AN ABSTRACT OF THE DISSERTATION OF

Deborah L. Bailey for the degree of Doctor of Philosophy in Science Education presented on May 29, 2015.

Title: An Exploration of an Out-of-School Garden Program: A Case Study of Youth [adolescents’] Perceptions

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John H. Falk

Garden-based learning (GBL) with young people has long been viewed as an educational experience capable of teaching numerous types of science content including general science, technology, engineering and math (STEM), as well as discipline specific areas such as biology, horticulture, agriculture and nutrition. However, much of the GBL literature focuses on young children in school and utilizes preconceived measures of what constitutes appropriate learning. Little work has been designed to systematically explore learning in the garden from a youth’s perspective. The goal of this study was to use a combination of qualitative methods, interviews and Personal Meaning Maps, to empirically determine the various ways in which older adolescents describe their learning in an out-of-school summer garden experience and to uncover adolescent perceptions of science learning from the garden. Youth perceptions were then compared to the most frequently used GBL theoretical framework, Experiential Learning Theory (ELT). Youth interpreted their garden experience mostly through an environmental- and agricultural-science lens. Although all youth learned about these content areas, not all youth learned
the same specific content nor did all youth make comparable meaning of similar content. The results from this study add to the literature on GBL and provide case-study evidence: 1) of the applicability of ELT for adolescents in out-of-school GBL programs; and 2) that gardening with adolescents in an out-of-school context can be an effective and pragmatic way to facilitate support in science learning. Future research should include exploration of other adolescent out-of-school garden programs to continue empirical work to demonstrate the applicability of ELT for older youth as well as how similar out-of-school summer gardening programs could better harness the inherently situated- and socially-relevant science content inherent in garden activity.
An Exploration of an Out-of-School Garden Program: A Case Study of Youth [adolescents’] Perceptions

by
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Dean of the College of Education

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Deborah L. Bailey, Author
I want to acknowledge my entire dissertation committee, Drs. Falk, Dierking, Flay, Richardson, Rowe and Braverman, for helping me reach this goal. I especially want to thank a last minute addition/replacement to my committee, Dr. Shawn Rowe. He stepped up for my defense at the last minute when one committee member was unable to attend due to illness. I really appreciate his willingness to provide substantial and helpful feedback on my work on such short notice. I also want to especially thank John Falk and Lynn Dierking for believing in me and supporting me during my time at Oregon State University. Working with them has not only informed my dissertation but also helped me develop as a scholar. I also want to thank Brian Flay for helping me through the Masters of Public Health degree concurrently with this dissertation work, as well as Marc Braverman who was not only my Ph.D. committee’s graduate school representative, but also my professor of Evaluation. Both Flay and Braverman’s advice and guidance helped me also complete a very intense evaluation project for my Masters of Public Health degree and I am indebted to their efforts. Finally, I would like to give a special thanks to Leslie Richards who believed in this project from our first meeting three years ago. Your smiling and nodding head during all of my committee meetings and exam helped me believe in myself, the project as well as helped me see the light at the end of the tunnel.

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Introduction

This dissertation includes the presentation of three research manuscripts based on a case study examination of one Pacific Northwest adolescent community garden program. The garden itself was chosen because it specifically targeted older youth in an urban environment, was not associated with a school curriculum, and the heaviest workload came during out-of-school summer months. I believed these reason made this particular garden program ideal for a case study for this research. I met youth that had participated in the first year of this garden program at a garden conference held in January of the proceeding data collection year. The coordinator was interested in this research and willing to encourage the gardening youth to participate. The three manuscripts written from work with this garden program are written from an educational theorist perspective. Due to the large gap in literature with older gardening youth I write these manuscripts with the intention of adding to the literature on adolescent garden-based learning (GBL) research. Specifically, the manuscripts focus on the applicability of experiential learning to understand GBL, the use of a more constructivist data collection method and final results when asking about the perceptions of sciences learned by participating youth gardeners.

Motivations for the research study

As far back as the seventeenth century, John Amos Comenius (1592-1670) stated: “A school garden should be connected with every school, where children can have the opportunity for leisurely gazing upon trees, flowers and herbs, and are taught to appreciate them” (Weed, 1909, cited in Sealy, 2001). These philosophical roots of nature appreciation gained significant popularity through time and by the 19th century using a
garden in a school setting was formally introduced as ‘nature study’ (Bigelow, 1914; Meyers, 1908; Mosely, 1925). The concepts behind nature study were advocated by educational pioneers like Maria Montessori (1964) who saw school-based gardening as a way to help develop patience, morality, responsibility, relationship skills and appreciation for nature. This use of gardens in a formal school environment sustained itself through the World War I and World War II eras through efforts such as the ‘United States School Garden Army’ and School Victory Gardens respectively (Hayden-Smith, 2007; Subramaniam, 2002). More recently, school gardens have again risen to prominence due to the belief that they can help educate about societal issues such as the war on poverty, local food initiatives and the environmental movement (Yamomoto, 2000). Currently the use of a garden to teach a wide array of topics is most commonly known as garden-based learning (GBL) and well-defined GBL “encompasses programs, activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences” (Desmond, Grieshop, & Subramaniam, 2002, p. 7). GBL programs have often framed learning in the garden as the panacea for numerous science-related literacy issues, including agricultural literacy (e.g. Rahm, 2002), environmental literacy (e.g. Bradley, Waliczek & Zajicek, 1999) and general STEM literacy (e.g. Williams & Dixon, 2013).

Previous Explorations of Garden-based Learning

The vast majority of previous educational research exploring garden teaching and learning has focused on the school environment as well as young children (Blair, 2009). A great deal of GBL has also been done to explore the very practical issues associated with starting and sustaining a school garden (Blair, 2009; Subramaniam, 2002), doing
little to add to the literature on understanding learning in the garden. When attempting to understand learning in the garden, most researchers also make little attempt to truly explore the application of the most popular learning framework applied to GBL, i.e. Experiential Learning (e.g. Alexander, North & Hendren, 1995). Finally, when researchers do attempt to better design work that explores learning from/in a garden, most projects still frame their research questions and methods utilizing positivist models of learning, using mostly preconceived ideas about appropriate knowledge that children should acquire from their garden activity (Blair, 2009; Bowker & Tearle, 2007; Dillon, Rickinson, Sanders, & Teamey, 2005; Titman, 1994). This reliance on framing GBL from a positivist perspective, as well as staying within the confines of an elementary school curriculum has left many gaps in GBL research. The popularity of using gardens to teach has spread far beyond the confines of elementary-aged children. Garden programming is now also firmly established in many secondary schools, as well as increasing within the out-of-school activity options for youth. Yet, little empirical work has been designed to systematically determine the outcomes from GBL from a child or youth’s perspective (e.g. Bowker & Tearle, 2007). This lack of attention to the actual lived-experience of youth engaged in GBL has led researchers to make assumptions about the nature of the garden experience, a practice that may leave certain areas of GBL potentially underexplored.

Significance of the dissertation

In an attempt to add to the literature on GBL with older youth in out-of-school learning environments, this project was specifically interested in providing pilot empirical evidence regarding how adolescent learners in a ‘free-choice’/out-of-school
summer garden program perceived their science learning. This dissertation presents data from a case study that was designed in part to systematically explore GBL from the perspective of adolescents engaged in an out-of-school gardening experience. The sample for this study included the one adult garden coordinator and seven out of eleven youth that were currently gardening a two-acre piece of property connected with a local public school. Youth were all 15-20 years old, four were second year garden program participants, five were part of an early college high school program, and five had been involved in a previous environmentally focused out-of-school club. Overall, these data add to the literature on garden-based science learning and issues of content acquisition in free-choice learning environments.

This project was designed to be a case study exploration of one particular garden program in that research questions were designed to gain an in-depth understanding of the perspectives of participants from this one particular garden program in the summer of 2014. Case studies themselves “are not characterized by the methods used to collect and analyze data, but rather its focus on a particular unit of analysis: a case” (Willig, 2008, p. 74). Therefore the methods for this project were chosen due to their ability to gain insight into these participant’s perspectives of experience and not simply from the fact the project worked with one small gardening program. In order to collect data from the participant’s perspective, this project utilized a series of interviews plus the constructivist data collection method called personal meaning mapping (Falk, 2003). Personal Meaning Maps (PMMs) allowed this project to empirically demonstrate youth perceptions of learning in general and science learning in particular. These direct ties to youth perceptions of lived experiences in the garden and learning were then empirically tied to
the six tenets of Experiential Learning (Kolb & Kolb, 2008) in an attempt to also add to the understanding of GBL. The study was also different from most previous GBL studies as it focused on older adolescents (16-20 years) in an out-of-school summer garden. Data are from one case-study garden program in a Pacific Northwest community, which had the intention of creating a working farm “that would have a market element, [Community Supported Agriculture] CSA, as well as donation [food bank] where teenagers are learning about community service, hunger in our community and how to help others in need; as well as getting a bit of agricultural education, environmental education and some job skills” (07/2014 interview).

Research Questions

In an attempt to explore the above areas in GBL this project took on several research questions. Specifically the three manuscripts investigated the following list of research questions:

1. Framed from an asset-based, relativist conceptual framework, what are the affordances and constraints of using Personal Meaning Mapping as a research method for understanding adolescent learning experiences within a long-term garden-based learning environment?

2. Do the self-perceptions of learning by adolescent participants in one summer garden program support experiential learning, as proposed by Kolb and Kolb’s (2008) six tenets?

3. Is there evidence that youth participants in this particular free-choice garden program learned any of the science content intended by the garden coordinator (i.e., environmental and agricultural education)?
4. Is there evidence that youth participants in this particular free-choice garden program learned any STEM content not intended by the garden coordinator but previously identified as taught and learned in other GBL programs (e.g. general science, nutritional sciences, math)?

5. Do youth make specific connections between the science content presented in the garden program and science content presented in school, and if so how?

In the following discussion, I present a brief overview of the three manuscripts and how they address the five research questions.

**Overview of the three manuscripts as one study**

The three manuscripts in this one study were set up to reflect the three areas of a traditional five-chapter dissertation—Methods, Theory, Findings. Chapter Two explores the specific methods that were chosen for this case study exploration and the affordances and constraints to using PMM (Falk, 2003) with adolescents in long-term free-choice learning environments. This particular chapter allowed me to fully describe the use of PMMs and how they allowed me to validly capture the garden experience utilizing an ecological lens that enabled an examination of the garden experience framed directly from the participant’s perspective. This chapter will be submitted to Research in Outdoor Education to reach those working with audiences in outdoor environments and help add to the field of data collection techniques in such educational environments. Chapter Three discusses the use of Experiential Learning Theory in previous GBL work and then uses data from this project to demonstrate the applicability of the six tenets behind experiential learning for youth in this summer-based program. This chapter will be submitted to the
Journal of Experiential Learning to address those working with experiential learning and help add to the literature on the use of experiential learning in out-of-school educational programing. Finally, Chapter Four discusses specific results of the study as they pertain to youth’s perceptions of the sciences learned from this garden program. This chapter will be submitted to the Journal of Research in Science Teaching to help add to the work in science education with youth in out-of-school or free-choice learning environments.
Chapter 2 - Personal Meaning Mapping as a Tool to Uncover Adolescent Science Learning from a Long-term, Free-choice, Garden-based Learning Program

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Outdoor Education Research
http://js.sagamorepub.com/roe/about.
To be submitted under authorship of Deborah L. Bailey, MS, MPH, PhD and John H. Falk, PhD
Introduction

Simply stated, Garden-based learning (GBL) uses a garden as a tool for learning as it “encompasses programs, activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences” (Desmond, Grieshop, & Subramaniam, 2002, p. 7). Using a garden to educate has its philosophical roots in 19th century ‘nature study’ (Bigelow, 1914; Meyers, 1908; Mosely, 1925) and was advocated by educational pioneers like Maria Montessori (1964) and more recently by the educational community that anecdotally believes gardens help educate about local food and the environment (Yamomoto, 2000). In general, gardens have long been viewed as an appropriate venue for teaching about a wide array of content, including science (Williams & Dixon, 2013), health and nutrition (Robinson-O’Brien, Story, & Heim, 2009), and the environment and agriculture (Blair, 2009).

However the vast majority of educational research exploring garden teaching and learning has focused on young children in schools and the learning is often framed within a positivist model as researchers typically have preconceived ideas about what the appropriate knowledge is that children should acquire from their garden activity (Blair, 2009; Bowker & Tearle, 2007; Dillon, Rickinson, Sanders, & Teamey, 2005; Titman, 1994). This reliance on framing GBL from a positivist perspective and only using it in schools with young children has left many gaps in GBL research. The popularity of using gardens to teach has spread far beyond the confines of elementary aged children. Garden programming is now also firmly established in many secondary schools, as well as increasing within the out-of-school activity options for youth. Yet little empirical work
has been done to explore learning in an out-of-school garden for older youth. Therefore, the larger project from which this chapter was drawn was specifically interested in discovering how adolescent learners in a ‘free-choice’ or out-of-school summer garden program perceived their science learning. In this chapter, I describe my utilization of Personal Meaning Mapping (Falk, 2003) as a method that allowed me to validly capture the garden experience through an ecological lens by directly viewing experience from the perspective of the participant.

**Review of Literature**

*Previous GBL Research Data Collection Methods*

A significant shortcoming of much of the previous research on GBL has been a lack of attention to participant perceptions of experience. Methods employed in many previous GBL research projects generally approach the learning from a positivist perspective where a ‘right’ answer was assumed or researchers predetermined a set of concepts that must be gained from the garden for a student to have ‘learned’. For example Klemmer, Waliczek and Zajicek (2005) explored activity in the garden and the science achievement of 3rd–5th grade children based on pre- and post science achievement test instruments and found that student achievement of specific outcomes was higher amongst children who had participated in some kind of garden activity. Similar positivist methods were also employed in other content learning areas of GBL such as acquisition of a more positive environmental attitude. For example Campbell, Waliczek, Bradley, Zajicek & Townsend (1997) explored the environmental attitude of forty-four 9th -12th grade students using a closed-ended pre- and post-test questionnaire where some of the statements for the attitude section came from the New Environmental Paradigm (NEP)
developed by Dunlap and Van Liere (1978). Here the questions were set-up on a Likert-type scale (Likert, 1967) and students had to agree or disagree to statements based on a one to four point scale. Students also indicated what level of success they had achieved in the plant propagation experiments. Findings indicated that environmental attitudes were more positive for those who reported success with hands-on plant propagation. Cammack, Waliczek and Zajicek (2002) explored knowledge of a similarly-aged sample of juvenile offenders to see if positive changes in horticulture knowledge obtained through hands-on activity with plants correlated with positive changes in environmental attitudes. Horticultural knowledge was determined from a pre- post inventory of 10 true/false statements and the 10 questions included in the environmental attitude inventory were rated on a five-point Likert scale and taken from a previously developed instrument (Bradley & Dettling, 1994; Campbell, 1994; Waliczek, 1997). Results indicated that participation in the garden program improved the sample’s horticultural knowledge and environmental attitudes. Bradley, Waliczek and Zajicek (1999) similarly questioned 475, Texas 9th-12th grade environmental science students, again using preconceive pre- and post knowledge. Attitude and knowledge instruments were used to demonstrate that youth in fact did increase both their environmental knowledge and attitude after participation in garden activity. Waliczek and Zajicek (1999) did similar work with a younger sample of elementary and junior high school students and using a preconceived environmental attitude inventory with thirteen statements rated on a three-point Likert scale, demonstrated that significant differences were found in students’ environmental attitudes after participating in the gardening project. Finally, researchers have also examined other areas commonly focused on in GBL such as nutrition and
health behavior. For example, using pre-determined nutrition knowledge and vegetable preference instruments, Morris and Zidenburg-Cherr (2002) demonstrated that fourth-grade school children could increase their nutrition knowledge and preferences for some vegetables using a garden-based learning experience.

