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Abstract

Garden-based learning (GBL), a form of outdoor education contextualized and framed within unpredictable and real-world learning environments, is ideally suited to the teaching of science. However, the vast majority of GBL educational research has utilized a cognitive and positivist research paradigm, one that artificially restricts the investigative lens. The goal of the larger project from which this paper was drawn was to develop a better understanding of how youth perceived a garden experience. This paper shares the affordances and constraints of the constructivist framework utilized and the primary measurement tool, Person Meaning Mapping (PMM). Despite some inherent limitations, the PMM methodology enabled important insights that enhanced understandings of the effects of GBL.

Keywords: Personal Meaning Mapping, gardening, agriculture, horticulture, science education, qualitative analysis

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Garden-based learning (GBL) is one form of out-of-doors learning which uses a garden as a tool that involves "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) and was advocated by educational pioneers like John Dewey (1915) and Maria Montessori (1964) and more recently by the educational community that anecdotally believes gardens help educate about local food and the environment (e.g., Yamomoto, 2000). Gardens have long been viewed as an appropriate context for supporting a range of outcomes, including content areas like science (Williams & Dixon, 2013), health and nutrition (Robinson-O'Brien, Story, & Heim, 2009), and the environment and agriculture (Blair, 2009), as well as student's attitude toward school (Waliczek & Zajicek, 1997) and the environment (Campbell, Waliczek, Bradley, Zajicek, & Townsend, 1997). Arguably, a key characteristic of gardens as teaching tools are that they represent rich contextualized learning environments that enable learners to have a wide range of experiences in the out-of-doors. As often happens in such real-world contexts, garden outcomes—such as what lives and what dies, when and why, and presumably the learning those outcomes afford—have some measure of unpredictability. Thus, one of the real benefits of GBL is that it situates educational practice within a real-world setting that is perceived by learners as authentic and immediately relevant.

Despite the prevalence of GBL across a wide range of settings and situations, e.g., with multiple aged youth and adults, both in- and out-of-school, and with a wide range of stated learning goals, many researchers continue to frame their investigations through a single paradigmatic lens, disproportionately utilizing what has been characterized as a cognitive, positivist model (Guba & Lincoln, 2005). Here investigations start with preconceived assumptions about what constitutes evidence of learning (e.g., Blair, 2009; Bowker & Tearle, 2007; Titman, 1994). This approach artificially restricts the investigative lens and has resulted in considerable gaps in the GBL research literature.

The larger project from which this paper was drawn was designed to investigate the science learning arising from an older adolescent free-choice, summer garden program. The research goal was to add to the GBL literature through a better understanding of how youth themselves perceived their garden experiences, with a particular focus on whether or not they felt that it contributed to changes in their understandings of science. The purpose of the paper is to describe the affordances and constraints of a particular constructivist, relativist tool—Personal Meaning Mapping (PMM) and its applicability for studying youth programs in an out-of-door setting.

Literature Review

The vast majority of GBL has framed participant learning using a cognitivist, positivist theoretical lens where researchers pre-define a set of facts or concepts they believe represent the key content to be gained by the GBL intervention. Evidence of learning using this paradigm is determined by whether or not learners are able to correctly show a statistical improvement in the number of questions answered correctly. This paradigm is present in GBL studies, as well as those focused on broader outdoor education (OE) initiatives, with many—especially preschool and early childhood OE interventions—often concentrating on science understanding as well as emotional and social skill attainment (Brasgalla, 1989; Gopal & Pastor, 2013; Miller, 2007; Nedovic & Morrissey, 2013). Studies focused on the higher primary school levels, such as those conducted by Klemmer, Waliczek and Zajicek (2005) tend to focus exclusively on science achievement, yet still rely heavily on pre- and post- science test instruments. Increases in knowledge correlated to a garden's out-of-doors environment (Wistoft, 2013) and relevance (Fusco, 2001) have also been demonstrated. The results from most GBL/outdoor and environmental education studies tend to be consistent with each other in that they find higher increases in student achievement amongst those who participate in some kind of outdoor activity (Bogner, 1998; Cronin-Jones, 2000; Shepard & Speelman, 1986). This cognitivist, positivist theoretical lens has also been employed in studies that explore the acquisition of a more positive environmental attitude (Campbell, Waliczek, Bradley, Zajicek & Townsend, 1997). Here Campbell et al. (1997) explored secondary student's pro- environmental attitude using a closed-ended pre- and post- survey with a Likert-type scale (Likert, 1967). Findings indicated that the highest environmental attitudes were among those youths who reported success with their hands-on plant propagation. These positivist methods and results are typical of GBL studies (Bogner, 1998).

