Gardening practices and sustainability in a school garden program in Berkeley, California

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ABSTRACT

Urban and school gardens have the potential to aid in the transformation of urban areas into sustainable environments, however few studies have documented how this is manifested or systematically assess this potential. This study makes a connection between school gardens and sustainability by using sustainable gardening practices as indicators to measure sustainability in school gardens. For systematic assessment, this study focuses on a structured school garden program in Berkeley, California called the Gardening and Cooking Program (GCP). The program uses a garden-based learning curriculum that aims to formally integrate gardening into academic instruction. Using surveys, I identified and compared sustainable gardening practices used in gardens in the GCP. I then created a sustainability score for each garden and broke these scores into three levels that represented basic, intermediate and advanced levels of sustainability. Initial ranges were skewed to basic and intermediate levels, however when adjusted against each other, scores were more evenly distributed among all three levels. Additional survey questions related to program curriculum identified the main focus of garden lessons and instruction while questions on instructor knowledge and pedagogy identified instructor rationales or reasons behind the use of sustainable gardening practices. Key findings showed that a structured curriculum has a strong influence on topics that are manifested in the garden and can shape the overall nature and goals of the garden program. Findings also identified barriers to sustainability and suggested that training on sustainable gardening practices and greater support for the garden program would result in higher levels of sustainability.

KEYWORDS

Urban agriculture, food systems, sustainability indicators, Berkeley Public School Gardening and Cooking Program (GCP), school garden programs

INTRODUCTION

School gardens are part of a growing movement for the "greening" of schoolyards and a key form of initiative in the urban agriculture movement. Research on school gardens has focused on their social, health, educational, environmental benefits within the broader contexts of urban agriculture and youth development (Armstrong 2000, Blair et al. 1991, Dickinson et al. 2003, Robinson and Zajicek 2005). School gardens may contribute to the enrichment of education and development of sustainable urban environments, however few studies have documented how this is manifested or systematically assess this potential (Blair 2009). In reviews of literature on school gardens, Ozer (2007) and Blair (2009) recognize this lack of systemic assessment, and identify key goals and benefits of school gardens, including academic enrichment, access to healthy produce, improvement of school aesthetics, connection to nature and youth empowerment (Pudup 2008, Ozer 2007, Beall et al. 2005, Rahm 2000, Bradley and Skelly 2000). Ultimately, however, Blair (2009) the reviews either fail to address ecological sustainability in school gardens or deem the sparse literature on school gardens inconclusive, suggesting that further studies should assess the ecological sustainability and overall effects of school gardens.

Research on urban farming, agroecology and sustainable food systems have documented sustainable practices in urban gardening contexts, however there are no studies of school garden sustainability practices. Examples of sustainable practices that school gardeners may engage in include reducing water use by planting drought-resistant or native plants and using drip irrigation, avoiding harmful pesticides and chemicals through integrated pest management, limiting waste by reusing materials for compost and other inputs and replenishing soil through the use of cover crops and rotations (Okvat and Zautra 2011, Carpenter and Rosenthal 2011, Peirce 2010). The existing literature recognizes sustainability practices applied to areas such as water conservation, biodiversity conservation, soil health, waste reduction and more; however, it fails to move beyond these specific subject areas to the broader concept of sustainability. For example, Altieri (1999) emphasizes the ecological role of biodiversity in agroecosystems, but only in regards to relationships between biodiversity and improved yields. A focus on the greater concepts of ecology and sustainability across gardening practices used to address specific garden characteristics may serve as key indicators of sustainable gardens.

The San Francisco Bay Area has a long history of alternative food movements and school garden programs. Since the 1970s, the Berkeley Unified School District, for instance, has implemented programs focusing on nutrition, gardening and cooking as a means of changing how children eat, empowering students to make healthy food choices and educating students about the connection their food choices have on their families, communities and nature (Pudup 2008, Rauzon et al. 2010, Severson 2004). Currently, the Berkeley Unified School District (BUSD) employs the Berkeley Public School Gardening and Cooking Program (GCP)–an interdisciplinary program and curriculum that connects academics to school gardens to affect academic achievement, increased health and essential life skills (BUSD 2014). The Program engages students in preschool through eighth grade using a Garden-Based Learning Curriculum in 16 school gardens. The curriculum is the first of its kind and was organized by teachers, garden instructors, standards specialists and school garden curriculum consultants to connect the program to classroom lessons.

The structured program and curriculum may provide unique advantages and help overcome barriers when compared to other school gardens without a formal program or curriculum. Lack of or ineffective integration into academic curriculum, among other factors, is one of the major barriers to maintaining school gardens (Ozer, 2007). School gardens strongly benefit from a structured program administered by paid staff (Ozer 2007, Graham and Zidenberg-Cherr 2005, Bradley and Skelly 2000). Moreover, teacher training in gardening and its connection to curriculum and the availability of curriculum materials linked to academic instruction increase academic benefits from school gardens (Graham and Zidenberg-Cherr 2005). Given that the GCP is a highly regarded, structured program that funds garden instructors and integrates gardening into academic instruction, the GCP may serve as model structured garden program. Comparative research on GCP school gardens offers an opportunity to assess sustainability in school gardens in terms of widely recognized sustainable gardening practices.

My primary research objective was to compare gardening practices across GCP schools in terms of a set of widely recognized ecological sustainability indicators. This culminated into two sets of sustainability scores that compared the levels of sustainability of GCP school gardens. In addition, I identified key findings related to sustainability that either highlighted commonality, best practices or areas for improvement. I also examined the content of program curricula and its alignment with and influence over lessons and instruction. Finally, I identified rationales for

instructor pedagogy related to the implementation of sustainable gardening practices and discussed ways that greater sustainability could be achieved in school gardens.

METHODS

Study system

My study system consisted of school garden programs in K-12 schools in the Berkeley Unified School District in Berkeley, California, all of which are part of the Berkeley Public School Gardening and Cooking Program (GCP), which uses an interdisciplinary Garden-Based Learning Curriculum to connect classrooms to the school gardens (BUSD 2014). I surveyed school garden program instructors with first-hand experience in and knowledge of their specific school garden programs. Out of sixteen schools in the Gardening and Cooking Program, thirteen schools participated in my study (Table 1, Figure 1, Figure 2). I collected ten surveys from nine instructors and one program supervisor as some garden instructors worked at more than one school.