**Theoretical Framework**

All of the above cited studies use pre-determined positivist instruments that are designed to show a change in participant characteristics, be it in knowledge, attitude, or behavior. These methods have a number of benefits, the most significant being that they allow for quantitative comparison of changes in participant characteristics relative to control groups using experimental or quasi-experimental research designs (Campbell & Stanley, 1963). However, I argue that there are also limitations to these positivist GBL studies. Specifically, traditional closed-ended research instruments make pre-defined assumptions about what are and are not valid learning outcomes; they rarely account for either the constructive nature of learning or the ecological, cumulative nature of learning (cf., Baron, 2006; Feder, Shouse, Lewenstein, & Bell, 2009; Bransford, Brown & Cocking, 2000; Bronfenbrenner, 1979; Jackson, 2013). From this more asset-based perspective, learning is an on-going and uniquely personal experience in which learning outcomes are highly variable and strongly influenced by the sociocultural and physical contexts in which they occur (Falk & Dierking, 2000; 2014; Lave, 1988; Scribner & Cole, 1973; Rogoff & Lave, 1984). This project was interested in approaching learning from a garden experience from this more complex ecological perspective, which ultimately assumes learning in the garden to be both personally constructed and context specific. By taking on this more ecological perspective this project recognized that a suite
of factors, including the motivations for participation, personal interests, prior knowledge and experience, as well social interactions over the course of the experience (Falk & Dierking, 2000; 2014; Falk et al., 2007; Falk & Storksdieck, 2005) all have the potential to significantly influence participant learning in the garden environment. Although the learning outcomes of a particular garden experience can in theory be proscribed and be common for all participants, it is more likely because of different entering and experiential realities encountered, that exactly what any particular youth might find salient and worth learning from a particular garden-based experience will be quite variable and only roughly predictable at the beginning of the experience. In fact, it is just such variability that has contributed to the difficulty in assessing learning in free-choice environments (Dierking et al., 2004; Groff et al., 2005). That said, it was not the intention of this project to correlate specific learning outcomes with particular personal characteristics, but rather to simply describe the continua of learning in general, science learning in particular, that resulted from the garden experience. Accomplishing this goal required an appropriate measurement tool. The tool I selected was Personal Meaning Mapping (PMM). The following presents a review of the use of mapping techniques in education research and how and why these led to the development of PMM.

Cognitive Mapping Tools in use in Education Research

Conceptual “mapping” tools were first developed in order to support better understanding, recall and presentation of complex information (Davis, 2010; Salmon, 2001). Such tools are often graphic in nature and take advantage of the ability to arrange ideas in relation to each other (Davis, 2010). Consistent with prevailing epistemologies, most of these mapping tools were ‘positivist’ in nature, designed to support the ‘correct’
presentation of an idea or concept, or as a mechanism to test an individual’s ability to ‘correctly’ display his/her knowledge (e.g., Wheeldon, 2011). Mind maps (Buzan, 1974) are one type of mapping tool best described as idea maps and “visual, non-linear representations of ideas and their relationships” (Biktimirov & Nilson, 2006, p. 72). As a research tool, mind maps are typically used as a way to demonstrate an understanding of the ‘appropriate’ associations that exist between ideas (Davies, 2010). However, mind maps have limitations for this kind of assessment because individuals often display considerable creativity in the development of their maps making them hard to read and analyze (Eppler, 2006). To overcome some of these limitations and be able to explore relationships more fully, researchers developed a more structure form of mapping called concept mapping (Novak & Cañas, 2006).

Like mind mapping, concept mapping utilizes graphic approaches to illustrating the relationships between concepts. However unlike mind mapping, concept mapping provides much less opportunity for unstructured representations and involves highly structured rules for how to show the relationship between ideas (Davis, 2010). Concept maps are designed to allow users to graphically depict the hierarchical interrelationships between ideas. Since even very complex and social ‘cyclical’ relationships can be depicted in this way (Safayeni, Derbentseva, & Canas, 2005), concept maps are often used as tools to support the conceptual teaching-learning processes. For example, Pushkin, (1999) asked if there was a form of concept maps that could help researchers better understand novice physics students’ problem-solving approaches. Participants were asked to produce equation maps so researchers could follow metacognitive processes as students successfully or unsuccessfully solved physics problems. Bandiera and Vicentini
(1999) used concept maps with in-service secondary science teachers in a training course. Here they wanted to explore both the artifact produced, as well as the production processes. Researchers used three different formats for artifact production and then analyzed and compared the three different concept maps. This allowed researchers to ask questions regarding the contexts of artifact production and make conclusions on which was the most appropriate format for the task. Because they are highly structured, often with a clear “right” and “wrong” configuration, a major affordance of concept maps has been the ability to directly compare the maps of multiple individuals to determine who has or has not grasped the relationships between complex ideas and relevant concepts (Eppler, 2006). However, this same characteristic can also be a liability to the method. Because concept maps require individuals to follow very specific rules in order to successfully depict relationships, to be proficient at concept mapping requires significant training (Davis, 2010).

Unlike these previously discussed mapping techniques Personal Meaning Mapping was designed to assess learning specifically in free-choice learning contexts using a more relativist-constructivist approach. Since most free-choice learning participants are not “captive” audiences as typically occurs within a school context, PMM needed to be easy to administer. PMM requires no pre-training of participants and is designed to feel “un-test-like” to the participant (Falk, 2003). Also in contrast to the expectations that there is a right and wrong answer, PMM was explicitly designed with the assumption that since all knowledge is uniquely constructed and contextually situated, representations of knowledge are also likely to be unique. What makes analysis possible is the consistent structure in how maps are produced and in many cases, the ability to
chart change in understanding over time. Over the last twenty years, the method has been used to explore learning in a large variety of ‘free-choice’ learning settings such as science centers, art and natural history museums, zoos, aquariums, community-based programs, as well as in classroom settings (for reviews, see Falk, 2003; McCreedy & Dierking, 2013). It has been shown to effectively allow participants to articulate and negotiate their own perceptions and understandings of the PMM prompt (Falk, Moussouri & Coulson, 1998) – a single word or phrase placed in the center of an otherwise blank piece of paper. For example, PMM has been used to quantitatively show changes in learning (e.g., Adams, Falk, & Dierking, 2003; Falk, Heimlich & Bronnekeant, 2008; Lelliott, 2008) and that individuals with different entering characteristics, e.g. motivations for visiting (e.g., Falk, Moussouri & Coulson, 1998) or differing prior knowledge and interest (e.g., Falk & Adelman, 2003; Falk & Storksdieck, 2005) learned different things. It also has been used more qualitatively to understand the public’s baseline conceptual understanding of specific ideas (e.g., Luke & Falk, 2005; McCreedy & Dierking, 2012).

**Method**

**Research Question**

Framed from an asset-based, relativist conceptual framework, I wished to understand the affordances and constraints of using Personal Meaning Mapping as a research method for understanding adolescent learning experiences within a long-term, garden-based, learning environment?

**Educational Context**
The study site was a two-acre organic ‘farm’ originally donated by a local school and in some form of food production for approximately six years. Approximately two years prior to the study an AmeriCorps member, working for the local food bank teaching elementary and community garden programs, saw an opportunity to organize the farm to better produce food for donation to the food bank and fill a gap in outreach efforts. He convinced the local food bank to take on the property and actively garden the land to produce food for the food bank and train adolescent youth in garden and job skills. Participating youth came from the local community and worked six hours a week during the spring and approximately twenty hours a week during the summer. Garden activities focused on the horticultural knowledge and skills required to produce farmer’s market quality produce and the small enterprise knowledge and job skills required to successfully market this produce through shares in a Community Supported Agriculture (CSA) program and a local farmer’s market. In addition to ‘in the moment’ training and conversation, youth were given weekly structured lessons either by the coordinator of the program or one of two program interns and participated in four field trips; a local greenhouse, organic farm, conventional farm, and industrial compost facility. Garden activities included planting, weeding, watering and harvesting, as well as activities to prepare food for purchase or donation such as garlic and onion skinning and drying. A schedule of lesson topics and more detailed information on field trips can be seen in Appendix A. At the end of the summer each youth was given a small stipend of $800 (approximately $4/hour–inclusive of educational hours).

 Procedures
Data were collected in the summer of 2014, which was the second official growing season for this garden program. The project’s sample included the garden coordinator, who participated in one key informant interview, and all youth who provided parental consent and assent and were able to complete a pre and post map. This resulted in a sample size of one adult and seven youth. The key informant interview provided information regarding the program’s history, funding structure and current goals, as well as background on the coordinator’s education and youth recruitment. Other non-PMM data included two semi-structured personal interviews with each youth, the first of which was framed as a ‘get to know you’ conversation and done before the PMM activity. Questions were used to understand youth’s backgrounds as well as some personal constructs of learning such as expectations, prior knowledge/experience, interest in gardening, and motivations for participation. The second semi-structured personal interview was conducted in the fall after most garden activity had stopped for the season. Questions were used to clarify information from the first personal interview as well as to explore the youth’s general view of science. Observations of garden activity also took place four times during the growing season during which time field notes were taken to note youth activity and enthusiasm toward garden work. Finally, researcher memos were taken after each PMM interview to make note of any additional observations about the experience, for example the youth’s general affect while participating in the PMM activity.

*Personal Meaning Mapping*

Youth were given two opportunities to complete a PMM. The first came in July 2014. Youth were presented with a 10” x 14” piece of drawing paper with the following
prompt placed in the middle of the paper ‘Community Garden(ing).’ Youth were not told what to write down or instructed to view the garden through any particular lens, e.g., as a science-related activity, but rather were asked to just reflect on the garden space itself and the experience of community gardening and to then write any and every word, idea, image, phrase, or thought that came to mind when they thought of the words “community garden(ing)”. These written words and images then formed the basis for a detailed open-ended interview where youth were asked to explain why they wrote what they did, always using the phrase, “so what did X have to do with “community garden(ing)”’. Youth were encouraged to expand on any ideas or thoughts they had about the topic and this interview then formed the main data collection procedure for youth’s internal perceptions of their garden experience. This activity was repeated with youth in October/November 2014 after all garden activity was completed. At this time youth were asked to reflect on their time in the garden program and were then given a second opportunity to complete a new PMM add to, subtract from, and/or change their earlier PMM. Examples of youth produced PMMs are attached in Appendix B.

Data Analysis

PMMs and PMM interviews were the two main sources of data for this project. PMMs and PMM transcripts from both the pre and post activity were treated as a single data source that explicitly reflected all of the participating youth’s perceptions of their garden experience, and implicitly revealed what they learned from the activity. Transcripts from the ‘get to know you’ interview, ‘view of science’ interview and researcher field notes and memos were a secondary source of data and used to both obtain general insight into youth backgrounds, including previous garden experience and
knowledge, as well as to gain some insight into youth perceptions of science learning both in the garden and in school-based environments. In general data analysis utilized an informed grounded theory approach where the process and the product are grounded in data yet are “informed by existing research literature and theoretical frameworks” (Thornberg, 2012, p. 249). In this way this project’s data analysis fit within the goal of all qualitative research—“to reconstruct the specific categories that participants used to conceptualize their own world view” (Goetz & LeCompte, 1984).

To answer the research question data analysis began with verbatim transcription of each interview. Transcripts were then read and reread to obtain general insight into the data, including youth backgrounds and perceptions of both general learning, as well as specific learning of science in the garden. It was clear from this initial reading there was an extensive amount of data and that this data was extremely deep yet varied. In order to systematically handle the data from these in-depth interviews each transcript was open-coded (Strauss & Corbin, 1998) into substantive descriptive emic (or participant’s perspective) categories that then allowed for comparison of statements within the same category (Maxwell, 2012). For example, it was clear many youth spoke to learning agriculture/horticulture sciences in the garden on their PMM and in PMM interviews. The open-coding method allowed grouping of these types of comments into one agriculture/horticulture category. Placing similar comments into one conceptual category allowed for easy comparison of the various ways youth described agriculture/horticulture sciences learned in the garden. This categorization scheme was followed for all major thematic areas of sciences perceived as learned. In addition, sub-categories of learning that occurred within these larger categories were created if data warranted. A final
analysis step of both the pre and post-PMM interview data was to also code the data from the etic or researcher’s perspective making some inference to youth perceptions of experience.

Results

‘Get to know you’ interviews with youth revealed that all youth had similar backgrounds, which included urban upbringings, challenging home situations, and heavy involvement in school. Even though this sample size of seven youth was small I was confident that youth choosing to participate were representative of all youth in the program as the interview with the coordinator revealed that youth who chose not to participate in the project came from very similar backgrounds. The PMM data collection activity was approached by all youth with a great amount of reflection and intention, with each youth spending upwards of 30 minutes working on their map. This attention to detail on the physical artifact of the map allowed for extensive PMM interviews as youth spent an additional 20-30 minutes explaining what and why they wrote what they did on their map. The in-depth ‘get to know you’ interview and numerous researcher site visits possibly provided more opportunities for youth to personally connect with the primary researcher. This may have influenced youth’s level of effort displayed in PMM creation and later PMM interviews; however, it is not uncommon for individuals to take extensive time filling out and talking about their maps (e.g., Falk, 2003; Luke & Falk, 2005; McCreedy & Dierking, 2013). The decision to conduct verbatim transcription and open-coding of these in-depth interviews then allowed for a deep qualitative exploration of youth’s reflections on their garden experience. Tables 2.1 and 2.2 summarize participant backgrounds.
Table 2.1 Participants

<table>
<thead>
<tr>
<th>Youth</th>
<th>Age</th>
<th>School</th>
<th>Gender</th>
<th>Prior Env. Club</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>17</td>
<td>Early College</td>
<td>Female</td>
<td>Yes</td>
</tr>
<tr>
<td>John</td>
<td>17</td>
<td>Early College</td>
<td>Male</td>
<td>Yes</td>
</tr>
<tr>
<td>Tessa</td>
<td>16</td>
<td>Early College</td>
<td>Female</td>
<td>Yes</td>
</tr>
<tr>
<td>Adam</td>
<td>15</td>
<td>Public</td>
<td>Male</td>
<td>No</td>
</tr>
<tr>
<td>Samantha</td>
<td>15</td>
<td>Early College</td>
<td>Female</td>
<td>Yes</td>
</tr>
<tr>
<td>Brian</td>
<td>15</td>
<td>Boarding</td>
<td>Male</td>
<td>No</td>
</tr>
<tr>
<td>Chris</td>
<td>20</td>
<td>Early College</td>
<td>Male</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1 All names are pseudonyms

Table 2.2 Personal Characteristics of Participants

<table>
<thead>
<tr>
<th>Youth</th>
<th>Motivation</th>
<th>Expectations</th>
<th>Interest</th>
<th>Prior Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>Expected continuation</td>
<td>Be able to translate school knowledge to garden</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>John</td>
<td>Something to do</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Tessa</td>
<td>Expected continuation</td>
<td>Job experience/skills</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Adam</td>
<td>Something to do</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Samantha</td>
<td>Money</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Brian</td>
<td>Money</td>
<td>None, possibly learn ‘something’</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Chris</td>
<td>Expected continuation</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
</tbody>
</table>

Affordances

One of the major affordances of PMMs is that they enabled us to capture a rich range of youth feelings, perceptions and ideas about the nature of their garden experience. By way of example, the categorical themes of “agricultural sciences/sustainable food production” and “environmental sciences/affect” that emerged from the data, demonstrate both the variety and the depth of reflection and thought many youth gave in creating their PMMs.