This cognitivist, positivist theoretical research paradigm has a number of benefits, the most significant being that it allows for quantitative comparison of changes in participant characteristics relative to control groups using experimental or quasi-experimental research designs (Campbell & Stanley, 1963). However, it is argued there are also limitations to this positivist paradigm. Although this approach affords high levels of reliability, it potentially suffers from poor validity since there is no room for interpretation of meaning (Walzer & Gross, 1994). In addition, the exclusive use of traditional closed-ended research instruments with pre-defined assumptions about what are and are not valid learning outcomes artificially limit understanding of the full range of possible effects of GBL or any outdoor learning experience, as well as opportunities for learners to demonstrate evidence of alternative types of intellectual growth. In addition, such approaches do not adequately account for either the constructive nature of learning or the ecological, cumulative nature of learning (cf., Baron, 2006; Bronfenbrenner, 1979; Jackson, 2013; Lemke, 2000).

Theoretical Framework

This paper advocates for more and better GBL research. It aims to add to similar work in outdoor education research that utilizes methods other than the traditional positivist measures. Using an alternative paradigm, one described as a constructivist, relativist theoretical approach (Guba & Lincoln, 2005) it defines learning as on-going and uniquely personal experience in which learning outcomes are highly variable across individuals and are strongly influenced by the socio-cultural and physical contexts in which they occur (Falk & Dierking, 2000; 2014; Lave, 1988; Scribner & Cole, 1973; Rogoff & Lave, 1984). This more complex ecological perspective ultimately assumes learning in the garden to be both personally constructed and contextually 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 common for all participants, it is more likely because of different entering and experiential realities encountered, that exactly what any particular individual might find salient and worth learning from a particular garden-based experience would 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). Capturing this more conditional, asset-based and unpredictable quality of learning requires a different approach and different tools than have traditionally been utilized by GBL. With this framework in mind, the measurement tool selected for this project was Personal Meaning Mapping

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(PMM), a tool developed from previous mapping techniques utilized in educational research.

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 (Davies, 2011; Salmon, 2001). Such tools are often graphic in nature and take advantage of the ability to arrange ideas in relation to each other (Davies, 2011). Not unlike other commonly utilized research tools, most existing mapping tools were framed within a cognitive, positivist paradigm, 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, 2011). 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 structured form of mapping called concept mapping (Novak & Cañas, 2008).

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 (Davies, 2011). Concept maps are designed to allow users to graphically depict the hierarchical interrelationships between ideas. Since even very complex and social 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. 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, the development of proficiency in concept mapping requires considerable time and significant training (Davies, 2011).