Table 1: Participating school gardens (Note that while there are 16 reported school gardens in the Gardening and Cooking Program, only 13 school gardens were identified and participated in this study).

School	Grade
Cragmont	K-5
Emerson	K-5
Jefferson	K-5
John Muir	K-5
LeConte	K-5
Malcolm X	K-5
Oxford	K-5
Rosa Parks	K-5
Thousand Oaks	K-5
Washington	K-5
Longfellow	6-8
Willard	6-8
Berkeley Technology Academy	9-12

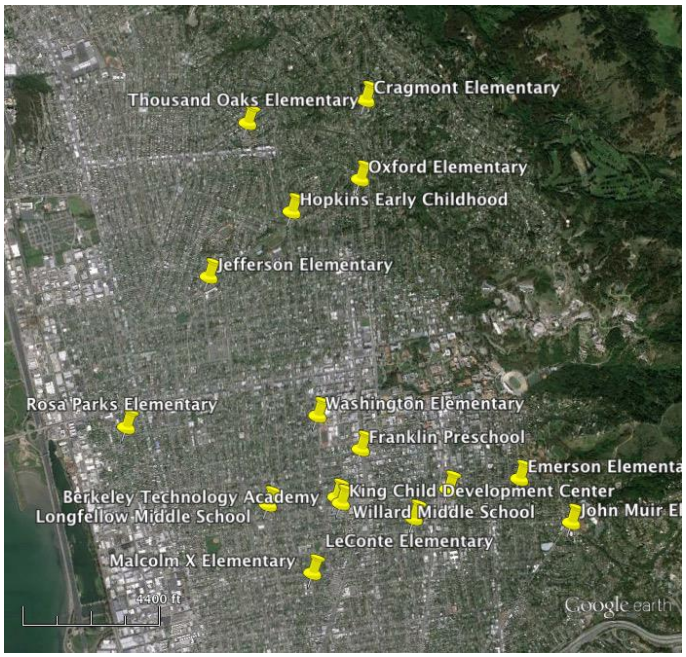

Fig 1. Map of school gardens in the BUSD Gardening and Cooking Program (Note: this map includes all 16 school gardens in the Gardening and Cooking Program and not just those that participated in this study).

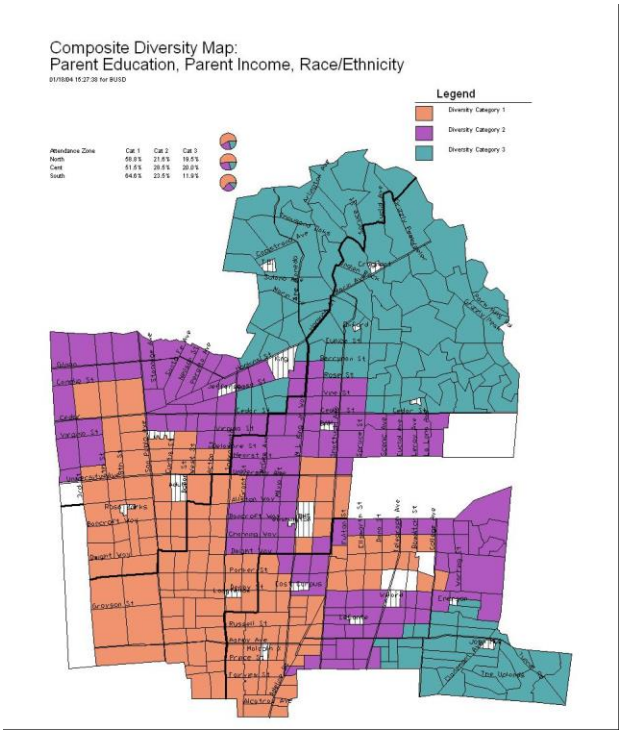

Fig 2. BUSD Composite Diversity Map: Parent education, parent income, race/ethnicity.

Surveys

Garden logistics and gardening practices

I created surveys on garden logistics, gardening practices, program curriculum, and instructor experience, knowledge and pedagogy. I reached out to the BUSD Gardening and Cooking Program coordinator, who contacted all of the program's school garden coordinators so that I could distribute surveys. Due to availability and time constraints of garden instructors, three out of ten total surveys were completed by phone.

To gather information on garden logistics I included questions about number of plots, number of crops and program schedule. I reviewed literature on sustainable gardening to identify common sustainable community gardening practices, and classified these practices in broad areas including water usage, material reuse and disease and pest management. I used these categories to analyze each garden program as a whole as well as within the specific categories. The category on water usage focused on irrigation techniques, frequency of watering and water sources. Material reuse focused on reuse of garden waste, food waste and other materials in the garden. Disease and pest management identified integrated pest management strategies such as crop rotation, planting of disease resistant crops, planting of insect attractor plants, successional planting and more. I used Google forms to create a variety of question types that focused on specific practices. For multiple-choice questions, I coded each option with a numerical value that contributed to an overall sustainability score. For ranking questions, instructors ranked their use of a specific practice on a 1-5 scale, 1 being never and 5 being always. In most cases, each question focused on a sustainable gardening practice identified in the literature meaning that a higher 1-5 response translated into a higher numerical value that contributed to an overall sustainability score (Table 2). In a few cases where the question focused on a practice that was not identified as sustainable, a higher 1-5 response translated into a lower numerical value. For example, when asked to rank the use of chemical pesticides/herbicides, a "5" rank of "always" would translate into a low numerical value for sustainability. On the contrary, when asked to rank the use of beneficial predators/insects, a "5" rank of "always" would translate into a high numerical value for sustainability.

Table 2. Coding system for calculating sustainability scores. School names removed for anonymity.