All youth made some mention of agricultural sciences learned or to sustainability issues related to growing food within their PMM and PMM interviews, though not
surprisingly, some focused on these issues more than others. Table 2.1 summarizes the number of comments made in this category. Comments ranged from direct reference to agricultural science content to comments that approached more affective components regarding issues of sustainable food production.

Table 2.3: Summary of Number of Agricultural Science Comments Made

<table>
<thead>
<tr>
<th>Youth</th>
<th>PMMs</th>
<th>PMM Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>John</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Tessa</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Adam</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Samantha</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Brian</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Chris</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td>71</td>
<td>33</td>
</tr>
</tbody>
</table>

The following quotes demonstrate the continuum of comments given in this thematic category during PMM interviews. Comments ranged from simply providing knowledge about applicable content regarding agriculture or growing food, to comments that appeared to reflect an emotional and deeper appreciation of sustainability issues related to growing food.

Comments regarding applicable content included:

Yeah, and I put soil blocking that is when we plant. We go into the shed and we do like trays of soil and we plant one plant each (Adam).

In my learning the interns help teach about soil and compost and functionality of the farm. (Brian).
I didn’t think there would be so many thistles, because thistles are something that are persistent. Well the ecology of thistles is impressive anyway (John).

We kind of just talked about the different parts of the plant every week (Adam).

Comments regarding broader in-depth appreciation regarding agricultural sustainability included:

Conventional farming in America what have we in the past half century we have taken out half the top soil and the burden on the top soil is only growing in the bread basket basically means that we have what 25 maybe 40 years left of growing in there before it becomes barren (John).

We are able to talk about agriculture and it is something that is very silly to think about because most teens don’t talk about oh I just saw this Facebook post on how this food is being genetically modified and it is a watermelon and it is square or something, it is something normal and normal kids usually don’t care about or their practices. So I felt like it was a very intellectual setting but yet it was very casual so it was really cool dynamic (Susan).

I have watched it grow from nothing to something and all my influences have helped it. Like we planted everything and we took care of it, I said, I referenced almost like raising a child, well I don’t know what that is like but I
mean you plant it everything that is in it and you take care of it and it grows and you keep taking care of it until it is fully developed and it becomes fruitful and what it produces help feed other people (Samantha).

A second major affordance of PMMs lies in their ability to not only collect this rich and deep data set and see the range of learning, but to then explore differences evident between participants. For example every youth in this program underwent the same lessons, work schedule and gardening duties, as well as experienced the same data collection method, yet data was extremely varied between each youth participant. By approaching the learning in this garden from an ecological framework and being mindful of youth assets, the differences in this data can be explained by differences inherent in each youth’s varied lived experiences. Therefore, PMMs allowed us to explore the variability in the data and to some extent explain this variability. For example, all youth made connections to general environmental sciences or environmental sustainability within their PMM and PMM interview. However the continuum of comments was extremely varied based on the amount of exposure youth reported having to both the garden program and environmental sciences. Second-year garden participants, as well as previously involved environmental science club members, generally discussed deeper connections to environmental sciences and sustainability.

The following quotes demonstrate the continuum of comments given in this thematic category during PMM interviews. Comments that were limited to general environmental facts or things noticed about the environment because they were outside all day were more likely to come from first year participants and participants that had no
previous experience with environmental work. An example of this can be seen in the following comments regarding factual environmental content:

Then I put different animals because we have a lot of different animals that we see out here, we have raccoons we have deer some times…….there are lots of trees around here, and we watch the plants grow each day how they get bigger and bigger (Adam).

Nature just sort of linked me to compost I don’t know how which made me think of raccoons and how they like to get into compost and compost and deer and raccoons just because they both hangout around the farm (Brian).

In comparison, second year participants and those that had previous work experience on environmental projects made lengthier comments that contained information about environmental issues facing the world, for example

People go from liking it to not liking it to liking it they begin to understand that dirt is not something you wash off it is something you have to live in or live on, understanding that we all come from the earth. Understanding that we are not separate from nature when in fact we are part of it even though we try to distance ourselves from it, well in later centuries we have anyway (John).
So community gardening is service learning, working with the environment, like people talk about how the environment is out there and our society is in here and we need to leave pockets of it but no I mean they live in our houses they live next to our houses, these species are living with us around us you know the trees on my farm those are not native species and they are on my farm and I am using them to live those trees are a part of nature it is all one big thing ‘(Chris’).

**Constraints** Typical constraints of using PMM are that the method itself is very labor intensive as it takes more time than many other methods to administer and the effort of participants usually generates a great deal of data. These facts almost always limit the size of sample sizes to which PMMs can be administered, ultimately possibly limiting the applicability of findings. Also PMMs rely on self-report of personal interpretations of experiences. This leads to great variability in data and can make them difficult to analyze. An example of how self-report can be a constraint to PMMs can be seen in the comments regarding human-environment interactions. Here Samantha has one interpretation that includes her picture of a mountain on her PMM, which she referred to and said

It just kind of represents life forms. Like the interaction between them.

Interactions the humans have with nature or the environment……… When you sit on top of a mountain and it is all quiet and stuff it is that type of peacefulness that gives you wisdom
This data is contrasted with Chris who also spoke to human-environment interactions yet he phrased it this way:

So this is kind of the environment and how people interact with the environment and all that good stuff. So this is kind of this is what I learned, is that this is kind of like this is where everything is before people muddle things. This is the essence of people this is the essence of the world this is before we as people become in the system you know this is us before impact, this is us before we impact the world this is what the real world is this is us without us.

Both youth in these instances are speaking to human-environmental interactions and using my method of thematic analysis both of these comments would be placed in the same category. Yet Samantha is speaking to the garden providing wisdom to understand the ‘life forms’ that she interacts with as a human and Chris is speaking to how ‘people muddle things’ due to their interaction with the environment. The personal nature of PMMs allowed for this discrepancy to emerge but the question still remains, ‘what is the ‘truth’ of how gardening youth see human-environment interactions?’—a question this method does not allow me to address.

Another constraint in PMMs arises from the fact that the method focuses participants on a single prompt. Even though it can be a very generic one like the one used in this project, this prompt generates rich and deep data in one area instead of broadly across many different areas. Therefore, the method limits the range of research questions that one might be able to ask and answer using PMMs. For example, this
project was interested in exploring the sciences learned from a particular out-of-school
garden-based learning program. Knowing the literature on GBL it was anticipated youth
would speak to the various sciences learned in the garden by using the single generic
prompt of community garden(ing). Data were rich and deep and contained many
connections to environmental and agricultural sciences, as expected. However, it was
clear that youth participating in this garden project gained more than science content.
Some youth spoke to such things as the garden being good for stress relief and/or
reflection saying such things as “I just enjoy the schedule and the fact that schedules
relax me” (Brian) and

The plants don’t care if you failed a paper or you are stressed out about home or
anything, you just go out and you work and stuff. I think even like the hard stuff
is mindless. It is fun sorting stuff because you don’t have to think about it, just on
autopilot (Tessa).

Another example of this is in the data that spoke to the garden providing social benefits
saying such things as “it widens my circle of people I interact with” (John) and “I put
meet new people” (Adam), as well as

I think this has been a really good experience, just to learn to work well with
others there is a lot of people here that I am glad that I met them but I wouldn’t
necessarily probably meet them at school because we run with different groups or
we don’t have similar hobbies but it is a good bonding experience that I probably wouldn’t have gotten at school (Tessa).

I do [connect with community] not just with the farm but with taking the bus everyday, I never really knew what community was until I kind of just got out there and I am responsible for myself most of the day (Samantha).

The major constraint in this area is that even though they spoke to these issues and made it known that they perceived these to be benefits of their garden experience, the PMM activity was done as an individual activity, after the fact. Therefore using PMMs as the main source of data collection did not allow for data to speak fully to how these social relationships were developed or how specifically the garden allowed for relaxation. This included the evidence not allowing for identification of what aspect of the program helped them form these social bonds or what aspect of the program specifically helped with stress relief.

A final constraint in using PMM for data collection in this particular project was created by the very long-term nature of the experience being investigated. PMMs were originally conceptualized as a tool for quantitatively measuring change in learning utilizing a series of specific protocols and measures (extent, breath, depth, mastery) (cf., Falk, 2003). The assumption from this work was that after engaging in a particular educational experience the ways in which an individual thought about and understood a topic would shift. Over the relatively short-term time frames of many educational experiences, e.g., a museum visit or a school lesson, the initial protocols developed for
PMM worked quite well at showing these changes (e.g., Adams, Falk & Dierking, 2003; Falk, 2003; Falk & Adelman, 2003; Falk, Falk, Heimlich & Bronnenkant, 2008; Moussouri & Coulson, 1998; Falk & Storksdieck, 2005; Lelliott, 2005). However, as I looked at the data from the PMMs collected during this study, I deemed these original quantifications of the data into extent, breath, depth and mastery to be less appropriate. Because of the much longer-term learning context represented by the youth gardening experience, with many of the youth having had more than a year’s worth of experience prior to the start of data collection, it became clear that even the initial PMM represented a very rich and nuanced “post-experience” map. Even for those youth who were just beginning their gardening experience, a delay in data collection meant that these youth had been working in the garden program four months before the first PMM could be administered. For all of these reasons it was decided early on to focus on more qualitative interpretations of the data.

**Discussion/Conclusions**

The youth in this sample found the task of completing PMMs suitably compelling to invest roughly an hour of their time in completing their maps – not once, but twice. In the process, they provided a rich repository of data reflecting their very personal perceptions of their garden experience, which they freely and willingly provided. I believe the time, attention and thought devoted to the production of their PMMs and their willingness to freely and willingly participate in an extensive discussion of the reasoning behind the items that they wrote down is a reflection of both the design of the PMM process, as well as the value-free nature of free-choice learning environments and the long-term nature of this particular garden program. That said, I can not discount the
comfort youth felt with me, the primary researcher who had built rapport with the youth both through the ‘get to know you’ interviews, as well as via the hours spent onsite over the course of the garden season. Therefore, the rich data collected was likely partially attributable to the affordances of the PMM activity itself, as well as the way in which youth were approached to participate in the study. The major affordances of the PMM appeared to be the ability of PMM to capture in each youth their unique voice, indicating their impressions and beliefs about the garden experience. The resulting understandings of what youth learned from this garden experience derives not from some preconceived researcher-defined list of outcomes, but rather from the unique perspective of youth themselves as stated in their own words. This lends significant validity to any findings and conclusions.

There were several limitations to this study. First this study explored one specific case study garden with many unique attributes. The connection to the food bank, as well as the coordinator’s background may have influenced the youth’s perceptions of experience. The choice of these particular data collection methods did not allow for this research to speak to these potential influences. This project also utilized an extremely small sample size and therefore results are not necessarily typical of other populations. PMMs also rely on youth self-report. Since youth may not have completely articulated their learning, it is possible data is not fully reflective of youth’s experiences. Finally, since there was a delay in data collection of pre-PMMs and PMM interviews, this work cannot speak to any changes that may have occurred in the youth due to the garden program. However, even with these limitations this work can provide several recommendations to others considering using PMMs in data collection. First, it is well
known PMMs are very labor intensive, yet produce deep, complex and varied data for analysis, this project was no different. Therefore, if there are significant time constraints on data collection researchers should take note and try to make accommodations for the longer data collection and analysis timeframes. Second, the PMM activity and interview itself can be very personally revealing. Not only should every effort be made to provide privacy to participants as they create their map as well as be interviewed about their map, effort should be given to develop rapport with subjects. Building a level of comfort and rapport with all subjects may not always be possible but one should bear in mind the level of personal information PMMs reveal when considering their use. Third, PMMs are very helpful in exploring meaning made from experience yet they do have several limitations, not only with data collection, but also with analysis. The fact that this project’s analysis methods resulted in a categorical theme that contained data that was extremely varied in meaning and depth, supports the idea that qualitative use of PMMs may always need to have an additional layer of data analysis to discern these potential discrepancies. This does not exclude using qualitative only analysis for PMM data, yet it suggests there is a real need for researchers to be evident of this potential issue within data. The focus on the single prompt in PMMs also has the real potential of limiting the research questions able to be asked of the data. If projects are interested in more broadly framed areas of inquiry researchers may want to consider other data collection methods or collect additional data using other qualitative methods. Finally, the long-term nature of this particular garden program appeared to influence the ability of PMMs to quantify change in learning utilizing the series of specific protocols and measures developed in the original use of PMMs. Those wishing to use PMMs in a long-term learning experience, yet wishing to
show changes in learning should pay special attention to when and how data is collected. If the educational experience will take place over many months, data collection should take place before a participant is exposed to ANY educational context. This will allow for assurances that data is reflective of a true pre- post- experience, which would then allow for changes in learning to be evidenced. This is not to say research could not attempt to collect data using retroactive reflection on pre-experience knowledge/perceptions, but this is an issue that should be considered and addressed within discussion of data collection methods.

In conclusion, the use of PMMs in this research not only provided evidence for the usefulness and applicability of using PMMs in the field with older adolescents but it also demonstrated that the data analysis method of thematically categorizing the rich and deep perceptions of youth learning could allow for extensive exploration of the differences in perceptions of participating youth. Since understanding GBL with adolescents is in its infancy and in need of further work (Blair, 2009), this method of data collection should be seriously considered when approaching other adolescent GBL programs. Further research should include studies using PMM activity with larger sample sizes at more than one adolescent youth garden. If additional research provides similar results, than PMM would be shown to be effective in capturing youth meaning making from GBL.
Chapter 3 - Adolescent Perceptions of Learning from an Out-of-School Garden: Evidence for Experiential Learning

Deborah L. Bailey, MS, MPH
Introduction

Well-designed garden-based learning (GBL) “encompasses programs, activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences” (Desmond, Grieshop, & Subramaniam, 2002, p. 7). GBL is firmly established within the American school framework as gardens are often seen as a panacea for numerous science-related literacy issues, including agricultural literacy (e.g. Rahm, 2002), environmental literacy (e.g. Bradley, Waliczek & Zajicek, 1999) and general STEM literacy (e.g. Williams & Dixon, 2013). However there are gaps in much of the foundational GBL research, as most researchers continue to focus on elementary aged students (e.g. Pigg, Waliczek & Zajicek, 2006) even though the number of garden programs with adolescents is continuing to grow and there is a real need to understand garden-based programming from the adolescent’s perspective (Blair, 2009). GBL research in the past has also been framed as an experiential way of learning about predetermined content and most often it attributes its positive outcomes to hands-on activity in the garden (e.g. Alexander, North & Hendren, 1995). This framing both preconceives what constitutes appropriate learning outcomes as well as assumes appropriate theory for participants. Very little empirical work has been designed to systematically determine the outcomes of GBL from a child or youth’s perspective (e.g. Bowker & Tearle, 2007). This lack of attention to the actual lived-experience of youth engaged in GBL has led researchers to make assumptions about the nature of the garden experience, a practice that may leave certain areas of GBL potentially underexplored.
In contrast, the larger study from which this chapter is drawn utilized a constructivist data collection method, personal meaning maps (PMM) (Falk, 2003) as well as guided and open-ended interviews, to first empirically demonstrate youth perceptions of learning in general and science learning in particular, and then empirically tie these perceptions to theory. The larger project also differed from most previous GBL studies as it focused on older adolescents (15-20 years) in an out-of-school summer garden. Data are from one case study organic garden program in a Pacific Northwest community, which had the intention of creating a working farm “that would have a market element, [Community Supported Agriculture] CSA, as well as donation [food bank] where teenagers are learning about community service, hunger in our community and how to help others in need; as well as getting a bit of agricultural education, environmental education and some job skills” (07/2014 interview). This chapter will present an in-depth analysis of experiential learning’s six tenets as evidenced by program youth’s perceptions of learning from their out-of-school summer garden experience.