Unlike these 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' (Falk & Dierking, 2003). 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 intrapersonal 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, festivals and community-based programs, as well as in more structured classroom settings (*for reviews, see* Falk & Adelman, 2003; Falk & Dierking, 2003; Van Winkle & Falk, 2015; McCreedy & Dierking, 2013). It has been shown to effectively allow participants to articulate and negotiate their own perceptions and understandings of the PMM prompt—a single word or phrase in the center of an otherwise blank piece of paper (Falk, Moussouri, & Coulson 1998). For example, PMM has been used to quantitatively show changes in learning (e.g., Falk & Adelman, 2003; Falk, Heimlich & Bronnenkant, 2008; Lelliott, 2008) and 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., Falk & Storksdieck, 2005; McCreedy & Dierking, 2012; Van Winkle & Falk, 2015)

Method

Framed from an asset-based, relativist conceptual framework, the purpose of this research study was 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. 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 proposed to 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. In addition to 'in the moment' training and conversation, youth were given weekly structured lessons and participated in four field trips—a local greenhouse, organic farm, conventional farm, and industrial compost facility. At the end of the summer each youth was given a small stipend of $800 (approximately $4/hour–inclusive of educational hours).

The project's sample included the garden coordinator 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. Even though this sample size was small, it was typical of qualitative studies attempting to explore youth learning (Patton, 2001) and according to the program coordinator this sample was reflective of all youth in the program. All data were collected in the summer/fall of 2014, the second official growing season for this garden program.

The key informant interview (garden coordinator) provided data on 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. Table 1 summarizes participant backgrounds including their school type and whether they were a prior participant to the established environmental club run onsite.

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.

Table 2 summarizes participant personal characteristics of learning gathered from non-PMM data interviews.

Observations of garden activity also took place four times during the growing season and field notes were taken to record youth activity and en-

Table 1 Participant Backgrounds

Youth[1]	*Age*	*School*	*Gender*	*Prior Env. Club*
Susan	17	Early College	Female	Yes
John	17	Early College	Male	Yes
Tessa	16	Early College	Female	Yes
Adam	15	Public	Male	No
Samantha	15	Early College	Female	Yes
Brian	15	Boarding	Male	No
Chris	20	Early College	Male	Yes

[1] All names are pseudonyms.

Table 2 Participant Personal Characteristics of Learning

Youth	*Motivation*	*Expectations*	*Interest*	*Prior Knowledge*
Susan	Expected continuation	Be able to translate school knowledge to garden	Low	None
John	Something to do	None	Low	None
Tessa	Expected continuation	Job experience/skills	Low	None
Adam	Something to do	None	Low	None
Samantha	Money	None	Low	None
Brian	Money	None, possibly 'learn something'	Low	None
Chris	Expected continuation	None	Low	None

thusiasm 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.

Youth were given two opportunities to complete a PMM. The first came in July 2014. Youth were presented with a 10" × 14" piece of drawing paper with 'Community Garden(ing)' as the center prompt. 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 simply 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 in which youth were asked to explain why they wrote what they did, always using the phrase, "so what does X [what youth wrote/drew] 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 Oct./Nov. 2014 after all garden activity was completed. At this time youth were given the choice of either completing a new PMM or adding to, subtracting from, and/or changing their earlier PMM. The PMM data collection activity was approached by all youth with a great amount of reflection and intention, with each youth spending a mean of 20 minutes working on their map. This attention to detail on the physical artifact of the map allowed for extensive PMM interviews, as youth spent a mean of 25 minutes explaining what and why they wrote what they did on their map. This type of investment is not uncommon for individuals completing and discussing a PMM (e.g., Falk & Dierking, 2003; Falk & Storksdieck, 2005; McCreedy & Dierking, 2013).

PMMs and PMM interviews were the two main sources of data for this project. PMMs and PMM transcripts from both the pre- and post- mapping activities were combined and treated as a single data source, one 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 several additional data collection sources—a 'get to know you' interview, 'view of science' interview and researcher field notes and memos—were utilized as a secondary source of data 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).

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 categorical comparison of statements (Maxwell, 2012). This categorization scheme was followed for all major thematic areas youth 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 inferences of youth perceptions of the garden experience.

Results

Affordances

A major affordance of PMMs is that they enabled researchers 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, demonstrated both the variety and the depth of reflection and thought many youths gave in creating their PMMs.

Agricultural Sciences

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. Comments ranged from direct reference to agricultural science to comments that approached more affective components regarding issues of sustainable food production.