School	Key	Perfect	A	B	C	D	E	F	G	H	I	J	K	L	M
Irrigation	drip = 3, hose only = 2	3	3	3	3	3	3	3	3	3	3	3	2	2	3
Watering Frequency	2-3 = 4, > = 5, < = 3	5	4	4	4	4	3	4	4	4	4	4	4	4	3
Garden waste reuse	scale of 1-4	4	4	2	2	2	3	4	4	4	4	4	4	4	3
Food waste reuse	scale of 0-4	4	1	1	1	0	0	0	0	1	2	2	0	0	0
Material reuse	scale of 1-4	4	2	3	3	4	2	2	2	3	3	3	3	3	4
Chemical pesticides/herbicides	reverse 1-5 scale	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Crop rotation	scale of 1-5	5	4	3	3	4	4	3	3	3	5	5	4	4	3
Pest/disease resistant crops	scale of 1-5	5	2	4	4	4	2	2	2	2	3	3	1	1	3
Insect predators and/or beneficial insects	scale of 1-5	5	4	3	3	4	4	2	2	1	4	4	1	1	3
Weed control	scale of 1-5	5	2	4	4	5	4	4	4	3	3	3	3	3	4
Seasonal planting	scale of 1-5	5	5	5	5	5	5	5	5	3	5	5	5	5	4
Companion planting	scale of 1-5	5	3	4	4	3	2	4	4	2	4	4	2	2	4
Physical barriers	scale of 1-5	5	3	4	4	2	4	2	2	3	3	3	3	3	2
Insect attractor plants	scale of 1-5	5	5	4	4	4	4	4	4	3	3	3	1	1	3
Hand removal	scale of 1-5	5	2	4	4	4	5	4	4	4	2	2	3	3	3
Sustainability score		69	49	53	53	53	50	48	48	44	53	53	41	41	47

Program curriculum and instructor experience

To identify the goals and focus of the Garden-Based Learning Curriculum I asked instructors questions on the content, focus, and alignment of the program curriculum with their pedagogy. To get a better understanding of the general content and focus of the program I asked instructors questions about specific topics such as health and nutrition, connection to nature, biological concepts, conservation and more (Figure 3). Instructors then ranked how often they focus on the specific topic on a 1-5 scale. Following these rankings, I asked teachers to select a percentage of time they felt the content/focus of their lessons aligned with the goals, objectives and procedures outlined in the program curriculum. Additionally, I asked instructors to rank on a 1-5 scale their level of agreement with a statement that the goals, objectives and procedures outlined in the curriculum are clear and easy to implement in lessons/instruction. These questions were meant to identify any potential shortcomings between what is outlined in the curriculum and what is actually taught in the garden.

To document rationales for curriculum and pedagogy choices, I asked instructors about their teaching experience, knowledge and values related to their garden and ecological gardening practices. I asked instructors to rank statements about their level of knowledge of ecological gardening practices, as well as the level at which they prioritized the use of those practices. Then instructors identified reasons why they would or would not implement specific ecological gardening practices (Figure 4). These questions were designed to provide insight into potential reasons or rationale as to why ecological gardening practices are or are not used.