**Review of Literature**

Most GBL research has framed garden outcomes through the lens of specific behaviors and/or knowledge change. The majority of this intervention research is framed around experiential learning (e.g. Klemmer, Waliczek & Zajicek, 2005; Waliczek & Zajicek, 1999). Experiential Learning Theory (ELT) (Kolb, 1984) obtains many of its foundational tenets from the writings of early learning theorist John Dewey (1958). The theory itself asserts “learning is the process whereby knowledge is created through the transformation of experience” (Kolb, 1984, p. 38). According to Kolb (1984), within ELT the knowledge gained through experience is both grasped AND transformed by the
individual and that gaining knowledge is done through movement in a learning cycle—experience, observation, reflection and experimentation. According to many ELT theorists, it is this active engagement in relevant experience that is critical and this is what accounts for knowledge learned experientially to be remembered long-term (Knapp & Benton, 2006). Due to some of the constraints of the chosen data collection methods (see Chapter 2) it was decided early on in this project that evidence of participant movement though Kolb’s learning cycle would not be possible. However, this did not exclude a thorough examination of experiential learning since in 2008 Kolb and Kolb explored the philosophical foundations of all experiential learning theorists and argued that there were six general tenets shared by all.

1) Conceives all learning is a process instead of a product. The way to improve learning therefore is to engage learners in the process that facilitates their most effective learning.

2) All learning is relearning so that student’s prior ideas on any one topic or concept must be considered so the student can examine their beliefs and integrate them into new concepts.

3) Learning any topic or concept requires the learner to resolve conflict between opposing ideas and it is this conflict that drives learning.

4) Learning involves a holistic notion of the learner inclusive of cognition, feeling, perceiving, and behaving.

5) Learning for any one individual results when that individual participates with experience and assimilates and accommodates existing concepts into new experiences.
6) Learning within ELT is constructivist, in that it is the process of creating new knowledge for and by the learner.

This direct connection to experience argued for in Kolb and Kolb’s six tenets is helpful in explaining how activity in a garden can lead to learning; however, much of the previous literature in GBL tends to assume experiential learning due to a garden’s pragmatic, hands-on activity. Many researchers either simply reference the learning experience as constructivist in origin (e.g. Fancovicova & Prokop, 2011) or somehow imply experiential learning through utilization of language such as experience/experiential (e.g. Cutter-Mackenzie, 2009), hands-on activity and/or tasks (e.g. Lekies, Eames-Sheavly, MacDonald, & Wong, 2007), or arguing learning due to reflection via journaling (e.g. Rye, Selmer, Pennington, Vanhorn, Fox & Kane, 2012). No GBL studies that I am aware of have tried to systematically tie evidence of learning to Kolb and Kolb’s (2008) six experiential learning tenets.

**Method**

*Research Question*

It was not the intention of this chapter to either concretely prove or disprove the larger ELT, but rather to deeply explore the perceptions of adolescent learning in one GBL program to evidence support for or lack of support for the six tenets of experiential learning proposed by Kolb and Kolb (2008). Therefore the one main research question for this chapter was as follows: do the self-perceptions of learning by adolescent participants in one summer garden program support experiential learning, as proposed by Kolb and Kolb’s (2008) six tenets?

*Educational Context*
This project utilized one youth community garden that was known as an organic urban ‘farm’. It was two-acres in size and originally donated, approximately six years ago, by a local public school to be used for community food production. Roughly two years prior to the beginning of this study, an AmeriCorps member teaching elementary and community garden programs for the local food bank, saw an opportunity to work with area youth to better utilize this land and fill a gap in outreach efforts. This AmeriCorps member eventually became a full-time staff member of the food bank and was in his second year of using this two-acre organic farm to train adolescent youth in garden and job skills when this project took place. The youth who took part in this garden program came from the local urban community and generally worked six hours a week during the school months and approximately twenty hours a week during the main growing season. Activities in the garden focused on horticultural and general agricultural knowledge and skills needed for the youth to produce high quality produce for sale through Community Supported Agriculture (CSA) shares and a local farmer’s market as well as donation to the local food bank. The coordinator said that in addition to his ‘in the moment’ training and conversation with youth he, or the two program interns, also gave weekly structured lessons on horticulture. Between July and October in addition to general gardening duties such as planting, weeding, watering and harvesting, youth also participated in four field trips related to gardening and food production, included a trip to a local greenhouse, an organic farm, a conventional farm and an industrial compost facility. Youth also took turns preparing lunch daily for each other using food from the garden and learned how to prepare certain foods for distribution such as garlic and onions by learning skinning and drying techniques. Youth were paid $800 in October for their
efforts over the previous six months (approximately $4/hour–inclusive of educational hours).

Procedures

Data were collected during the 2014-growing season and the project’s sample included the adult coordinator and seven out of the eleven youth participating in the program’s second official growing season. Data were collected using several, complimentary qualitative methods, including key informant interviews, personal interviews, personal meaning maps and personal meaning map interviews.

Key Informant, Personal Interviews

In July 2014, one semi-structured key informant interview was conducted with the coordinator/founder of the program to gather information on the background and current structure of the garden program. Next, semi-structured personal interviews were conducted with the seven participating youth in which questions were framed as ‘get to know you’ conversations. Interview questions were loosely structured and questions regarding youth’s expectations, prior knowledge/experience, interest in gardening, and motivations for participation were asked of the youth to get a better sense of the backgrounds of youth choosing to participate in the program. In October/November 2014 a post experience interview was conducted and was referred to as the ‘view of science’ interview. It was used to obtain answers to questions that arose from the first ‘get to know you’ interview as well as to concretely ask questions about youth perceptions of learning science in school and in the garden.

Personal Meaning Mapping
One of the main sources of data for this chapter came from interviews associated with a relatively new method called Personal Meaning Mapping (PMM) (Falk, 2003). Unlike ‘positivist’ mapping techniques developed for determining whether complex conceptual learning was achieved, e.g. concept maps (Novak and Cañas, 2006) and mind-maps (Buzan, 1974), PMM was designed to assess learning specifically in free-choice learning contexts using a more relativist-constructivist approach. PMM is easy to administer since it requires no pre-training of participants and is designed to feel “un-test-like” (Falk, 2003). In PMM, all learners are assumed to uniquely make meaning based on their own prior experiences and their current perceptions of the learning context. Hence there is no presumed ‘right’ answer and no presumption that all learning will follow a pre-determined course. Learning is assumed to be highly personal and highly situated within the learning context (Falk, Moussouri & Couson, 1998). This method has been used to explore learning in numerous ‘free-choice’ learning settings such as science centers, art and natural history museums, zoos, aquariums, community-based programs, as well as in classroom settings (for reviews, see Falk, 2003; McCreedy & Dierking, 2013). PMMs afforded a very personal and in depth approach to qualitative data collection for this project, which allowed the data to reveal the range of youth perceptions of GBL.

PMM and PMM Interview Data Collection

Youth were given two opportunities to complete a PMM, in July and October/November 2014. To complete their PMM youth were given a 10” x 14” piece of drawing paper with the center prompt ‘Community Garden(ing)’ and asked to reflect on the garden space itself and their experience of community gardening. Youth were asked
to write words, ideas, images, phrases, or thoughts that came to mind in relation to the center prompt. These maps were the ‘jumping off point’ for individual PMM interviews, which were extremely open-ended and designed to ask youth to explain in their own words why they wrote what they did on their map. Youth were repeatedly probed to expand on any of their ideas or thoughts they had conveyed on paper - the main source of data for this project. In October or November 2014 youth were given the opportunity to reflect on their experience and earlier PMM activity and asked if they wanted to add, subtract, change or make a completely new PMM. Appendix B contains two examples of PMMs produced by youth in this study.

Data Analysis

There were three main sources of data for this project, ‘view of science’ interviews, PMMs, and PMM interviews, which allowed for triangulation of qualitative data, ultimately increasing this project’s credibility, dependability and confirmability (Anfara & Brown, 2001). Unlike previous PMM work (e.g. Falk, 2003) where pre- post extent, breath, depth and mastery scores were calculated and compared, maps and transcripts from the PMM interviews were treated as a single qualitative data source— that which reflected all youth perceptions of learning from garden activity. Therefore transcripts from the PMM interviews were one of the primary sources of data that provided evidence of youth perceptions of learning. Transcripts from the ‘view of science’ interviews were a second primary data source that specifically allowed for insight into youth’s perceptions of science in general, and science learning both in and outside of the garden in particular. Two questions from the ‘view of science’ interview that were of particular interest in answering the research question were “How do you
think the science you are learning here in the garden is the same/ is different from school-based science?” Finally, transcripts from the ‘Get to know you’ interview were a secondary source of data and read and reread to obtain general insight into youth backgrounds, including previous garden experience and knowledge.

Data analysis began with verbatim transcription of each interview. Data analysis was approached as a form of axial coding (Strauss & Corbin, 1998) where the concepts the youth expressed about their garden experience were related and placed in various analytical categories (Constas, 1992) indicative of the six tenets of experiential learning. This process of identifying themes was both deductive and inductive and not only allowed for quantifying the comments made within each tenant, but also allowed for a comparative analysis (Maxwell, 2012) of statements made about each tenet. In this way this project’s data analysis fit within the goal of all qualitative research—“to reconstruct the specific categories that participants used to conceptualize their own world view” (Goetz & LeCompte, 1984).

Results

The coordinator interview, lasting approximately one and one-half hour, revealed the history and current contextual environment of the garden. Initial youth recruitment came mostly from an established environmental program that had been known to volunteer on the farm, as well as conduct environmentally themed community service projects such as invasive species removal and beach cleanups. The project coordinator stated that he originally approached this environmental club because he believed these environmentally involved youth might be interested in having more consistent participation on the farm. The garden coordinator also stated that he suspected that the
previous involvement in this environmental club might have influenced the ‘type’ of youth who ultimately chose to participate in the garden program. ‘Get to know you’ interviews confirmed that this procedure for initial youth recruitment did result in many similar characteristics across participating youth such as pre-existing positive environmental beliefs, values and attitudes. Interestingly the garden coordinator also commented that he believed that youth who had previously participated in this environmental club were already environmentally minded individuals and therefore he felt he could not conclusively say that the work on the farm influenced these youth’s environmental affect.

Many in this environmental program were also students at a local early college high school program. This program is a partnership between the local public school district and a community college and is designed to have students earn both their high school diploma and associates degree within 5 years. To be admitted a student must demonstrate passing grades of a C or better, good attendance and good citizenship. It was believed by the garden coordinator that this early college high school program attracts motivated and mature youth, a suspicion, which was not explicitly explored with this study.

The ‘get to know you interview’ revealed various personal characteristics of learning of the seven youths participating with this study. Generally the youth had all been raised in an urban setting, had various challenging home lives, and were heavily involved in school. I was confident that this sample was representative of all youth in the program as the key informant interview revealed that the four youth choosing not to participate in this study were all very similar in background to the youth in this study.
Youth participating in this study were all 15-20 year olds and 4 were second-year garden program participants. Five currently attended or had attended the early college high school program, one attended an East coast boarding school and one attended a non-early college public high school. All youth stated that they had little to no interest or prior experience with gardening before participation and that they had very little expectations regarding their own individual learning. Motivations for participation included expected continuation of their environmental club participation, ‘something to do’ and for money. The majority of the youth described their home life in non-traditional terms, ranging from being raised by family relatives, foster care or separated parents. Two youths reported living within a ‘traditional’ household of long-term married parents. Few youth did any other out-of-school activities with only two indicating a potential future interest in other community volunteer opportunities. Sports participation was also limited, as the early college and boarding school do not have opportunities for afterschool sports. Tables 3.1 and 3.2 summarize backgrounds of participants.

Table 3.1 Participants

<table>
<thead>
<tr>
<th>Youth</th>
<th>Age</th>
<th>School</th>
<th>Gender</th>
<th>Prior Env. Club</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>17</td>
<td>Early College</td>
<td>Female</td>
<td>Yes</td>
</tr>
<tr>
<td>John</td>
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</tr>
<tr>
<td>Tessa</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>Yes</td>
</tr>
<tr>
<td>Brian</td>
<td>15</td>
<td>Boarding</td>
<td>Male</td>
<td>No</td>
</tr>
<tr>
<td>Chris</td>
<td>20</td>
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<td>Yes</td>
</tr>
</tbody>
</table>

1 All names are pseudonym
### Table 3.2 Personal Characteristics of Participants

<table>
<thead>
<tr>
<th>Youth</th>
<th>Motivation</th>
<th>Expectations</th>
<th>Interest</th>
<th>Prior Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>Expected continuation</td>
<td>Be able to translate school knowledge to garden</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>John</td>
<td>Something to do</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Tessa</td>
<td>Expected continuation</td>
<td>Job experience/skills</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Adam</td>
<td>Something to do Money</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Samantha</td>
<td>Money</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Brian</td>
<td>Money</td>
<td>None, possibly learn ‘something’</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Chris</td>
<td>Expected continuation</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
</tbody>
</table>

### Evidence of Six Tenets of Experiential Learning

1. *Process instead of a product:* Although coding of the PMMs and PMM interviews revealed many examples of youth describing the products of their science learning, e.g., "I didn’t learn about GMOs and the risks involved in that before I came here either and so that was kind of scary" (Tessa) and “I didn’t think there would be so many thistles, because thistles are something that are persistent. Well the ecology of thistles is impressive anyway” (John), there was also ample evidence of science learning as a process. It is argued that this evidence of product perceived as learned does not necessarily disprove tenet one because there was far more evidence of youth describing their experience of learning in the garden as a *process*. When speaking to their science learning in the garden, all youth referred to the *process* of their learning using words such as practical, hands-on, and applied. For example Tessa said the science learned in the garden was “just a lot more [of] something you can *apply* later on in your life too, rather than just after that test”. Adam said that science learning in the garden was ‘more *hands-***
on and we actually go out there and worked with the plants’. John said learning for him in the garden was: “practical not textbook and for another it is a lot more **hands-on** because you have hands-on labs in schools, but this learning is on the job basically”  
*[bolded added for emphasis]*.

2.  *All learning is relearning*: Kolb and Kolb’s emphatic statement that *ALL* learning is relearning was not completely supported by all seven youth. There was one youth who did not support this tenet, Adam who rather than framing his perceptions of learning in the garden in terms of “relearning”, talked exclusively about his garden experiences as novel/unique, e.g., “Well just learning things that I didn’t know before how everything works.” Adam was very adamant that everything he was learning in the garden was brand new to him and he was not necessarily relearning content from previous experiences. The other six participating youth in this study all did describe their learning in the garden as a form of relearning. For some, this relearning was directly tied to school-based science content revisited. For example, in between the first and second summer Susan took school-based chemistry. She believed her garden-based science learning was greatly increased the second summer due to this chemistry class.