Comments regarding applicable content:

> Yeah, and I put soil blocking [on my map] 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 a broader in-depth appreciation regarding agricultural sustainability:

Conventional farming in America what have we [done] 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. [This] 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 [things like] '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 kids usually don't care about. So, I felt like it was a very intellectual setting but yet it was very casual so it was a 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 referenced [on map] it was almost like raising a child, well I don't know what that is like but I mean you plant 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).

Environmental Sciences

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 PMM data revealed the extreme variability in meaning-making of each youth. By approaching the learning in this garden from an ecology of learning 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 this work to capture the variability in the data in ways that facilitated the researcher's ability to understand and explain it. 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 had prior to their garden experience, both in terms of prior garden experiences and in terms of prior content knowledge in the environmental sciences. Comments that were limited to general environmental facts or things noticed about the environment 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 [on my map] because we have a lot of different animals that we see out here, we have raccoons, we have deer sometimes . . . 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 then 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).

Human-Environment Interactions

Like many surveys and most interview research methods, PMMs relies on self-report of personal experiences and knowledge. Self-reported data can impart various limitations on research results, some of which include concerns regarding 'faking' or providing false answers due to social desirability, lack of metacognition, lack of question understanding, and response bias (Miller, 2012; Porter, Rumann & Pontius, 2011). In addition, self-report also can lead to a great deal of variability in data and can make PMMs 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 [mountain picture] 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 [pointing to area on map] is kind of the environment and how people interact with the environment and all that good stuff. So, this is kind of what I learned, 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 come 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. The thematic analysis method used in this study would result in both of these comments being 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 relative, constructive nature of PMMs allowed for this discrepancy to emerge, which clearly the garden-based experience did not resolve. This provides a clear example of the relative, constructed nature of knowledge. Although in this case it could be argued that neither of these answers is totally right or totally wrong, it does point out the challenges of using a more open-ended, self-reported approach such as PMM. If a closed-ended question around this issue had been used it would have potentially forced a decision as to which of these two youth's conceptualization of the issue came closer to expert opinions on this topic, but maybe not. The richness of PMM responses enables researchers to determine the context of the remarks and thus intelligently infer whether similar responses represent true convergence or possibly, as in the above case, the use of similar words to answer different questions. This is a methodological asset, one not afforded by closed-ended questionnaires.

Other Learning

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, by design, the method is designed to elicit rich and deep data in one area instead of broadly across many. Therefore, the method limits the range of research questions that one might be able to ask and answer. For example, this project was interested in exploring the sciences learned from a particular out-of-school garden program. Knowing the literature on out-of-doors and GBL it was anticipated youth would speak to these sciences by using the single generic prompt of community garden(ing). And in fact, data were rich and deep and contained many connections to sciences, as expected. However, it was clear youth 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 the hard stuff is mindless. It is fun sorting stuff because you don't have to think about it, you are just on autopilot (Tessa).

Similar to the theme of stress relief, youth also spoke about the garden providing social benefits saying such things as "it widens my circle of people I interact with" (John) and "I put [on my map] 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).

However, since social benefits were not an explicit focus of the prompt, and youth completed the PMM as individuals outside of the social context of the garden, the actual comments made on the social nature of the garden did not allow for full understanding of how these social relationships were developed or specifically what role the garden activities themselves supported or impeded social interactions between and amongst youth.

A final constraint in using PMM for data collection in this particular

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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 & Dierking, 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 relatively modest changes (e.g., Falk & Adelman, 2003; Falk & Dierking, 2003; Falk & Adelman, 2003; Falk, Moussouri & Coulson, 1998; Falk & Storksdieck, 2005; Lelliott, 2005). However, as the data from the PMMs was explored, it became clear the sheer depth and quantity of experience created by a year-long garden program made even the most elaborate map an incomplete record of such a rich and potentially life-changing experience, reducing the reliability assumptions underlying earlier PMM analysis approaches (cf., Falk & Dierking, 2003).