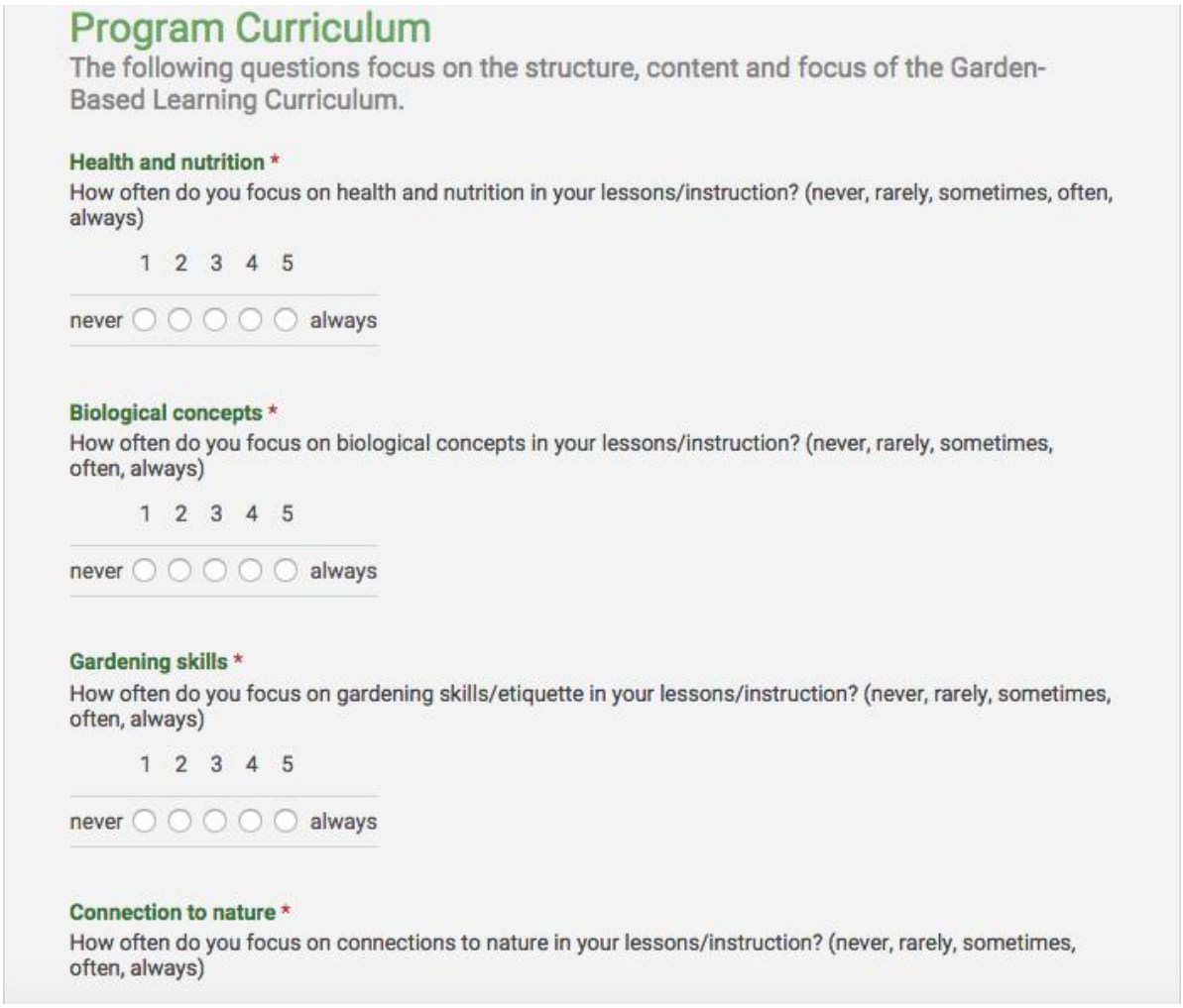

Fig 3. Sample questions on program curriculum content and focus

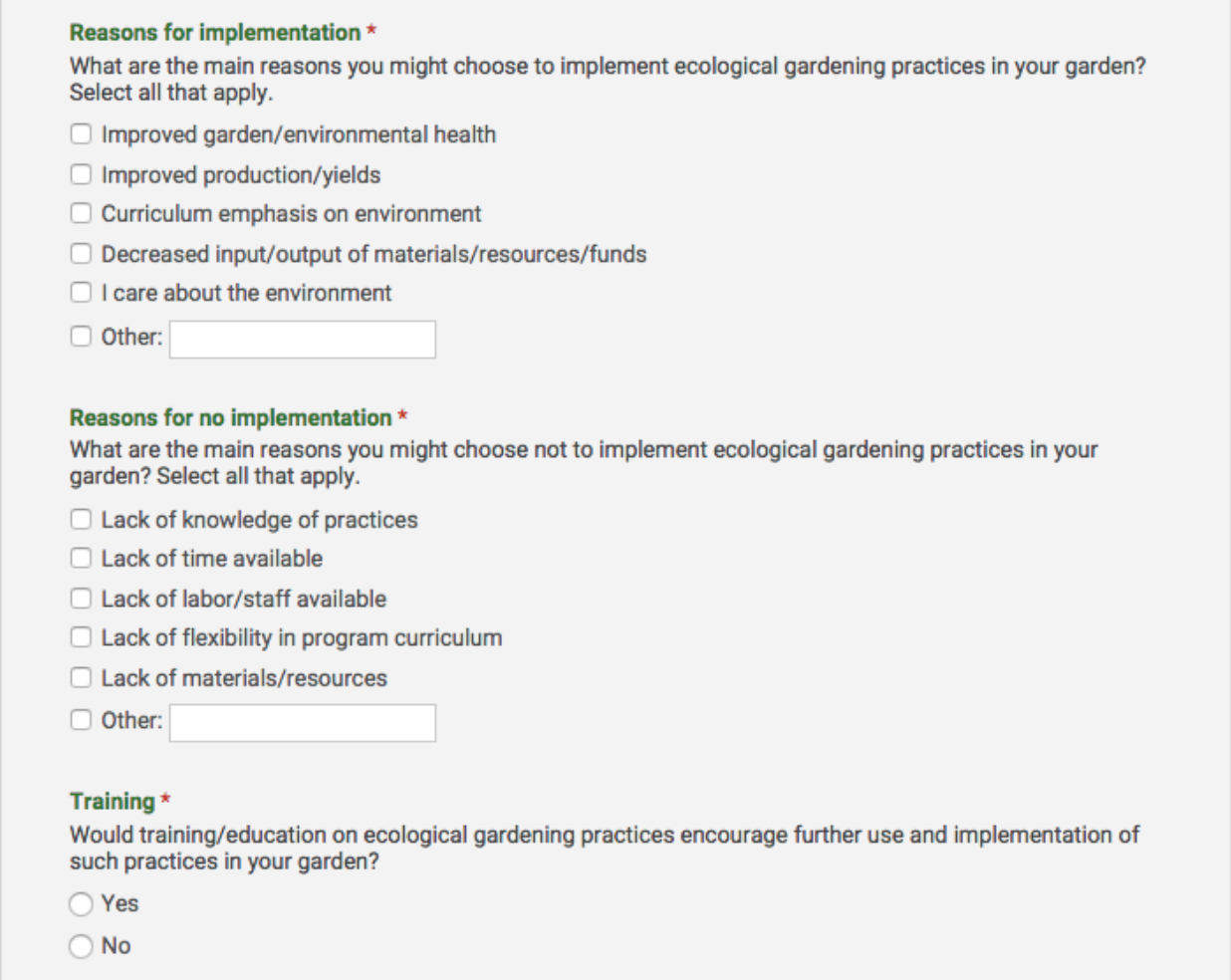

Fig 4. Sample questions on instructor knowledge and pedagogy

Analysis

Sustainability scores

After summing the numerically coded values from survey questions, I created three levels of sustainability. Based off of my questions I identified a perfect score of 69 and used a low score of 40 to create a range from 40-69 (Table 3). School garden programs with Level 1 sustainability scored 40-49 points. Programs at this level demonstrated a basic use of ecologically sustainable gardening practices, often receiving sustainability points from the most common practices such as drip irrigation or composting. Programs at Level 2 sustainability scored between 50 and 59 points.

These programs demonstrated an average use of ecologically sustainable gardening practices by receiving points for the most common practices in addition to more innovative or unique practices that replaced other, less ecological practices. Programs at Level 3 sustainability scored 60-69 points after demonstrating an above average use of ecologically sustainable practices. These programs used the highest quantity of sustainable practices and made a conscious effort to replace non-sustainable practices with more sustainable ones through innovation and diversity.

After placing each garden in the appropriate initial level and receiving results skewed to the lower end, I created adjusted levels to provide a more comprehensive comparison of the gardens in relation to each other. To do this, I used the highest and lowest sustainability scores to define the range, rather than the perfect and lowest scores. This adjustment resulted in a much smaller range of 40-54 (Table 3). With this range, school gardens with Level 1 sustainability scored 40-44 points, Level 2 scored 45-49 points and Level 3 scored 50-54 points. These adjusted levels allowed for comparison of school garden sustainability relative to other schools in the program, however they are not meant to replace the initial sustainability levels.