    Each lesson that we incorporated each week was an opportunity for me to really reflect back on my knowledge that I took in my chemistry class and I felt like I sometimes, I would raise my hand and I would ask [coordinator] what about this or what would happen if this happen but I was just asking questions that related back to my chemistry knowledge.
For John relearning in the garden was not necessarily tied to specific content, but rather revising larger conceptual ideas of applying science to new issues or interpreting old content to new application. When discussing learning in the garden he said:

It is about learning to look at new things and interpret things in a different way than you have before so it is learning how, or new skills, to look at data that you have already previously looked at. So learning skills and content learning new ways to look at content and apply content. Analyze data in new ways to come up with new content.

Relearning for Susan, Tessa, Samantha and Chris was even more broadly positioned, as all believed the garden helped them explore larger personal issues such as beliefs, values, morals or identity. For ‘Susan this emerged as she reflected on her position on sustainable food purchases. As she described the field trip to a conventional farm she stated that it “was a very powerful event that really defined what I believe and what I have been taught here at the farm”. She went onto say that the experiences in this garden program made her think about her own beliefs and values, including: “What are my standards for sustainable agriculture? How will the knowledge that I have accumulated relate to my plans for the rest of my life?” For Chris the garden program was about relearning in that it helped with ‘recovering his identity’ through being a part of nature.

Recovering identity. I think that being a part of nature is how we understand all things; I think that we are a part of nature; I think that our mind is a part of nature
I think that everything is a part of nature and community gardening is really trying to understand all of it at once.

3. *Learning requires resolving conflict between opposing ideas:* As above, all but one youth (Brian) showed evidence to some kind of conceptual conflict resolution. For Brian he could see no conflicting ideas in his garden learning. Rather he spoke more to the similarities between his learning at the garden and his learning at his school where they do similar food production work, saying things such as “I thought about how at my school we have interns and it linked me to just being outdoors and warmth” and “we do a lot of the stuff [at boarding school] that we do [here] at the youth farm”. However most youth did speak to how the garden program helped them resolve conflict around opposing ideas. For some this was a much larger struggle than for others. Two youths, Adam and John appeared to have limited struggles, mentioning only once a particular topic they contemplated during their garden experience. For John it was related to the ethics of whether or not insects should be killed. For example, he talked about what to do when he would find beetles in the garden. He framed this as a question, “do we want to kill it or not, is it a pest, is it good, what does it do?” For Adam (as was well as Susan, Tessa and Samantha) these conflicts were more personal, relating to the garden program forcing them to question their future career choices. For example, Adam said the garden “was my first job and I thought do I really want to do this or do I want to do something else and what do I really want to do with my life”. Tessa said “I kind of feel like just working at the farm has helped me get a better idea of who I am and who I want to be later in life and what I want to be involved with”.
A major conflict that arose for many youth related to the ways most food is grown in the United States. For example Samantha said:

I like the main reason that the farm is here, like it is not just a farm to grow food and then just kill the rest of the environment with pesticides or something, we are actually here to grow good food for people who need it which is like the ethics of growing it.

Interestingly it was this ethical conflict that also led Samantha to question her future career choice as she was originally interested in aeronautical engineering. However, she now finds herself more interested in fields that she perceived would be more ‘helpful to others’ such as social work or some kind of ‘cancer doctor’ so she can ‘use her life wisely’.

Susan also spoke to how the garden program had influenced her own thoughts around buying organic food. She stated that the garden

Reinforced my knowledge and I was able to really have my own standards of sustainability when it comes to agriculture and what it means to me and what am I, what am I going to pay for as a consumer? What am I willing to be happy with? or what are the practices that I will advocate for?
She went on to share a story about a woman choosing a highly processed organic granola bar over a non-organic banana for her young child. She said the garden experience helped her ponder and really see, well am I going to be like the Starbucks lady that prefers the highly processed granola bar just because it is organic rather than the actual fruit itself?

For Tessa, Samantha and Chris the internal conflicts described also related to food. Tessa questioned her past practice of only eating prepackaged frozen meals and how the garden has taught her to see there is a difference in food cooked from scratch as they cook every day for each other with food from the garden. Samantha struggled with the larger societal problem of not knowing where your food comes from stating that

Most people in America revolve around their grocery store and they are never out there to experience like being in the woods or taking care of the vegetables and fruits that take care of you.

The PMM interviews also revealed some very personal, identity-related conflicts. For example, Susan shared that through service with the garden program she has reconciled the significant internal conflict she had experienced for years as a Mexican-American.
Because here in America even though I am a US citizen because I was born in Mexico you get labeled as Mexican nobody really labels me as American… through the work I do through the collaboration and the things that I have done for my community I have noticed that I can be both I don’t have to classify myself.

4. Learning involves a holistic notion of the learner: All of the youth interviewed for this project provided some indication that learning from/in the garden program was experienced holistically. Susan’s internal conflicts regarding her Mexican-American identity and questioning of sustainable food production practices, along with her strong cognitive connection to her school chemistry class was one of the best examples of this holistic notion of the learner. She also expressed that some of their activity in the garden program such as placing sunflowers in the CSA baskets really brought her a lot of ‘joy’ and made her ‘fall in love’ with the farm. John expressed that through the garden he developed his interpersonal relationships, reinforced his connection to nature, and found the garden activity “a little more rewarding because you get to taste whatever you are growing, you get to interact with it constantly”. “Tessa” also thought the garden program helped her interpersonal skills “because it teaches you how to deal with other people” and “work well with others”. She also stated that the program helped mature her and grow as a person because it helped her learn life lessons too and you learn to go out there and commit your time and be out there because even if you don’t want to go out there things are still growing and
things are still happening and when you have a job you can’t be like ahh I can’t get out of bed today I am not going.

Samantha and Chris were also good examples of how the garden influenced them holistically and not just cognitively. As stated earlier Samantha believed the garden taught her values and morals as well as helped her have insight into herself. She along with ‘Chris’ also believed the experience in the garden was somewhat of a spiritual experience with Chris stating that for him the garden was

Happiness, fulfillment unity, education, biology, I think these are all important things, that without a sense of each other and a sense of kind of like our spirit about where we come from, our ancestors what we mean to ourselves, psychology, there is no way to like interact with the environment, because we just kind of take it and destroy it and do what we want with it so if we don’t understand these things we can’t better protect the environment.

5. Learning results from participation with experience and assimilation and accommodation of existing concepts into new experiences: All but one youth (Adam) clearly demonstrated assimilation and accommodation of existing concepts into their new understandings of the nature of gardening. Adam did not seem to make any connections between his pre-existing conceptual understandings and his current gardening experiences. He repeatedly stated that the garden experience and learning involved were all new to him e.g., “There is always something new to learn.” Again this is limited lack
of support for the fifth tenet and youth were much more likely to speak to their learning in the garden as connections between old concepts and their garden experience. For example, in addition to Susan’s repeated discussion of how she assimilated and accommodated her existing concepts of chemistry from her school-based chemistry class into her new understandings about gardening, she also spoke to material she had learned from her global studies class. The garden allowed her “to finally accomplish some of the concerns that I really had during the class”. In addition to the garden experience helping her accommodate her old concepts regarding food preparation (packaged versus fresh), Tessa also spoke more generally to how concepts learned in school were applied in the garden.

Yeah, because school is more like how it works why it works the way it works, where else out here there is just a lot more than that. I just think it is, I don’t know, just doing it and applying it [school-based content] and learning on your own with your hands in the soil.

John who had previously stated that content learned in the garden was similar to science content in school, specifically soil science, stated the garden was pretty cool the general stuff about that, about how the different parts of the soil and the inorganic soil part in particular makes the gray loam and how organics play into that and help the plants grow and what plant take and give what to the soil and just the science of farming.
Here he seemed to be saying that he was able to take the school-based science content and apply it to ‘the science of farming’. Chris also discussed how he applied previously learned content in school to the garden but for him this included biology, psychology and philosophy content.

6. Knowledge in ELT is created by and for the learner:

All youth demonstrated that the learning from this particular garden was a constructivist experience in that they believed they were learning new things by actively creating knowledge for themselves. This is clearly evident in many of the youth quotes above. Additional evidence includes the following from Susan: “interns provide weekly lectures on farming and bring new insights as well as myself whenever I have random talks with people there is a lot of knowledge that is associated with farming.” John also stated very clearly that he was actively involved in creating new knowledge for himself when he said, “You are growing your knowledge of how to make them [edible foods] and growing of experiences, experiences you might or might not liked depending on if you stay here long”.

Table 3.3 summarizes the frequencies and data source for each youth of the incidence of Kolb and Kolb’s 6 tenets of experiential learning.

Table 3.3: Evidence of Kolb and Kolb’s 6 Tenets of Experiential Learning Theory

<table>
<thead>
<tr>
<th>Tenet 1</th>
<th>PMM Interviews</th>
<th>View of Science Interview</th>
<th>X Tenet 1=1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susan</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>John</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tessa</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Adam</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Samantha</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brian</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chris</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tenet 2</td>
<td>PMM Interview</td>
<td>View of Science Interview</td>
<td>X Tenet 2=6.1</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>---------------------------</td>
<td>---------------</td>
</tr>
<tr>
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<td></td>
</tr>
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<td>1</td>
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<td>0</td>
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<tr>
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<td>Brian</td>
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<td>7</td>
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<td></td>
</tr>
<tr>
<td>Tessa</td>
<td>9</td>
<td>1</td>
<td></td>
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<tr>
<td>Adam</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Samantha</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Brian</td>
<td>0</td>
<td>0</td>
<td></td>
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<td>Chris</td>
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<tr>
<td><strong>Tenet 4</strong></td>
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</tr>
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</tr>
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</tr>
<tr>
<td>Samantha</td>
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<td>0</td>
<td></td>
</tr>
<tr>
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<td>0</td>
<td></td>
</tr>
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</tr>
<tr>
<td><strong>Tenet 5</strong></td>
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<td>0</td>
<td></td>
</tr>
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Discussion/Conclusion

Taken together the multiple sources of data for this project helped reveal how youth conceptualized their garden experience, in particular how they conceptualized their learning from the experience. The methods utilized for this study appear to have been an effective way to demonstrate relatively strong evidence for the applicability of Kolb and Kolb’s (2008) six tenets of experiential learning. As predicted from constructivist theory (Cobb, 1994; Driver, 1995), each youth constructed their own unique understanding of their garden learning experience. However despite the diversity in the data, Kolb and Kolb’s (2008) basic tenets could still be discerned.

Overall this research supports Kolb’s (1984) ELT assertion, that “learning is the process whereby knowledge is created through the transformation of experience” (p. 38) as all youth in this particular garden program emphatically stated that the experiential nature of the program influenced their learning. However, this project did not necessarily set out to prove or disprove ELT. Rather this project was designed to explore an adolescent youth out-of-school gardening program to better understand their perceptions of learning and how these perceptions may or may not directly support Kolb and Kolb’s (2008) six tenets of all experiential learning theorists.

According to Kolb and Kolb (2008) these six tenets are what should be evident if one is engaging in experiential learning. Therefore those working with experiential learning should argue that evidence of all six of these tenets in any learner is the gold standard that should be applied to evident experiential learning. However, this research would seem to have disconfirmed this hypothesized gold standard as not all seven youth viewed their learning through the lens of all six tenets. There are many possible
explanations for this, only one of which is that Kolb and Kolb’s (2008) six tenets of experiential learning do not hold true for these gardening youth. A second possibility is that the particular data collection methods of PMM, PMM interviews and personal interviews were not adequate to evident all six tenets for all seven youth. Interview protocols for personal interviews were semi-structured and PMM interviews were open-ended based on what youth had created on their individual map. It is possible these two types of qualitative interview collection methods were not fully successful in eliciting a complete depiction of learning in the two youth that appeared to disconfirm the six tenets. A third possibility may lie in each youth’s developmental stage. Since many of the six tenets could be argued to be reflective of a youth’s ability to participate with metacognition, it is possible the two youth not providing evidence for the six tenets were delayed in this area. However without further evidence of each youth’s developmental stage, this possibility is only a speculation. Finally, it is also possible that the data analysis procedures were not adequate in identifying all six tenets for all seven kids. It is very possible that there was data that supported all six tenets for all seven youth and it was missed during data analysis. It is also important to note here that the supporting evidence for the six tenets was also very unevenly distributed among participating youth. It is possible this uneven distribution of evidence was also due to the four named possibilities of disconfirming evidence discussed above.

Although there were limitations to this project’s methods, for example youth self-report and small sample size, there were also strengths. For example, as proposed by Falk (2003), the PMM method provided a broad and open-ended way to explore participant meaning making as it enabled us to fully “hear” the voice of the participants, unbiased by
any preconceptions of the “right” or “wrong” way for them to construct meaning from their experience. Therefore, even though one of this study’s limitations was that it was based on youth self-report, given the goals of the study, this aspect of self-report provided substantial validity to the findings. This confidence in the data allowed for a more direct test of Kolb and Kolb’s (2008) six tenets of experiential learning theorists and this data suggest that the majority of the seven adolescents participating in this particular free-choice garden experience did perceive they were engaged in experiential learning, as defined by Kolb and Kolb.

In conclusion, I argue the majority of evidence presented in this chapter provides support for the use of the six tenets of experiential learning as a viable framework for understanding adolescent youth’s garden learning experiences. The lack of evidence found for different tenets from two participating youths has many possible explanations, only one of which is experiential learning not holding true for these gardening youth. I argue overall there was sufficiently strong support for experiential learning for these youth and this seems to suggest it would be likely that similar results would be found in other GBL contexts. Data supporting experiential learning from these youth support the notion that older youth do find the experiential nature of the garden learning experience particularly salient and valuable. Educators should take note and remember that at least based on this case study; garden-based older adolescent learners find learning through active engagement a valuable and enriching experience. Certainly additional research will be necessary to fully substantiate these findings. Future research should include more explorations of adolescent’s, as well as younger children’s learning from/in gardens,
possibly utilizing other qualitative methods. Collectively such studies are essential in
order to fully understand the nature of garden-based learning experiences.
Chapter 4 - Out-of-school gardening as science education: A study of adolescent perceptions of learning

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Introduction

This paper presents data from a case study of one ‘youth farm’ in a Pacific Northwest community where teenaged youth were actively recruited to participate in a summer garden-based learning (GBL) program on 2 acres of underutilized public school property. It was the program coordinator’s intention for the program to create a working farm that

“would have a market element, [Community Supported Agriculture] CSA, as well as donation [food bank] where teenagers are learning about community service, hunger in our community and how to help others in need; as well as getting a bit of agricultural education, environmental education and some job skills” (07/2014 interview).

What is Garden-Based Learning and where is it used?

Using a garden to educate has its philosophical roots in 19th century ‘nature study’ (Bigelow, 1914; Meyers, 1908; Mosely, 1925) and was advocated for at this time by such educational pioneers as Maria Montessori (1964). More recently the educational community advocating for garden education include those working in the local food and environmental movements (Yamomoto, 2000). Formally, Desmont, Grieshop and Subramaniam (2002) define garden-based learning as programs that use “activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences” (p. 7). In general, gardens have long been viewed as an appropriate venue for teaching about a wide array of
content, including science (Blair, 2009). However the vast majority of educational research exploring garden teaching and learning has focused on young children in schools and the learning outcomes have typically been framed within a positivist, deficit-based epistemology with GBL researchers typically having preconceived ideas about what the appropriate knowledge is that children should acquire from their garden activity (Blair, 2009; Bowker & Tearle, 2007; Dillon, Rickinson, Sanders, & Teamey, 2005; Titman, 1994). Yet the popularity of using gardens to teach has spread beyond the confines of elementary aged children and is now incorporated into many secondary schools as well as adolescent out-of-school or free-choice learning programs. This paper will present data from a case study that was designed in part to systematically explore GBL from the perspective of adolescents engaged in an out-of-school gardening experience. These data will add to the literature on garden-based science learning and issues of content acquisition in free-choice learning environments.

