010; Owen, Healy, Dunstan, and Matthews 2010). Thus, more than just the increased physical activity, school gardens are valuable in this study because of the significant decrease in sedentary behavior found when comparing garden to non-garden days.

Direct Observation

Researchers and research assistants completed a total of 76 student observations, with a total of 68 individual students (8 students were observed twice). This represents 5.1 hours of garden activity observed throughout the course of the study (4 minutes per student from 16 separate 15s observation epochs). There were several instances where students did not remain outside long enough for researchers to collect data for each of the sixteen observation/recording epochs per student; however these instances were a minor amount of time and did not change the average of time observed per student to below four minutes.

During the course of the outdoor student gardening experience that was observed, students spent 57.2% of the time standing, 17.5% of the time walking, 16.5% of the time squatting, 3.6% of the time kneeling, 3.3% of the time sitting, and 2% of time in vigorous activity (figure 3). Several of these are very comparable to what Wells found using PARAGON which found that student in their study spent 52.8% of time standing, 14.09% of time walking, and 2.28% of time in vigorous activity (Wells et al. 2014)

The intensity of each garden activity level has been previously validated and categorized (Myers & Wells, In Press). LPA, consisting of activities coded standing and squatting, accounted for 73.7% of the time (figure 2). MPA, including activities coded as walking, accounted for 17.5% of the time. VPA, consisting of activities coded vigorous,

accounted for only 2% of the time, and 6.9% of the time was spent in sedentary activities which included activities coded as lying, sitting or kneeling. Overall MVPA totaled 19.5% of time spent in the garden, which is again consistent with previous findings with PARAGON (Wells et al. 2014).

Table 3

Garden Activity Level

Activity Intensity	Activity Code
Light Physical Activity, 73.7%	Standing, 57.2%
	Squatting, 16.5%
Moderate Physical Activity, 17.5%	Walking, 17.5%
Vigorous Physical Activity, 2%	Vigorous, 2%
Sedentary, 6.9%	Lying, 0%
	Sitting, 3.3%
	Kneeling, 3.6%

Though these numbers seem to indicate less physical activity is gained from the garden experience than accelerometer data suggests, this disparity could be the result of several factors. First, because times spent in the school garden are variable at each school, and even between each lesson, researchers chose to use 16 minutes as the base for directly observing and collecting data using the PARAGON instrument. Actual time spent in the garden averaged 29.3 minutes, and it is possible that different activities and associated intensities of physical activity took place at different parts of the lessons. Also, researchers did not begin recording until students reached the garden

area, which excluded the walk to and from the garden area. Although some classrooms had direct access to at least one part of the garden area, all schools had a significant portion of the garden some distance from the classroom. Furthermore, the direct observation tool does not account for physical activity effects the school garden may have on the remainder of the school day. It is also possible that accelerometers did not remain in place throughout the day, which could distort reported results.

Garden tasks were also monitored using the PARAGON instrument. Student gardeners spent 33.6% of the time resting or observing, 23.6% of the time doing non-garden activities, 15.4% of the time weeding, 8.2% of the time digging, 7.7% of the time harvesting, 7.32% of the time carrying, 3.24% of the time planting, and 1% of the time cleaning. It seems apparent that students are actually directly involved in specific garden activities for less than 50% of the time. However, it is important to note that observing or non-garden activities would also include academic portions of the garden lesson, though from the data it is not clear what non-garden tasks take place.

Study Strengths and Weaknesses

The primary strength of this study is that it analyzed physical activity trends in already existing garden-based-learning programs. This better demonstrates the real-world impact as opposed to a specific garden-based PA intervention that may not meet teacher goals for the program and may not be continued after the study concludes. Teachers were not required to use a specific garden curriculum, but rather, were asked to continue their garden programs as usual. Also, because teachers were already invested in the gardening program, there was a high level of support for the research project, which resulted in high enrollment in the study.

Using multiple methods for determining physical activity also strengthened this study, even though the results did not align as expected. High inter-rater reliability was also a benefit of this study. Finally, the interdisciplinary nature of this study and collaboration between academic disciplines was a benefit at all stages of this study.

Weaknesses of this study include failure to observe and record PARAGON data for the entire class period, as opposed to a sixteen minute garden interval. Observing the entire class period may have led to different correlations between accelerometer and PARAGON data. The 16 minute interval was chosen because researchers expected some garden visits would not last the 32 minute interval used in the original validation of the PARAGON instrument, and indeed there were several occasions where students were not observed for all 16 observation epochs. However, students spent an average of 13.3 minutes in the garden after research assistants finished observing. Because PARAGON focuses on observing individual students rather than a class, the entire time in the garden was not observed in order to have more complete data for each student, but in retrospect it seems that it would be more valuable to observe the entire class period, rather than to attempt to observe each student a predetermined amount of time.

Next Steps

Moving forward, it is clear that additional research is needed in understanding the role of school gardens in increasing MVPA and decreasing sedentary time during the school day. Measuring a greater number of garden and non-garden days within each school could be beneficial in better understanding the cumulative effect of school garden programs. A qualitative portion, specifically field observations of students and

teachers in the garden, could also be useful in determining what type of lesson plans, teaching styles, or general program qualities contribute to greater MVPA outcomes.

Furthermore, PARAGON could be a very effective tool in understanding the impact of garden-based-learning programs on PA. However, rather than just observe and record time spent in the garden, especially because those times can be highly variable and do not include PA associated with the classroom portions of garden-based-learning programs, observing and recording data throughout the entire class period where garden-based-learning takes place might provide a more holistic view of the impact of these programs. A continued area of focus should be to measure PA in existing school garden programs, rather than to implement specific interventions.