Table 3. Initial and adjusted ranges for sustainability levels

Level	Level 1	Level 2	Level 3
Initial range	40-49	50-59	60-69
Adjusted range	40-44	45-49	50-54

RESULTS

I received 11 surveys concerning 13 school gardens. Instructors who manage more than one garden completed the survey once. I used questions on gardening practices and logistics to calculate sustainability scores. Questions on program curriculum identified the main focuses of lessons and instruction and their alignment with the curriculum. Questions on instructor knowledge and pedagogy identified rationale and reasoning behind practice implementation.

Sustainability scores

I found differences in the garden logistics and gardening practices at each site that I converted into a range of sustainability scores. Seven school gardens received an initial sustainability score of Level 1, six received Level 2 and none received Level 3 (Table 4, Figure 1). Out of a perfect score of 70, the highest score was 53 and the lowest score was 41. After adjusting for a perfect score of 54, three school gardens received an adjusted sustainability score of Level 1, four received Level 2 and six received Level 3 (Table 4, Figure 1). Major differences in sustainability scores reflected different responses to survey questions on material reuse and integrated pest management. Most questions on integrated pest management had high variations in responses (1-5 or 1-4), showing no real patterns or commonalities. See Table 2 for a key and coded calculations for each question contributing to the overall sustainability score.

Table 4. Distribution of school garden sustainability levels for initial and adjusted scores

Level	Level 1	Level 2	Level 3
Initial sustainability score	7	6	0
Adjusted sustainability score	3	4	6

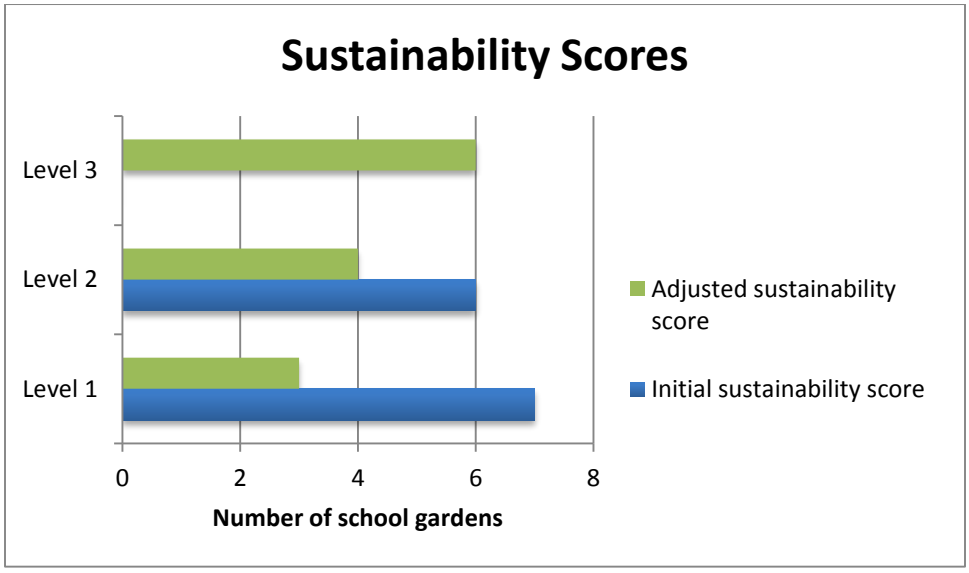

Fig 5: Initial and adjusted sustainability scores

Garden logistics and gardening practices

The most common frequency of engagement for students in the garden was every other week (84.6%), with only one garden reporting a frequency of more than every other week and one garden reporting less than every other week. 92.3% of gardens reported using hose or hand watering as a form of irrigation, and 84.6% of gardens reported using drip irrigation. No other irrigation practices were reported. In general, questions on water use had the most commonality in responses. Garden waste (clippings, weeds, etc.) was used at least 50% of the time by 84.6% of instructors and at least 75% of the time by 69.2% of instructors. Only one instructor reported a significant use of school food scraps in the garden, with majority of instructors (84.6%) reporting less than 25% or none. Crop rotation, seasonal planting and weed control were the most commonly reported forms of pest and disease management. Planting pest and disease resistant crops, using insect predators and/or beneficial insects, and use of physical barriers were the least commonly reported forms of pest and disease management. Refer to Table 2 for more details including a key and coded calculations for each question on garden logistics and gardening practices.

Program Curriculum

When asked how often they focused on a specific subject in their lessons and instruction, 76.9% of instructors reported that they focused on health and nutrition and connection to nature "often" or "always". Integrated pest management was reported the least frequently, with 46.1% of instructors reporting "rarely" or "never". Based on averages, connection to nature, health and nutrition and biological concepts were the subjects most often focused on in lessons and instructions while integrated pest management, food systems, and youth development were the subjects least often focused on (Table 5). When asked how often the content and focus of their curriculum aligns with the goals, objectives and procedures outlined in the curriculum, 69.2% reported 80-100% of the time, and 84.6% reported at least 60% of the time.

Table 5. Program curriculum focus on a 1-5 scale of frequency (1 = never, 5 = always)

School	A	B	C	D	E	F	G	H	I	J	K	L	M	Total	Average
Health and nutrition	4	4	4	4	3	4	4	5	3	3	4	4	4	50	3.8
Biological concepts	3	4	4	4	3	5	5	3	4	4	3	3	3	48	3.7
Gardening skills	3	4	4	5	3	2	2	2	4	4	4	4	4	45	3.5
Connection to nature	3	4	4	3	3	5	5	4	5	5	4	4	5	54	4.2
Conservation	2	4	4	3	4	3	3	3	4	4	3	3	4	44	3.4
Ecological concepts	3	4	4	2	4	4	4	3	4	4	3	3	4	46	3.5
Youth development	4	3	3	3	3	2	2	3	4	4	4	4	4	43	3.3
Food systems	3	4	4	2	4	1	1	2	3	3	3	3	4	37	2.8
Integrated pest management	3	2	2	2	4	3	3	1	1	1	3	3	3	31	2.4

Instructor knowledge and pedagogy

When asked if they felt knowledgeable about ecological gardening practices and/or have experience implementing such practices, 100% of instructors agreed that they have this knowledge and experience. 76.9% of instructors agreed that they prioritize the use of ecological gardening practices in their garden, even if they require less conventional methods and greater innovation.