**What science content acquisition does a garden afford?**

Though science content acquisition is just one of many potentially valid goals of GBL, it is arguably one of the most frequently cited (see review Williams & Dixon, 2013). As increasing numbers of educators search for meaningful ways to increase students’ science, technology, engineering, and math (STEM) interest and performance (Gibson & Chase, 2002; Markowitz, 2004; Sheridan, Szczepankiewicz, Mekelburg, & Schwabel, 2011), more have turned to GBL as a potentially effective way to influence student STEM outcomes. Specific science content connected to GBL varies widely but is most often tied to ecology, horticulture, soil chemistry, plant taxonomy, plant parts, flower dissection, water properties, seed germination, seed variety, plant diseases, insects,
and other wildlife, (Williams & Dixon, 2013) as well as nutrition and other health sciences (Robinson-O’Brien, Story, & Heim, 2009).

Until relatively recent, the evidence that GBL aids in STEM content acquisition had mostly been anecdotal with little empirical work to support such conclusions. Blair (2008), one of the first to systematically review the academic benefits of school GBL programs, included STEM outcomes in her examination and specifically found “9 of the 12 studies revealed a positive difference in test measures between gardening students and non-gardening students” (p. 20). More recently, Williams and Dixon (2013) reviewed 48 studies and found 22 of these measured the impact of GBL directly on science, math, language arts, writing and social studies outcomes (e.g. test scores, grades, GPA). Of these, 38% measured science, 25% measured math, and the majority of all studies found a positive relationship between garden activity and academic outcomes, with science outcomes having the highest proportion of positive effects (93% of studies explored).

Findings positively correlating GBL with academic outcomes have been demonstrated at all grade levels and settings, but are most commonly found in studies involving science and children in grades 3-5 (Williams & Dixon, 2013). For example, Klemmer, Waliczek and Zajicek (2005) explored the relationship between the science achievement of 3rd – 5th grade children and gardening and found that student achievement was higher amongst children who had participated in some kind of garden activity. However, Pigg, Waliczek & Zajicek (2006) found conflicting evidence. When students were matched by age, those who had not participated in a garden program achieved higher math and science test scores than did those students who had participated in a gardening program. These authors concluded further research was needed as many GBL
studies have repeatedly shown positive influences on academic outcomes. It is important to note, however, that most of the previous GBL studies conducted have been done utilizing a positivist framework where the outcome of interest was pre-determined and learners were tested to see if they achieved those outcomes. Very few GBL studies have utilized more open-ended, asset-based approaches (e.g. Fusco, 2001), which accommodate the reality that science content acquisition may vary from learner to learner depending upon their prior interests and experience. Explorations of this type are more keenly aware of the context of participation (Rahm, 1999) or how participant learning is positioned within the social and cultural environment of the garden and/or food-related activities (Mayer-Smith, Bartosh, Peterat, 2007). It is also important to note that many of the previous GBL studies correlated science content acquisition with various other, often indirect non-academic outcomes, such as environmental attitude or locus of control. This may have complicated data analysis and conclusions regarding content acquisition.

Efforts to tie gardening activities to science learning have been more prevalent at the elementary level but a number of secondary science educators have also claimed a relationship between garden activity and science learning. Secondary science is generally taught in academic silos including but not limited to chemistry, biology, horticulture, agriculture, physics and health, which may ultimately complicate a researcher’s ability to measure content acquisition from the garden. Also similar to elementary school-based GBL research, secondary school GBL research is complicated by explorations of correlations between direct science content acquisition and indirect academic constructs. For example, Cammack, Waliczek & Zajicek (2002) demonstrated how positive changes in horticulture knowledge correlated with positive changes in environmental attitudes of
juvenile adolescent offenders involved in a gardening project. Similar results were found in a study examining 475, Texas 9th-12th grade environmental science students who showed both increased environmental knowledge and attitude scores after participation in a garden activity (Bradley, Waliczek & Zajicek, 1999). However similar to studies of elementary school aged children, much of the GBL research on secondary school aged youth has also been framed from a positivist perspective using predetermined outcomes as the measure of success. In all such cases, the researcher, rather than the youth themselves, defined the nature of science learned.

In addition to general science and domain specific sciences such as horticulture or environmental science, GBL researchers have also been interested in how gardening can lead to nutrition and health science content acquisition, which in turn has been used as an indicator of potential pro-nutrition behaviors (e.g. Morris, Koumjian, Briggs, & Zidenberg-Cherr, 2002; Project Food, Land, & People, 2000). Studies in this area have also paid particular attention to more indirect outcomes such as tastes for and attitude toward fruits and vegetables (e.g. Lineberger & Zajicek, 2000; Morris, Neustadter, & Zidenberg-Cherr, 2001; Morris & Zidenberg-Cherr, 2002; Twiss, Dickinson, Duma, Kleinman, Paulsen, & Rilveria, 2003), as well as skill self-efficacy regarding cooking (e.g. O’Brien & Shoemaker, 2006). However, these latter investigations share similar deficit-based epistemologies to the studies with elementary school aged students exploring general science and studies of secondary school aged youth exploring discipline specific science. Work in this area has tended to be positivist in nature, utilizing pre- and post- test designs focused on changes in pre-defined nutrition content knowledge (e.g. Morris & Zidenburg-Cherr, 2002). No studies that I are aware of have
asked what nutrition and health sciences youth perceived they learned from a garden experience.

Theoretical Framework

Many of the above GBL studies apply an experiential framework to learning in the garden. An exploration of the appropriate application of this learning theory for this particular garden program is addressed in separate paper (Chapter 2). For the purposes of this paper, the educational outcome of interest was acquisition of science-related content knowledge. I fully acknowledge that science-related content acquisition is not the only possible, or even necessarily the most important outcome of an educational experience, including those of GBL. However science-related content acquisition is often cited as one of the main goals of student/youth participation in GBL (see review Williams & Dixon, 2013), which is why I have focused on this outcome in this paper.

I assumed that the science content youth evidenced as learned was only partially the result of the direct instruction provided since the garden experience was just one aspect of these youths’ learning ecology (Bronfenbrenner, 1979; Jackson, 2013). After all, the youth in this program live in a world in which they are constantly engaged with a host of rapidly changing technologies and ubiquitous media outlets, any one of which could lead to potential science learning (cf., Falk & Dierking, 2010). The learning resulting from immersion within these complex ecological networks was assumed to be situational and context specific (Lave, 1988; Scribner & Cole, 1973; Rogoff & Lave, 1984) and by definition, ‘free-choice’ in nature (Falk & Dierking, 2000). It is also understood that motivations for participation, as well as personal interests and prior knowledge and experience also significantly influence what a participant learns in these
free-choice environments (Baron, 2006; Falk & Dierking, 2000; Falk et al., 2007; Falk & Storksdieck, 2005). The situated contexts of these ‘free-choice’ environments, along with the complexity of participants’ personal characteristics and learning ecologies, combine in ways that ultimately make assessment of learning from any specific context challenging (Dierking et al., 2004; Groff et al., 2005).

Unlike most GBL research, this research utilized a relativist, asset-based approach to measuring youth learning (e.g. Scales & Leffert, 2004). Unlike positivist, deficit-based models of learning (e.g. Villarruel, Perkings, Dorden, & Keith, 2003) where it is assumed there is a ‘right’ answer or a predetermined set of concepts that must be learned from the garden for a student to have ‘learned’, this project approached learning from a youth-centered perspective which assumed that science learning was likely to vary from youth to youth and would be determined by both the content and realities of the garden program, as well as by individual differences between the youth themselves. This approach assumes that youth enter the garden with certain characteristics, including differing prior experience and knowledge, interests, motivations as well as differing socio-cultural realities that directly influence what they found salient and worth learning.

**Method**

**Research Questions**

1. Is there evidence that youth participants in this particular free-choice garden program learned any of the science content intended by the garden coordinator (i.e., environmental and agricultural education)?

2. Is there evidence that youth participants in this particular free-choice garden program learned any STEM content not intended by the garden
coordinator but previously identified as taught and learned in other GBL programs (e.g. general science, nutritional sciences, math)?

3. Do youth make specific connections between the science content presented in the garden program and science content presented in school, and if so how?

Educational Context

The site for this project was a two-acre urban ‘farm’ located on public school property and originally donated for food production approximately six years ago. In 2012 an AmeriCorps member doing community outreach on gardening with elementary aged students and community adults, saw an opportunity to not only better organize the farm food donation but to also fill a gap in gardening outreach and education efforts. He decided to work with the local food bank to design a program that would train local urban adolescents in garden and job skills to produce food for the food bank as well get youth involved in the local farmers market and a community supported agriculture share program. Youth choosing to participate came from the local urban community and committed to work six hours a week during the school months and approximately twenty hours a week during the summer. Youth activities in the garden focused on horticultural knowledge and agricultural skills and the coordinator stated that training included ‘in the moment’ conversation, as well as weekly structured lessons provided by himself or one of two program interns. Youth also participated in four field trips to a local green house, an organic farm, a conventional farm, and an industrial compost facility. A schedule of lesson topics and more details regarding the field trips can be seen in Appendix A. At the
end of the summer each youth was given $800 (approximately $4/hour—inclusive of educational hours) for the efforts they had put in at the garden.

Sciences Taught

The intention of the coordinator of this summer garden program was to teach ‘a bit of environmental and agricultural education.’ Environmental sciences taught were related to issues of pollution regarding farming and the environment. These issues included topics such as nutrient management and soil exhaustion. The curriculum did not directly cover affective components often covered in environmental education experiences. The majority of the curriculum was focused on horticulture/agricultural science, as this was most important for growing quality produce for market. Topics covered included issues such as cover crops, pest management and plant nutrient deficiencies. None of the formal lessons covered nutritional sciences/health/wellness topics. Finally, what could be considered general STEM in school-based courses was covered throughout the summer through various agricultural topics such as soil science.

Procedures

Data were collected summer and fall of 2014, the second official programming year of this particular garden. In the summer of 2014 this program had eleven youth in total participating yet the sample for this project contained only seven of these youth and the adult program coordinator. There were many varied reasons youth may have chosen not to participate or their parents chose not to allow the youth to participate. It was suspected this included potential fear of harm from the research and generally not wishing to be part of any research study. Data for this project were collected using various complimentary qualitative methods including: key informant interviews, personal
interviews, personal meaning maps and interviews, observations, field notes and researcher memos.

**Key Informant, Personal Interviews**

In July 2014, one key informant interview was conducted with the coordinator/founder of the program. This interview was designed to capture the rich history of the program and current goals. Questions were also used to reveal the background of youth recruitment and the garden’s funding organization within the food bank. The coordinator was also asked specific questions on his educational background and perceptions of garden curriculum implementation.

Next, semi-structured personal interviews were conducted with the sample of participating youth. Interviews were framed as a ‘get to know you’ conversation. Questions were used to understand their backgrounds as well as some personal constructs of learning such as expectations, prior knowledge/experience, interest in gardening, and motivations for participation. The interview protocol was loosely structured and included questions regarding the their family and school background, other out-of-school activities, gardening experience, motivation and interest.

In October/November 2014 after most garden activity was concluded for the season, a post experience interview was conducted. This interview was referred to as their ‘view of science’ interview. Questions were used to inquire about any issues that may have arisen from the youth’s initial ‘get to know you interview’ as well as directly ask about the youth’s perceptions of science learned both in and out of the garden (research question #3).

**Personal Meaning Mapping**
The main source of data used to answer research questions #1 and #2 came from the interviews associated with a relatively new method called Personal Meaning Mapping (PMM) (Falk, 2003). Unlike ‘positivist’ mapping techniques developed for displaying whether complex conceptual learning was achieved, e.g., concept maps (Novak and Cañas, 2006) and mind-maps (Buzan, 1974), PMM was designed to assess learning specifically in free-choice learning contexts using a more relativist-constructivist approach. PMM is easy to administer since it requires no pre-training of participants and is designed to feel “un-test-like” to the participant (Falk, 2003). In PMM, all learners are assumed to uniquely make meaning based on their own prior experiences and their current perceptions of the learning context. Hence, there is no presumed ‘right’ answer and no presumption that all learning will follow a pre-determined course. Learning is assumed to be highly personal and highly situated within the learning context (Falk, Moussouri & Couson, 1998). This method has been used to explore learning in numerous ‘free-choice’ learning settings such as science centers, art and natural history museums, zoos, aquariums, as part of community-based programs, as well as in classroom settings (for reviews, see Falk, 2003; McCreedy & Dierking, 2013). It is effective in allowing participants to articulate and negotiate their own perceptions and understandings of the PMM prompt (Falk, Moussouri & Couson, 1998) – a single word or phrase placed in the center of an otherwise blank piece of paper. In this project PMMs afforded a very personal and in depth approach to qualitative data collection, which then allowed the data to reveal the wide range of youth perceptions of science learning in the garden.

PMM Data Collection
Youth were given two opportunities to complete a PMM. The first opportunity came in July 2014 after IRB approval was received. Youth were presented with a 10” x 14” piece of drawing paper with the center prompt ‘Community Garden(ing).’ Youth were not directly instructed to view the garden as a science related activity, but rather to just reflect on the garden space itself and the experience of community gardening and to then write words, ideas, images, phrases, or thoughts that came to mind in relation to the prompt. These written words then formed the basis of an open-ended interview where youth were asked to explain why they wrote what they did and expand on any ideas or thoughts they had conveyed on paper. This activity was repeated with youth in October/November 2014 after all garden activity was completed. Youth were given the opportunity to reflect on their experience and earlier PMM and then add, subtract, change or make a completely new PMM. Examples of youth PMMs are attached in Appendix B.

Research question #1 was designed to answer IF youth directly perceived their garden experience as connected to the science intended to be taught by the coordinator. Research question #2 wished to explore if there were other areas of STEM that youth perceived they learned from this garden experience. Research question #3 was designed to then answer if, and if so HOW youth perceived their garden experience in relation to school-based science instruction. In order to make sure that every youth was ‘on the same’ page when thinking about garden activity and science learning, before their final interview, which was their ‘view of science’ interview, the first author had a brief conversation with each youth. The brief conversation went something like this: “in this garden program there was probably a lot of science that you had to learn, like horticultural sciences or environmental sciences in order to be successful in growing
food. Would you agree that is true?” The interview then went on to inquire how they believed the sciences they were learning in the garden were similar to or different than the science they had learned in the past, particularly in school.