Discussion/Conclusions

Sampled youth in this project appeared to find the task of completing PMMs compelling and in the process they provided a rich repository of data reflecting their very personal perceptions of their garden experience. The youth's time, attention and thought devoted to the production of their PMMs and their willingness to participate in an extensive discussion of the reasoning behind the items on their map is argued here to be a reflection of both the design of the PMM process, as well as almost certainly the non-judgmental nature of this particular long-term gardening program. That said, results also cannot discount the influence of the youth's comfort with the primary researcher (first author) who had spent many hours building rapport with the youth.

One of the clear major benefits of the PMM appeared to be the ability of PMM to capture each youth's unique voice, indicating their impressions and beliefs about the garden experience. The resulting understandings of what youth learned from this garden experience derived 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 lent significant validity to data itself and the conclusions able to be developed from these data.

One potential drawback of the chosen method was the need to rely on youth self-report as the primary dependent measure, which does impose a limitation to the validity of results as previously discussed. Although self-report data has long been criticized as lacking validity, a number of studies from various disciplines have established that self-report data though not perfect, are a reasonable surrogate for more direct measures, especially in the context of "low stakes" data collection situations (e.g., Chan, 2009; Gonyea, 2005; Vaske, 2008).

There clearly are trade-offs involved with using a single prompt to elicit data such as is typical of PMM. On the negative side, the focus on the single prompt in PMMs has the potential of limiting the research questions able to be asked of the data. However, on the positive side, the generic nature of the prompt enables researchers to explore how learners themselves construct meaning that they consider salient and conceptually relevant. As the rich but diverse response of youth revealed, PMM provides a safe and non-judgmental platform for sharing personal narratives and reveals potentially hidden insights about effects of an experience. A unique strength of PMM is that it does not distinguish between cognitive, affective and psychomotor learning as does most positivist approaches. Hence, learners naturally combine these elements in their responses to the prompt, revealing as is actually the case neurologically (cf., Damasio, 1994; Eagleman, 2015), the interconnections between these ways of perceiving the world.

Worth further study are the challenges of using PMM across longer time-frames. As suggested by this particular study, 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. This is not to say research could not attempt to use this method for longer-term experiences, it just means that new data analysis methods may be required to adequately capture the full breadth and depth of learning that results from events occurring over time frames of months and years.

Finally, it is worth noting that the use of PMMs involves two noteworthy trade-offs. Data collection using PMM is very labor intensive and yields very personal, potentially even sensitive information from participants. However, the method yields extremely deep, complex and highly personally relevant data. Therefore, researchers wishing to utilize PMMs need to be mindful of the relative costs and benefits involved—deep, rich data from a relatively small subset of individuals who may wish privacy when they engage in the process versus more superficial data from a large subset of individuals capable of being collected in a relatively anonymous fashion. Either approach can be justified, but clearly PMM affords some benefits not easily obtained in other ways.

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In conclusion, this project has provided empirical evidence that as a tool to evaluate learning, PMMs can be utilized to expand upon the common cognitive and positivist paradigmatic lens often used to frame many types of GBL. This expanded analytic lens was clearly visible within the PMM data as youth indicated a wide range of rich learning experiences, both on their map artifact and their map interview. Through the use of thematic analysis this project also demonstrated the ability of PMMs to capture the varied levels of perceived learning from a contextualized environment. Since the understanding of GBL is still in need of further work (Blair, 2009), this paper provides support for expanding the GBL paradigmatic lens to include methods such as PMM. Further research should include studies exploring GBL using PMMs or other constructivist, relative approaches to add to our understanding of GBL. In fact, it should be clear that PMM has utility far beyond the GBL context and could add to the field's understanding of outdoor learning by virtue of the rich, in-depth view it can provide to these diverse and often unscripted, unpredictable learning experiences.

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