The main reasons for choosing to implement ecological gardening practices in gardens were improved garden and environmental health, caring about the environment and decreased input and/or output of materials, resources and funds (Figure 6). The top reasons for choosing not to implement sustainable gardening practices in their garden were lack of time available, lack of labor/staff available and lack of materials/resources (Figure 7). 100% of instructors reported that training and/or education on ecological gardening practices would encourage further use and implementation of such practices in their garden.

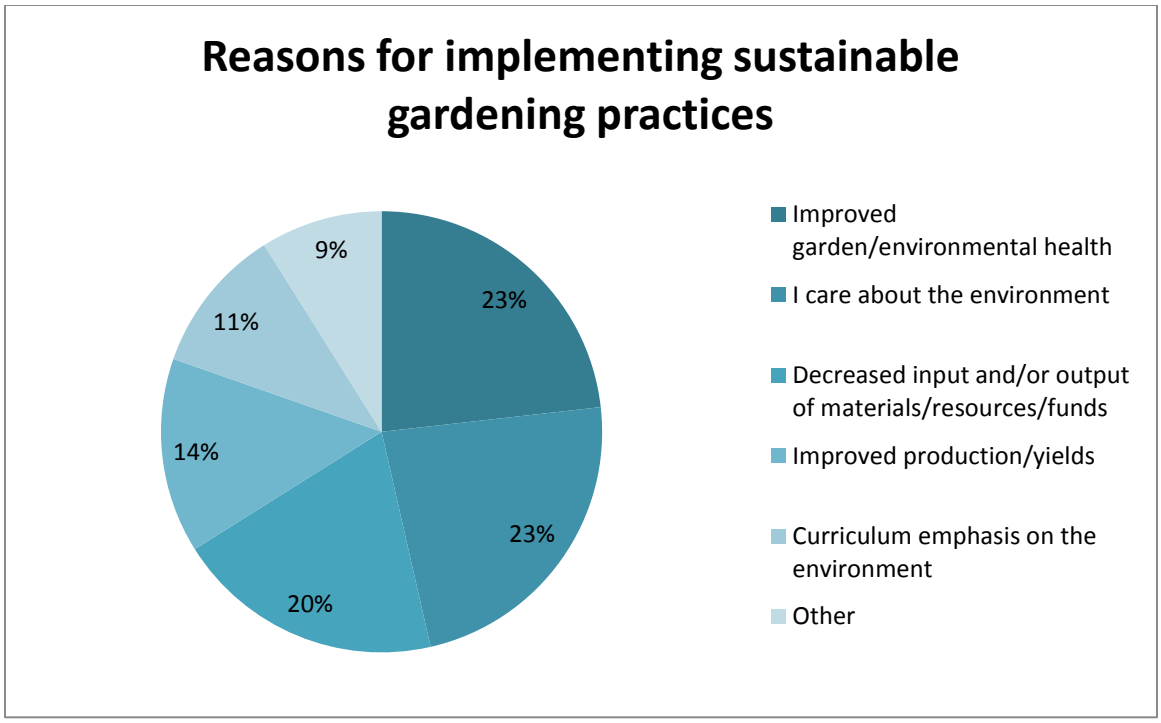

Fig. 6 Reasons for implementing sustainable gardening practices (as reported by garden instructors)

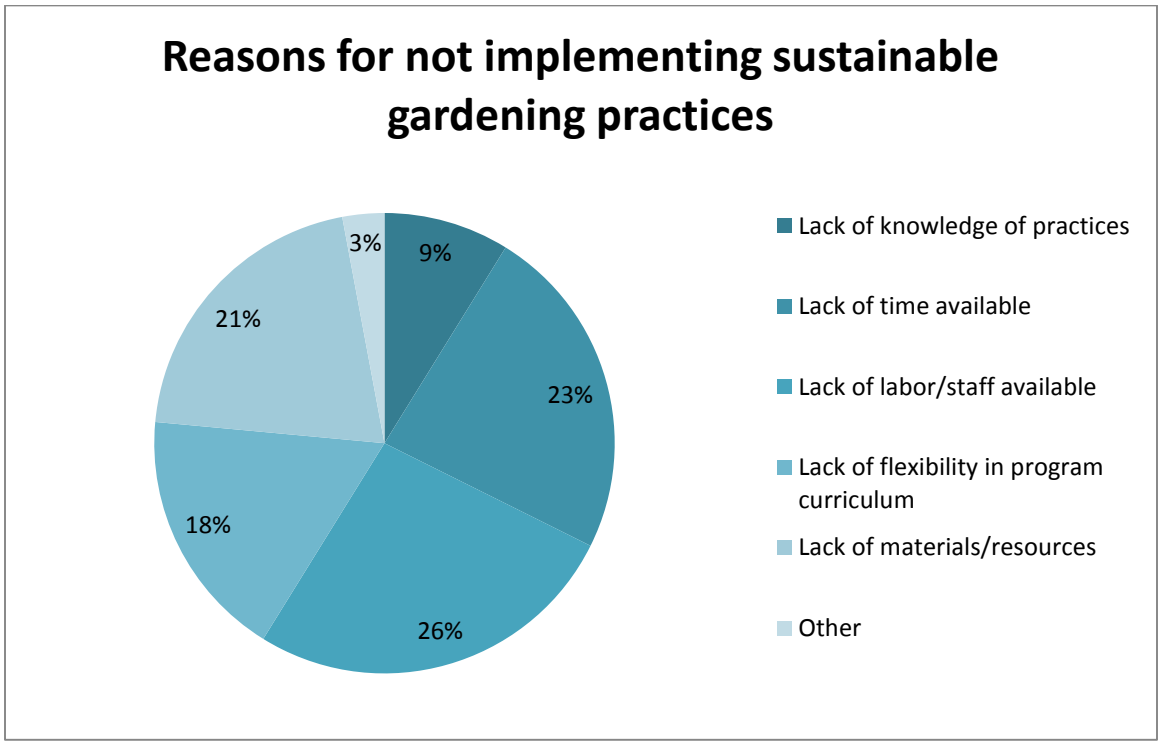

Fig 7. Reasons for not implementing sustainable gardening practices (as reported by garden instructors)