Data Analysis

Data analysis began with verbatim transcription of each interview. Transcripts were then read and reread to obtain general insight into youth backgrounds and perceptions of sciences learned in the garden. Since there was a delay in collecting pre-garden experience PMM interviews, transcripts from both the pre and post PMM interviews were treated as one single data source—that which reflected youth’s perceptions of learning from garden activity. These transcripts were open-coded (Strauss & Corbin, 1998) into substantive descriptive emic (or participant’s perspective) categories that allowed for comparison of statements within the same category (Maxwell, 2012). For example, PMM youth interview comments where youth spoke to their learning of environmental sciences were placed in one environmental science category. This then allowed for easy comparison of the different ways youth related to environmental sciences learned. Sub-categories, learned within the larger sciences learned category, were created if data warranted. A final step in analysis of both the pre- and post-PMM interview data was to code the data from the etic or researcher’s perspective (Maxwell, 2012). For example youth comments on a particular science learned may have not have been clearly articulated by the youth. In these instances we made some level of inference to the youth’s perceptions of science content learned. Due to the small sample size frequency counts regarding the different sciences learned were not compiled.
Youth’s ‘view of science’ interview was then read and data for the perceived similarities and differences between the science learning in the garden and science learning in school were tagged. Two questions from the ‘view of science’ interview that were of particular interest in answering research question #3 were “How do you think the science you are learning here in the garden is the same/is different from school-based science?” These responses along with the rest of the ‘view of science’ interview responses were then open-coded (Strauss & Corbin, 1998) into substantive descriptive emic categories (Maxwell, 2012). Comments within each of these categories were then compared and used to compile a narrative describing how youth make specific connections between the science content learned in the garden and science content learned in school. For example, a category of detailed versus broad was created and all youth comments related to this aspect of science learning within the two contexts were used to create the description of youth’s perception of science learning. Finally, transcripts from the ‘Get to know you’ interview were a secondary source of data and read and reread to obtain general insight into youth backgrounds, including previous garden experience and knowledge.

Results

Participants

The coordinator interview, lasting approximately one and one half hour, revealed the history and current contextual environment of this garden. According to the program coordinator, this particular garden program has a well-established culture of service, as the connection to the food bank and produce donation were ever-present topics in garden discussions, group presentations and lessons. The garden coordinator went on to say that
he has anecdotally noticed this ‘culture of philanthropy’ had been ‘picked-up’ by some of the youth as some were able to recite the ‘hunger speech’ (introductory explanation of hunger in their area and the food bank’s mission with this garden) to visiting volunteers.

Initial youth recruitment came from an established environmental program known to volunteer on the farm, which the coordinator suspected influenced the ‘type’ of youth that chose to participate in the program. ‘Get to know you’ interviews confirmed that this procedure for initial youth recruitment did result in many similar characteristics across participating youth such as pre-existing positive environmental beliefs, values and attitudes. Many in this environmental program were also students at a local early college high school program. This program is a partnership between the local public school district and a community college and is designed to have students earn both their high school diploma and associates degree within 5 years. The program is not competitive but according to their website to be admitted a student must demonstrate passing grades of a C or better, good attendance and good citizenship. This program attracts motivated and mature youth.

From the key informant interview it was discovered that the four youth who choose not to participate in this study had very similar backgrounds to the seven who were willing to be interviewed. This provided confidence that the sample was indeed representative of all gardening youth. Youth participating in this study were all 15-20 year olds and four were second-year garden program participants. Five currently attended or had attended the early college high school program, one attended an East coast boarding school and one attended a non-early college public high school. All youth stated they had little to no interest or prior experience with gardening before participation in this
program and they had very little expectations toward their own individual learning. Motivations for participation included expected continuation of their environmental club participation, ‘something to do’ and for money. The majority of the youth expressed their home life in non-traditional terms, ranging from being raised by family relatives, foster care or separated parents. Few of the youth did any other out-of-school activities with only two indicating a potential future interest in other community volunteer opportunities. Sports participation was also limited, as it was explained the boarding school and early college high school do not have opportunities for afterschool sports due to a longer school day. Only the one youth attending the non-early college public high school participated in any sports-related activity. Tables 4.1 and 4.2 summarize the participating youth’s backgrounds and personal characteristics.

Table 4.1 Participants

<table>
<thead>
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<th>Age</th>
<th>School</th>
<th>Gender</th>
<th>Prior Env. Club</th>
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<tr>
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'All names are pseudonym
Table 4.2 Personal Characteristics of Participants

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<th>Expectations</th>
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<td>Expected continuation</td>
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</tr>
<tr>
<td>John</td>
<td>Something to do</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Tessa</td>
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<tr>
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<td>Money</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Brian</td>
<td>Money</td>
<td>None, possibly learn ‘something’</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Chris</td>
<td>Expected continuation</td>
<td>None</td>
<td>Low</td>
<td>None</td>
</tr>
</tbody>
</table>

Sciences perceived as learned from the garden Research Questions #1 and #2

The post-PMM activity resulted in two youth completing a new map, one making no changes to their previous map and four either making very few changes or simply indicated on their first map what they felt was ‘most important to their learning’. Open coding (Strauss & Corbin, 1998) of both the pre- and post- PMM interviews, in conjunction with the creation of descriptive categories (Maxwell, 2012) revealed evidence related to research questions #1 and #2. Data revealed four main science domains either directly reported as learned from the garden (emic perspective) or inferred as learned by the researcher (etic perspective).

Environmental Science

Environmental science, taken here as the more affective aspect of what is taught in many efforts of environmental education, was the only domain that necessitated a sub-category to adequately describe youth’s perceptions of this domain of. Here all youth made some type of statement that clearly described one or both of two different aspects of
environmental affect—a positive environmental value/attitude and/or a positive view or general awareness toward larger issues of human-environment connections. The following excerpts exemplify each environmental science sub-domain:

a. *Positive environmental value/attitude*

   Often times when people come out here, or quite a few people that come out here, haven’t worked in the dirt before so they are gaining a lot of those skills that will help them be able to work further in that or just give them a new appreciation for what goes on…..transformation of the mind….. People go from liking it to not liking it to liking it they begin to understand that dirt is not something you wash off it is something you have to live in or live on, understanding that we all come from the earth (John).

b. *Larger connections seen between humanity and nature/environment*

   So community gardening is service learning, working with the environment, like people talk about how the environment is out there and our society is in here and we need to leave pockets of it but no I mean they live in our houses they live next to our houses, these species are living with us around us you know the trees on my farm those are not native species and they are on my farm and I am using them to live those trees are a part of nature it is all one big thing (Chris).

*Horticulture/Agricultural Sciences*

   All youth made comments regarding more concrete environmental science context knowledge perceived as learned and which were always directly tied to horticultural/agricultural sciences or the growing food. Therefore these more concrete
perceptions of the hard sciences learned from gardening were coded as horticulture/agricultural sciences and examples of these perceptions can be seen in the following quotes:

I didn’t think there would be so many thistles, because thistles are something that are persistent. Well the ecology of thistles is impressive anyway (John).

The first thing that I thought of was every Wednesday we have these mini lessons from our two interns they each teach something so we have pest management we learn about the soil and diseases (Tessa).

*Nutritional Science/Health/Wellness*

Not every youth spoke to issues of nutritional sciences/health/wellness. The few that did express nutrition/food or health/wellness related concepts in their PMM interview did not speak at great depth regarding any nutritional sciences learned. Instead youth spoke briefly about skill self-efficacy regarding cooking and the health or wellness benefit this has provided them. The following exemplifies the comments made

I kind of just went to healthy food, I could have put it under something else I guess like experience for the future but for me I never used to cook at home. I always used to eat frozen meals and stuff and here we learn about different vegetables and how to cook because every day we cook for each other and make ourselves lunch and stuff (Tessa)
Kind of like the world is so big and you are just a small being and when you go out and you experience all the things that are part of the world, like taking care of yourself growing vegetables (Samantha).

Other STEM

Only two youth made a connection to other STEM subjects taught in school during either of the PMM interviews. One youth made a superficial observation between the garden activity and school-based STEM subjects commenting that he “put math [on his PMM] because we have to do a lot of math here, counting and adding” (Adam). The second youth made a deeper connection between school science knowledge and garden-based science learning.

I have taken college level chemistry classes and I have really been able to incorporate my knowledge and learning and I have been able to apply it to farming and the causes or just notice some things that some of the students here have not been exposed to so when they say water soluble they probably not even sure what that means, not at a chemistry level and that is very important and that is something that I learned, it is very cool to have that perspective as a chemist…..it was very helpful to know it because when we were giving out lessons during the summer about crop rotation or about hybrids or all that sort of stuff it all connected and in a sense I valued this kind of setting more because I was reinforcing the knowledge I learned from school (Susan).
Connections seen between garden science and school science

Research Question #3

When asked before their post experience ‘view of science’ interview if they perceived their learning in the garden as based in science, all quickly agreed that yes, they did view their experiences in the garden as science learning. When asked to speak directly to the differences they perceived between garden-based science and school-based science youth were quick to use words such as ‘practical’, ‘hands-on’, ‘applied’ and ‘real world’ to describe their garden-based science learning. Youth felt the science content was something that was applicable to their lives saying things like “it [is] just a lot more [of] something you can apply later on in your life too, rather than just for that test” (Tessa). Youth viewed their learning as ‘on the job’ and often more rewarding “because you get to taste whatever you are growing, you get to interact with it constantly even if you might not like all of those interactions” (John).

Detailed vs. Broad Learning

Many of the youth discussed the differences seen between garden and school-based sciences in relation to the level of detail explored within the particular subject. One youth believed that the sciences they were learning in the garden were more broadly oriented than anything they would learn in school. An example of this can be seen by the youth who believed that a school-based science like Chemistry would be taught in much more specific depth than the science they learned in the garden. This youth felt that garden-based science was presented as a broad overview and something that you needed to know and utilize to produce quality crops on the farm. This view was directly contradicted by two other youth who believed that the science in school was presented at a much more basic level and there was much more detail in the sciences they learned at
the garden, especially around environmental and agricultural sciences. For example, one youth expressed how he viewed these basic versus detailed differences as follows

I think that they were more detailed on what really happens when you are working in the garden and what the seeds and what the other stuff really do. Within school they just kind of give you a basic layout that they do every year……..like in school they will just tell you that the seed you put it in the ground and it makes the plants they don’t really give you more of a detail but when at the youth farm they told you that it has to germinate and some do and some don’t and they have to go through this special process and it is just more detailed (Adam).

Another youth viewed the differences between school and garden-based science as a difference between technical detail, which is learned from a textbook at school, and the practical applicability of content, which is learned from activity in the garden. To this youth, the garden taught applicability of content by framing it within the context of the ‘circle of life’, saying

You see things grow and you see things die and you get to be a part of that process. I don’t’ know it’s calming—also little things like you can take this home and you can do it yourself at your own house or something along those lines and also just little patterns that aren’t always in the text book just how things grow or why things work or you should add this to the soil or why things kind of just fit together. Because like I said textbooks they are usually very technical I mean this
goes here that goes there and this is the definition of that and this is far away from that (Tessa).

This youth also went on to say that her current science class (anatomy) taught her a great deal of detailed information but it was something she learned for the test and then ‘let go’. In the garden she believes that the science she was learning she ‘hung onto’ and still needed to apply in the ‘real world’ of the garden and she believed she was still learning new information from the garden that helped her ‘grow’ as a person.

‘Real World Science’

In addition to actually using terms such as ‘real world’ to describe their science learning, a ‘real world’ perception of science learning for some youth had everything to do with real life consequences to their learning. This perception was expressed by a youth who very eloquently stated

What happens if I fail this test or what happens if I don’t do this assignment right? A bad grade goes on your record. They tell you it is going to affect your job [and] it may or may not, but if you kill those onions you may not get to take them home or those could have gone to the food [bank] and fed someone that was hungry. Those are two very big differences you know (Chris).

Value of and Reinforcement of Sciences Learned

When asked about the differences in science learning, most youth also placed a different value on the sciences learned in the two contexts, with many expressing that garden-based science was more valuable because it was more applicable, hands-on and
had real world consequences. Most youth subtlety alluded to this in their interviews yet
one youth very clearly expressed this perception by saying

I valued this kind of setting more because I was reinforcing the knowledge I
learned from school and I was also able to connect it to different ways that it is
helpful for us in agriculture or whenever I plan to grow my own garden at my
house (Susan).

These reinforcing connections were also expressed by another student who
provided an example of learning ‘about something on the farm’ and then being presented
with similar information at school. For her this was an exciting connection because she
could say “yeah I learned that at my farm” (Tessa). This youth went onto say that this
prior knowledge gained at the farm and then reinforced at school helped her ‘grow’ even
more.

*Similarities perceived between garden-based and school-based science learning*

When asked to speak about similarities between garden and school-based science
learning youth either felt very strongly that they could see no similarities and for one
youth this increased the value he saw to the farm because it “made the whole farm worth
going to” (Chris) or they could see that the similarities rested in the science content. For
example, this youth illustrated how she saw the content at the farm as similar to school-
based science
The soil, we learn a lot about soil out here but we also do in school. We learn about healthy soil and what makes up soil or like compost we learn that a lot at school and here that is like the main thing (Samantha).

Another youth could see that not only were the concepts the same but also some of the critical thinking skills learned were the same and ultimately transferable to any setting.

Ah yes, the concept is always the same it is not going to change, so that is why I really like it because wherever you go regardless of the setting, the knowledge that I learned from school will be able to be implemented into the setting that I want to use it in whether it is agriculture or whether it is just the critical thinking skills that I learned from that course will help me in any setting I think (Susan).

However even though some youth could see similarity in content and larger scientific concepts, these youth were often still quick to point out that the form in which it was taught was very different, again using words such as more ‘hands-on’ to describe the garden-based science learning. However, this lack of similarity perceived between science learning in the two contexts was not necessarily a negative. For example, one youth who felt there were few similarities between the classroom and garden-based science later went on to elaborate that the sciences learned were not similar but they reinforced each other.

I think the reason that [reinforcement] happened was it was the same content just it wasn’t necessarily the same content it was the same subject just coming at it
from two very different angles. One was real world, one was theoretical--you know like a class--and it felt like on the farm there wasn’t as much content to learn but I felt that the little content that I did learn I learned better than in the classroom (Chris).

When asked to elaborate on why he believed he learned the content from the farm better than a school-based science class he stated that he would better remember science content that came from an informal conversation with the coordinator of the garden program for two reasons. First, he believed that the information learned on the farm was repeated often, but more importantly he believed he remembered the content information better because it was relevant science to a problem at hand. For example, “how do you get rid of beetles that are eating your plants?” Another youth very eloquently expressed this same overall connection between sciences learned in both environments by stating: “Yeah school is like you are learning the different Lego pieces and here [the farm] you are putting them together” (Tessa).

General View of Science

As mentioned, most of the youth participating in the project were recruited from the previous environmental program and were students in the local early college program. Therefore, it is understood that these students were mostly high achieving youth and generally interested in environmental sciences. In order to get a better sense of how youth perceived school in general, youth were also asked to speak to their favorite and least favorite subject in school. As expected, many stated that science was either their favorite subject or a close second. Interestingly, youth who said they enjoyed science stated that it
was often because of the applicability of science to help solve human-caused
environmental problems or that science generally helps develop critical thinking skills
and is applicable to other areas of life.

Discussion/Conclusion

PMM interviews revealed that youth in this study perceived they learned science
as part of their garden experience. The content of sciences youth perceived they learned
was largely congruent with the sciences the program director sought to teach and with the
kinds of science learning most GBL literature suggest is appropriate for these kinds of
experiences. Since data came from an asset-based approach to learning and development
(Scales & Leffert, 2004) I argue that these open-ended, self-reports of science learning
from this particular summer program provides an important validity check to the array of
closed-ended, pre-determined measures of GBL science learning.

One area of particular importance in many GBL studies is content acquisition in
both environmental science (e.g. Bradley, Campbell, Waliczek & Zajicek, 1999) and
general science (e.g. Klemmer, Waliczek, & Zajicek, 2005). Youth in this particular
garden program did perceive that they learned environmental science and general science
content from the garden activity, yet this content was not often perceived as concrete
knowledge acquisition. Most youth perceived that their environmental learning focused
around environmental education’s affective domain of positive environmental attitude
and/or greater understanding of larger issues of environmental sustainability. Given the
belief by many GBL educators and researchers (e.g. Waliczek & Zajicek, 1999) that
environmental affective is a key outcome of many GBL interventions, this connection
made by participating youth was in itself not surprising. However, I cannot definitively
say from this data that this particular garden program was the sole influence on these youth’s environmental attitude or perceptions of sustainability since most youth recruited for this program were already highly interested and motivated for participation in environmental issues, as evidenced by their participation in the previous environmental club.