Conclusions

Overall, this study showed that the school gardens studied had a significant impact on increasing physical activity and decreasing sedentary during the school day. While additional studies are needed to broaden the application of these study results, the positive conclusions demonstrate that participation in school gardens may be comparable if not more effective than other youth-based physical activity interventions.

It seems unlikely that school gardens would be implemented solely on the basis of increasing MVPA in the student population. However, school gardens have been shown to increase academic performance, improve social skills, and increase fruit and vegetable preference and consumption among participants (Blair, 2009; Williams & Dixon, 2013; Metcalf et al., 2012; Robinson-O'Brien et al., 2009; Morgan et al., 2010; Ratcliffe et al., 2011). Increased physical activity and decreased sedentary time could potentially be additional benefits of school garden programs.

References

- Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education*, 40(2), 15-38.
- Crespo, C. J., Keteyian, S. J., Heath, G. W., & Sempos, C. T. (1996). Leisure-time physical activity among US adults: Results from the third national health and nutrition examination survey. *Archives of Internal Medicine*, 156(1), 93-98.
- Desmond, D., Grieshop, J., & Subramaniam, A. (2002). Revisiting garden based learning in basic education: Philosophical roots, historical foundations, best practices and products, impacts, outcomes, and future directions. *Food and Agriculture Organization*, , 59-59.
- Domenghini, C. M. (2011). *Physical activity and curriculum development of an after-school gardening program for youth health*. Unpublished Doctor of Philosophy, Kansas State University, Manhattan, Kansas.
- Janssen, I., & LeBlanc, A. G. (2010). Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral nutrition and physical activity*, 7(40), 1-16.
- Kahan, D. (2008). Recess, extracurricular activities, and active classrooms: Means for increasing elementary school students' physical activity. *Journal of Physical Education, Recreation & Dance*, 79(2), 26-39.
- Katzmarzyk, P. T. (2010). Physical activity, sedentary behavior, and health: paradigm paralysis or paradigm shift?. *Diabetes*, 59(11), 2717-2725.
- Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans, D. R. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine*, 56(2), 152-161.

- Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., et al. (2008). Amount of time spent in sedentary behaviors in the united states, 2003-2004. *American Journal of Epidemiology*, 167(7), 875-881.
- Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: Systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). *BMJ (Clinical Research Ed.)*, 345, e5888.
- Morgan, P. J., Warren, J. M., Lubans, D. R., Saunders, K. L., Quick, G. I., & Collins, C. E. (2010). The impact of nutrition education with and without a school garden on knowledge, vegetable intake and preferences and quality of school life among primary-school students. *Public Health Nutrition*, 13(11), 1931-1940.
- Myers, B. M., & Wells, N. M. (2015). Children's physical activity while gardening: Development of a valid and reliable direct observation tool. *Journal of Physical Activity and Health*,
- Wells, N. M., Myers, B. M., & Henderson, C. R. (2014). School gardens and physical activity: A randomized controlled trial of low-income elementary schools. *Preventive medicine*, 69, S27-S33.
- Nettlefold, L., McKay, H. A., Warburton, D. E., McGuire, K. A., Bredin, S. S., & Naylor, P. J. (2011). The challenge of low physical activity during the school day: At recess, lunch and in physical education. *British Journal of Sports Medicine*, 45(10), 813-819.
- Owen, N., Healy, G. N., Matthews, C. E., & Dunstan, D. W. (2010). Too much sitting: the population-health science of sedentary behavior. *Exercise and sport sciences reviews*, 38(3), 105.
- Park, S., Shoemaker, C. A., & Haub, M. D. (2009). Physical and psychological health conditions of older adults classified as gardeners or nongardeners. *Hortscience*, 44(1), 206-210.
- Parrish, A., Okely, A. D., Stanley, R. M., & Ridgers, N. D. (2013). The effect of school recess interventions on physical activity. *Sports Medicine*, 43(4), 287-299.
- Ratcliffe, M. M., Merrigan, K. A., Rogers, B. L., & Goldberg, J. P. (2011). The effects of school

- garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice*, 12(1), 36-43.
- Robinson-O'Brien, R., Story, M., & Heim, S. (2009). Impact of garden-based youth nutrition intervention programs: A review. *Journal of the American Dietetic Association*, 109(2), 273-280.
- Steele, R. M., Van Sluijs, E., Sharp, S. J., Landsbaugh, J. R., Ekelund, U., & Griffin, S. J. (2010). An investigation of patterns of children's sedentary and vigorous physical activity throughout the week. *Int J Behav Nutr Phys Act*, 7(1), 88.
- Turner, L., Sandoval, A., & Chaloupka, F. (2014). *School garden programs are on the rise in US public elementary schools, but are less common in schools with economically disadvantaged student populations - A BTG research brief*. Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago.
- US Department of Health and Human Services, & US Department of Health and Human Services. (2008). Physical activity guidelines for Americans.
- Welk, G. J., Corbin, C. B., & Dale, D. (2000). Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport*, 71(sup2), 59-73.
- Wells, N. M., Myers, B. M., & Henderson, C. R. (2014). School gardens and physical activity: A randomized controlled trial of low-income elementary schools. *Preventive medicine*, 69, S27-S33.
- Williams, D. R., & Dixon, P. S. (2013). Impact of garden-based learning on academic outcomes in schools synthesis of research between 1990 and 2010. *Review of Educational Research*, 0034654313475824.