DISCUSSION

My survey results point to means of achieving sustainability in school gardens by implementing specified practices. After analysis I identified two key areas of improvement to achieve greater sustainability. These areas, in addition to others, could be improved upon with more training and education for instructors on sustainable gardening. I identified time, resources and staff as limitations or barriers to achieving sustainability that coincided with barriers and limitations to maintaining a successful garden in other studies. If these barriers were reduced through greater support in the form of involvement, funding, resources and more, sustainability could be achieved with greater ease. I also found that a structured curriculum has strong influence on the content and focus of garden lessons and should be used to formally emphasize and integrate more focus on sustainability in school gardens.

Key findings

Two key areas in need of greater implementation are the reuse of school food waste and integrated pest management strategies. Few gardens reused school food waste, but many reported reusing garden waste. This suggests that convenience is a major factor in material reuse. Garden scraps, weeds, etc. are readily available in the garden and can easily be incorporated into compost, while composting food waste for gardens requires coordination with teachers and staff. The City of Berkeley already collects food waste for compost, which may be another reason why food waste reuse in the garden is so low. Compost composed of primarily green or yard waste may have a carbon to nitrogen (C/N) ratio that is higher than the optimum ratio for composting. Adding waste with higher nitrogen ratios, such as food waste, can help correct this ratio and create a more optimum environment for best compost results (Bertoldi et al. 1983). To maximize the benefits that Berkeley school gardens can receive from compost, food waste should be more actively integrated into the composting process.

Integrated pest management strategies, such as crop rotation, planting insect attractor plants, and planting pest/disease resistant crops varied the most in responses. One instructor noted that many of these practices were not intentionally implemented for specific benefits, but that they did

recognize them as part of a holistic approach to gardening. This suggests a disconnection between implementing integrated pest management strategies and recognizing their benefits. Since all garden instructors reported that they have knowledge of sustainable gardening practices or have experience implementing such practices in a garden setting, lack of knowledge or experience may not account for this. However, aside from lesson materials, teachers do not receive formal training through the program, meaning that their level of experience and knowledge may vary depending on their background. To address this variation, formal training in integrated pest management strategies and other sustainable gardening practices should be provided for instructors. Training would not require implementation of specific practices, but would prevent lack of knowledge or experience with sustainable gardening practices from posing a barrier to achieving sustainability.

Barriers to sustainability

Berkeley school gardeners faced barriers to sustainability similar to those identified in other studies, particularly limited personnel, time and resources (Ozer 2007, Graham et al. 2004). Berkeley school garden instructors identified lack of time, lack of staff/labor and lack of resources/materials/funding as the three main reasons instructors would choose not to implement sustainable gardening practices. This suggests that the overall level of sustainability can be tied to the overall success of maintaining a garden. While most studies identifying limited personnel as a barrier were in school gardens that rely on teachers to run the garden, I found that Berkeley having a paid garden instructor does not completely address personnel challenges (Ozer 2007, Azuma et al. 2001). For instance programs with only one leader at the site are vulnerable to failure in the event of staff turnover, "burnout", or other extenuating circumstances (Ozer 2007). I found this to be true for Berkeley school gardens as some instructors reported that they had to take on managing an extra garden in order to keep it running as part of the program. Schools with successful programs that have been sustained over time have attributed their success to widespread, long-term support of the principal, teachers, parents and students (Ozer 2007). This suggests that support in general, and not just reliance on a single teacher, instructor, or volunteer, is necessary to achieve and maintain garden sustainability. In Los Angeles, California, an active garden program could not be sustained due to lack of time support and funding, among other factors (Ozer 2007, Azuma et al., 2001). And Bradley and Skelly (2000) identified funding and

expenses associated with school gardens in Florida as something that may discourage many teachers from using a garden. This parallels instructor responses in Berkeley that identified lack of funding as a barrier to implementing sustainable gardening practices. Thus, challenges associated with using and maintaining successful gardens coincide with challenges to achieving sustainability in gardens.

Benefits of a structured program

A structured curriculum and program has strong influence on the content and focus of garden lessons and instruction. A majority of instructors (75%) reported that their lessons and instruction aligned with the goals, objectives and procedures outlined in the curriculum 80-100% of the time. This is supported by seeing that the stated goals of the Gardening and Cooking Program, to improve academic understanding, improve health and foster student engagement, align with the subjects instructors reported they focus on most often. These subjects were biological concepts, connection to nature and health and nutrition. Focusing on biological concepts serves as a means of improving academic understanding as they can be directly related to structured science lessons. Focusing on connection to nature is a means of fostering student engagement, as it encourages students to interact in the garden and make connections with each other and their surroundings (Blair 2009). It also encourages students to develop roles and ground themselves in the garden environment, which can be more engaging than other, more traditional classroom settings. Finally, emphasizing health and nutrition in lessons aligns with the improving health. Many studies have focused primarily on the health and nutrition benefits of school garden programs, and have found that they support healthy eating habits and behavior (Pierce 2012, Graham et al. 2004). This alignment in the stated goals of the Gardening and Cooking Program and the main subjects focused on in the program shows that the structured curriculum has a strong influence on what is manifested in lessons and instruction.

To further support this idea, traces of former program curricula and goals can still be seen in lessons and instruction today. Specifically, the Gardening and Cooking Program was formerly funded by the California Nutrition Network (CNN) to focus on nutrition education (BUSD 2014). The GCP lost funding from CNN in 2013, however health and nutrition is still one of the main subjects focused on in lessons today. This continued focus on health and nutrition is likely a

product of the GCP's former funding and influence from CNN that has manifested itself in the new program as a goal of improving health. Thus, although the Gardening and Cooking Program is no longer solely focused on nutrition education, its old curriculum may still have influence over what is taught and manifested in the garden today.