In general youth in this program were very aware of the practicality of garden activity and again made several references to the sciences learned as more ‘relevant’, ‘practical’ and ‘applicable’ to ‘real world’ situations. This view of the applicability of sciences learned was especially salient to those who mentioned the program’s cooking experience component. Those who reported increases in cooking skills discussed it at great length and stated the garden program was where they gained many if not all of the cooking skills they would need for their future lives. This result was similar to O’Brien and Shoemaker (2006) and provides some evidence that a program such as this can convey meaningful real-world skills that increase participant’s home cooking self-efficacy.

Horticulture/agricultural science was the main domain of science youth perceived they learned. This is not a surprising finding as the program emphasized agricultural sciences in its program goals (coordinator interview 7/2014) and this connection is often made in GBL interventions (e.g. Cammack, Waliczek, Zajicek, 2002). What was surprising and relatively unique to this program was the direct connection to growing for food bank donations. This appeared to influence not only the social cultural context of learning (Lave, 1988) for these youth, but also their motivations for learning. Many youth expressed a desire to learn horticultural sciences specifically so they would be successful
in growing food because the food grown in this garden went to those in need. This direct tie to this particular garden’s social cultural context (one of philanthropy) may provide preliminary case study evidence for the benefits a more situated environment for learning (Brown, Collins & Duguid, 1989).

There were several limitations to this study. First it was a small case study using youth self-report to assess learning. This not only means results may not be applicable to other garden programs, but also youth may have not been able to clearly articulate their own learning. Second, due to delays in pre-garden experience data collection, the study was not a true pre-post exploration of GBL. This did not allow for a more detailed analysis that could have presented changes in science knowledge from pre-garden experience to post-garden experience. Finally, youth from this garden may be non-representative of most gardening youth, as they were already environmentally conscience and motivated young people.

However, even with these limitations it is clear from this small case study that youth do perceive they learned science from a free-choice garden-based learning environment. Youth demonstrated this directly through their PMMs and PMM interviews as they both contained numerous representations of sciences learned in the garden. This project is one of the few that has explored science learning in the garden from a constructivist framework and it provides interesting results for the field of science education. This study, like McCreedy and Dierking (2013), provided continuing evidence that youth do indeed learn science content when participating in out-of-school free-choice science related programs. The implications of this project are potentially important when you consider the large number of hours youth spend in out-of-school programming (Roth,
Brooks-Gunn, Murray, & Foster, 1998) and especially given the increasing use of GBL strategies for teaching science (see review Williams & Dixon, 2013). If educators can better learn to harness the potential of these out-of-school garden programs to teach science content and if this can be documented through research, there may be more evidence to substantiate an increase in funding for these types of programs. Further research in this area should include a larger study that would examine more youth in similar programs to determine the wide scale applicability of these findings.
Conclusion

In this dissertation I have presented three research manuscripts that aimed to add to the literature on GBL for adolescent youth by exploring one case study garden in a Pacific Northwest Community. The study’s manuscripts aimed to add to the literature on, (1) the affordances and constraints of utilizing Personal Meaning Mapping (PMM) with adolescents in a free-choice long-term garden-based learning environment, (2) the applicability of using experiential learning with adolescents in a free-choice long-term garden-based learning environment and (3) youth perceptions of their own learning in a free-choice long-term garden-based learning environment.

Each of the three manuscripts I have presented in this dissertation has contributed to addressing one or more of the research questions discussed in Chapter One. Separately they have each advanced research in GBL with adolescents in free-choice learning environments and could be used to improve programming with such demographics. Collectively they have added to the literature on GBL and have helped inform further research studies with adolescent youth’s in garden-based programs.

Conclusions Regarding Dissertation Research Questions

The second manuscript, Chapter Two I used to specifically explore PMMs and their evolution in educational research. I specifically asked the following question: framed from an asset-based, relativist conceptual framework, what are the affordances and constraints of using Personal Meaning Mapping as a research method for understanding adolescent learning experiences within a long-term garden-based learning environment. I reviewed other mapping techniques, such as mind maps and concept maps and outlined the affordances and constraints of using these methods in educational
research. I then discuss the evolution of PMM and the applicability of its use in exploring the individual learning from this particular learning garden program. Utilization of PMMs and PMM interviews revealed that one of the major affordances of the PMM approach appeared to be the ability of PMM to capture each youth’s unique ‘voice,’ in this way, supporting exploration of their impressions and beliefs about the garden experience. Using PMM data regarding learning from the garden allowed data to be reflective of direct perceptions of experience and not reflective of preconceived researcher-defined list of outcomes.

This work was helpful in revealing several general recommendations for others wishing to utilize PMMs in their own work. First, researchers need to remain mindful of the time commitment to using PMMs. Both data collection and analysis are time consuming as the environment for data collection and general data analysis can be very complex. The complexity of using PMMs in data collection does not exclude it from certain types research but those wishing to capitalize on its affordances must continue to be mindful of the rich data that may necessitate numerous levels of analysis to discern discrepancies between participants. Researchers must also be aware of the focus of the single prompt and the limitations that might introduce in the research questions able to be asked of the data. Finally, those wishing to use data analysis to explore changes in learning need to be very aware and make sure that PMM data collection is designed around a true pre- post- experience so that quantitative measures such as extend, breath, depth and mastery can be determined from participant maps.

I conclude chapter two demonstrated that this asset-based, learner-centered approach lends significant validity to findings and conclusions. Overall I believe the time,
attention and thought devoted to the production of PMMs in this study, as well as the willingness of youth to freely participate in an extensive discussion of the reasoning behind the items they wrote down, is reflective of both the design of the PMM process as well as youth’s participation in a long-term, value-free free-choice learning experience. Therefore, even though there were some limitations to this project and data were reflective of only one case study garden, I believe a major contribution this piece brings to work using PMMs is that PMMs can be utilized to collect data that is truly reflective of youth ‘voice’. There is a great need to understand GBL from the perspective of youth participants. Researchers in this field should take note of PMMs and their unique and meaningful affordances to data collection. More utilization of PMMs in youth and children gardening programs may help us better understand the learning arising from garden context which would better help program designers develop activities for youth.

Chapter Three presented in this dissertation investigated the following research question: Do the self-perceptions of learning by adolescent participants in one summer garden program support experiential learning, as proposed by Kolb and Kolb’s (2008) six tenets? To answer this question I first explored the details on Experiential Learning Theory (Kolb, 1984) yet was clear to state I was not attempting to prove or disprove the broader theory of experiential learning. Rather I went on to discuss the six tenets of all experiential learning theorists as outlined by Kolb and Kolb (2008) and how, if I could provide evidence for youth’s engagement in these six tenets, then Kolb and Kolb’s (2008) specific tenets would hold true for out-of-school gardening adolescents. To explore this question, I drew upon data from PMM and ‘view of science interviews’ and found that generally, data were helpful in revealing that youth do perceive their learning in this
environment as “the process whereby knowledge is created through the transformation of experience” (p. 38). However data was not evenly distributed for all seven youth and two youth provided no evidence for three of the six experiential learning tenets. I identified many potential reasons for this seemingly disconfirming evidence, only one of which could be that Kolb and Kolb’s (2008) six tenets do not hold true. The possibilities of data collection methods or data analysis error are real in this work and any future work attempting to explore experiential learning using PMMs should be aware of the potential errors. It would also be important to consider youth’s development stage in future work as a youth’s ability to participate in metacognition could seriously influence data.

Even with the potential disconfirming evidence found in this project, I conclude there was still substantial evidence found to support the presence of each of Kolb and Kolb’s (2008) six experiential learning tenets. The data also overwhelmingly support the notion that learning was varied and unique to each individual youth, which in turn provides further support for utilizing experiential learning as a conceptual framework for understanding the learning of adolescent youths within this and potentially other free-choice environments. I assert that utilization of PMMs were helpful in this endeavor as they allowed for data analysis that facilitated ‘hearing’ the voice of the participants, since collection was unbiased by any preconceptions of a “right” or “wrong” way for them to construct meaning from their experience. This data is particularly helpful in advancing the field of GBL since little work has been done in this area of free-choice learning with adolescent youths.
Finally, in Chapter Four, I specifically explored the finding from this project as related to the youth’s perceptions of sciences learned and differences between school-based learning and garden-based learning. Specifically, this manuscript attempted to answer the following research questions:

1. Is there evidence that youth participants in this particular free-choice garden program learned any of the science content intended by the garden coordinator (i.e., environmental and agricultural education)?

2. Is there evidence that youth participants in this particular free-choice garden program learned any STEM content not intended by the garden coordinator but previously identified as taught and learned in other GBL programs (e.g. general science, nutritional sciences, math)?

3. Do youth make specific connections between the science content presented in the garden program and science content presented in school, and if so how?

Utilizing an asset-based approach to learning and development (Scales & Leffert, 2004), both the PMM interviews and the ‘view of science’ interview data in general revealed youth in this study perceived they learned science as part of their garden experience. Specifically the sciences youth perceived they learned was largely congruent with the sciences the program director sought to teach and with the kinds of science learning most GBL literature suggest is appropriate for these kinds of experiences, i.e. environmental and agricultural sciences. An interesting finding from this study was found in the area of sciences youth most discussed in their learning. Contrary to many previous GBL studies that focused on more concrete environmental science (e.g. Bradley,
Campbell, Waliczek & Zajicek, 1999) and general science (e.g. Klemmer, Waliczek, & Zajicek, 2005) content acquisition, many of the youth in this particular garden program perceived their learning focused around more affective domains of positive environmental attitude and/or greater empathy towards larger issues of environmental sustainability. This was an interesting finding and more work in this area is needed to definitely show the hoped-for correlation between garden participation and environmental affect. However, results from this project certainly add support to previous work that suggests that garden programs positively influence youth environmental attitudes and perceptions about sustainability.

In general youth in this program were very aware of the practicality of garden activity and again made several references to the sciences learned as more ‘relevant’, ‘practical’ and ‘applicable’ to ‘real world’ situations. This connection to ‘real world’ situations, for many youth, appeared to come from the direct connection this garden program had to the area food bank. This connection appeared to influence not only the social cultural context of learning (Lave, 1988) for these youth, but also their motivations for learning. This finding should serve as a reminder to future program developers and researchers of GBL of the highly situated nature of GBL experiences (Brown, Collins & Duguid, 1989), particularly for this aged participant.

I recognize that this study is a small part of the overall GBL literature. I know that my results are possibly not applicable to other garden programs due to the fact this project was done with a very small case study utilizing environmentally minded and motivated youth who self-reported their learning. I also know some of the difficulties encountered in this project, such as the delay in pre-garden experience data collection,
did not allow for a more detailed analysis, which could have presented changes in science knowledge from pre-garden experience to post-garden experience. However, I argue that even though this project did not permit investigation of changes in learning, it was designed as a youth-centered and asset-based approach and this is unique in the GBL literature, which I believe will ultimately help move the field forward.

In conclusion, not only does this project add to the literature in GBL it also adds to the field of science education. This study, like McCreedy and Dierking (2013), provided continuing evidence that youth do indeed learn science content when participating in out-of-school free-choice science related programs and therefore the implications of this project are potentially important when you consider the large number of hours youth spend in out-of-school programming (Roth, Brooks-Gunn, Murray, & Foster, 1998) and especially the historic heavy reliance on GBL to teach science (see review Williams & Dixon, 2013). I argue that there is a need for the educational community working with GBL to better harness the potential of out-of-school garden programs to teach science content and document their findings through research. This project’s findings add one more bit of evidence to the value of supporting GBL programs, particularly as educators continue to seek innovative ways to keep students interested and engaged in science learning.
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Appendix A – Lesson Schedule

Pre-Season Workshops

Farm Sanitation and Food Handling
- Completed online food handler’s certification course
- Watched Good Agricultural Practices (GAP) videos on clean harvesting and produce washing
- Completed on farm training of proper harvest sanitation

Farmer’s Market Customer Service
- Learned how to set up market booth
- Reviewed common questions asked at booth
- Practiced explaining the Youth Farm program to customers
- Practiced good customer service with mock transactions

Summer Program Workshops

Lesson 1: Soil Health
- Learned about soil types
- Learned history of Willamette Valley soils
- Discussed primary plant nutrients (NPK)
- Learned importance of organic matter in fostering good tilth
- Took soil samples from around farm, assessed structure and type

Lesson 2: Composting
- Learned about importance of good composting for: Nutrient management, Weed management and pest and pathogen management
- Discussed the ideal of the “closed loop” farm
- Learned about N:C ration
- Practiced building compost pile

Lesson 3: Crop Rotation
- Learned about problems of monocultures and soil exhaustion
- Learned basic plant families and their impact on soils
- Learned about cover crop types
- Practiced designing three season rotations

Lesson 4: Integrated Pest Management
- Discussed the IPM “pyramid”
- Examined cultural, physical, biological, and chemical solutions to different pest problems
- Discussed thresholds for when to implement more invasive strategies
- Toured farm identifying pest problems

Lesson 5: Pollination
- Learned difference between monocots and dicots
- Examined different vectors of pollination – wind, insect, and self-pollination
- Examined structure of different flowers
- Practiced hand-pollination of melon plants

Lesson 6: Plant Diseases and Deficiencies
- Learned signs of macro- and micro-nutrient deficiencies in plants
- Learned how deficiencies make plants more vulnerable to disease
- Discussed the organic principle that healthy plants deter pests and diseases
- Calculated amendments to add phosphorous and calcium deficient plants around farm

**Lesson 7: Seed Saving**
- Learned about primary methods of vegetative plant propagation
- Selected tubers and bulbs for seed saving
- Discussed principles of plant selection for seed saving
- Discussed differences between OP, hybrid, and GE seeds
  Harvested tomatoes for seed saving

**Lesson 8: Hunger and Ethics**
- Learned about scope of hunger in US and world
- Discussed problems of waste and non-food uses of farmland
- Discussed ethical obligations to feed the hungry according to three ethical matrices: rights, goods, and virtues

**Field Trips**

**Community College Greenhouse**
- Guided tour of greenhouses and gardens
- Discussed greenhouse functions such as watering systems and heating elements
- Discussed various styles of grafting and plant propagation
- Participated in service project weeding one of their gardens

**Sustainable Farm**
- Guided tour of the farm while discussing the farm’s history and place in Willamette University community
- Discussed different sustainable agricultural practices on the farm
  - Toured several hoop houses and farm forest area

**Organic Farm**
- Guided tour of the organic farm while learning about farm history
- Discussed fertilizing practices used
- Discussed recent pest problems and how they deal with that organically
- Learned about the business side of the farm including CSA expansion throughout the years, deciding which markets to attend, and employing people

**Conventional Farm**
- Discussed reasons for farming conventionally rather than organically
- Toured the certified organic broccoli portion of the farm as compared to the conventionally grown broccoli
- Discussed mechanization of the farm and costs of equipment
- Talked about issues of having such a large farm (1,200 acres) including theft of produce

**Industrial Compost Facility**
- Tour
  - Learned about the differences between the small scale system at the Youth Farm and this much larger scale of composting
  - Discussed history of the facility and how it started composting in the first place
  - Talked about the closed-loop system that they have in place; no waste product
Appendix B Examples of PMMs

Figure 1.1

Figure 1.2