Broader implications

In identifying barriers to sustainability and benefits of a structured garden program it is clear that more training for instructors on sustainable gardening practices, more support in general and greater emphasis on sustainability in program curriculum would result in greater potential for school gardens to achieve sustainability. Sustainable gardening practices still have relatively high variation in a structured garden program. However, with more training, garden instructors would be equipped with the same level of knowledge and/or ability to implement said practices. Theoretically, the only thing preventing garden instructors from implementing sustainable gardening practices would be the identified barriers: time, labor/staff and resources/funding. All of these factors lie under the umbrella of support, suggesting that if teacher, staff, and volunteers involvement, increased funding, district support, etc. were addressed, barriers to sustainability would be substantively reduced. Finally, considering the power that a structured curriculum and program goals have over actual lessons and instructions, formally integrating concepts of sustainability into program curriculum and goals would result in greater emphasis on sustainability in the garden.

Limitations

This study had several limitations relating to time, responsiveness and subjectivity of survey questions and responses. In searching the literature on sustainable gardening practices, survey questions were limited to those practices I identified and may have left out certain practices that are considered to be sustainable. If the gardens were surveyed on other sustainable gardening practices the, sustainability scores and outcomes may be different. In addition, coding for responses was subjective in order to maintain uniformity and consistency. In the future, a detailed scoring rubric should be established in order to allow for more complex analysis and take into

account any discrepancies my scoring method failed to capture. Finally, time and responsiveness limited the extent to which data could be collected. With more time and quicker responses from garden instructors, this study would have included interviews and detailed observations of each study site. However, these were limitations that I predicted in advance and led me to make adjustments to in my survey in order to capture more data.

Future directions

In the future, similar studies should be carried out in more detail, with more time and a wider range of study subjects. Ideally, a study would compare two groups of school gardens, one group with a formal program and curriculum and one group without. This would allow for comparisons to be made between the sustainability levels of schools with a garden program to the sustainability levels of those without. The implications of these comparisons could be further connected to the benefits of having a structured program and the influence a curriculum has on what is taught and focused on in school gardens. In addition, more time would allow for interviews and observations to be carried out in order to substantiate survey findings. Finally, surveys would include a more comprehensive list of sustainable gardening practices and would go into greater complexity in scoring and creating sustainability scores.

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REFERENCES

Altieri, M. 1999. The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems and Environment 74:19-31.

Armstrong, D. 2000. A survey of community gardens in upstate New York: Implications for health promotion and community development. Health & Place 6:319-327.

Azuma, A., T. Horan, and R. Gottlieb. School Gardens in the Los Angeles Unified School District: A Survey, Case Studies, and Policy Recommendations. Los Angeles: Center for Food & Justice, Urban & Environmental Policy Institute; 2001. 1 p.

Berkeley Unified School District. 2014. Berkeley Public Schools - Gardening and Cooking Program. Berkeley Unified School District 2014:2.

de Bertoldi, M., G. Vallini, and A. Pera. 1983. The Biology of Composting: A Review. Waste Management and Research 1:157-176.

Blair, D. 2009. The Child in the Garden: An Evaluative Review of the Benefits of School Gardening. The Journal of Environmental Education 40:15-38.

Blair, D., C. C. Giesecke, and S. Sherman. 1991. A dietary, social and economic evaluation of the Philadelphia urban gardening project. Journal of Nutrition Education 23:161-167.

Carpenter, N., and W. Rosenthal. 2011. The Essential Urban Farmer. Penguin Books, USA.

Dickinson, J., S. Duma, T. Kleinman, H. Paulsen, L. Rilveria, and J. Twiss. 2003. Community Gardens: Lessons Learned From California Healthy Cities and Communities. American Journal of Public Health 93:1435-1438.

Graham, H., G. Feenstra, A. Evans, and S. Zidenberg-Cherr. 2004. Davis school program supports life-long healthy eating habits in children. California Agriculture 58:200-205.

Graham, H., D. Beall, M. Lussier, P. McLaughlin, and S. Zidenber-Cherr. 2005. Use of School Gardens in Academic Instruction. Journal of Nutrition Education and Behavior 37:September 24, 2014-147-151.

Ovkat, H. A., and A. J. Zautra. 2011. Community gardening: a parsimonious path to individual, community, and environmental resilience. American Journal of Community Psychology 47:380-382.

Ozer, E. J. 2007. The Effects of School Gardens on Students and Schools: Conceptualization and Considerations for Maximizing Healthy Development. Health Education & Behavior 34:846-863.

Peirce, P. 2010. Golden Gate Gardening: The Complete Guide to Year-Round Food Gardening in the San Francisco Bay Area and Coastal California. Sasquatch Books, Seattle.

Pierce, M. L. An Evaluation of Urban Youth Gardening Program Participants' Dietary Behaviors, Agricultural Knowledge, and Leadership Skills: A Case Study. Urbana, Illinois: University of Illinois at Urbana-Champaign; 2012. 1 p.

Pudup, M. B. 2008. It takes a garden: Cultivating citizen-subjects in organized garden projects. Geoforum 39:1228-1240.

Rahm, I. 2002. Learning Opportunities in an Inner-City Youth Gardening Program. Journal of Research in Science Teaching 39:164-184.

Rauzon, S., N. Studer, and M. Wang. An Evaluation of the School Lunch Initiative. Berkeley: University of California at Berkeley - The Dr. Robert C. and Veronica Atkins Center for Weight and Health, College of Natural Resources and School of Public Health; 2010. 1 p.

Robinson, C., and J. Zajicek. 2015. Growing Minds: The Effects of a One-year School Garden Program on Six Constructs of Life Skills of Elementary School Children. HortTechnology 3:453-457.

Skelly, S., and J. Bradley. 2000. The Importance of School Gardens as Perceived by Florida Elementary School Teachers. HortTechnology 10:229-231.

Severson, K. 2004. Food joins academic menu in Berkeley school district / Credits, not calories -- Chez Panisse founder cooks up new 'core curriculum'. SFGate News.