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ORIGINAL PAPER

Can learning in informal settings mitigate disadvantage and promote urban sustainability? School gardens in Washington, DC

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Abstract This article explores how school gardens provide learning opportunities for school-aged children while concurrently helping cities achieve sustainability. The authors analyse this process in Washington, DC, a particularly innovative metropolis in the United States. This national capital city boasts two of the most progressive examples of legislation aimed at improving environmental awareness and inciting citizens to engage in environmental stewardship, both of which focus on school-aged children: (1) the *Healthy Schools Act of 2010* and (2) the *Sustainable DC Act of 2012*. Together these policies focus on bringing healthy lifestyles and environmental awareness, including meaningful outdoor learning experiences, to students and families in the District of Columbia. This article is organised into three parts. The first part discusses how Washington, DC became a sustainable learning city through the implementation of these specific policies. The next part presents the results of a pilot study conducted in one kindergarten to Grade 5 (K–5) elementary school located in Ward 8, the poorest part of the city. The authors' analysis considers the support and the obstacles teachers and principals in the District of Columbia (DC) are experiencing in their efforts to integrate school gardens into the curriculum and the culture of their schools. Exploring the impacts of the school garden on the students, the local community, and the inter-generational relationships at and beyond schools, the authors aim to shed light on the benefits and the challenges. While Washington, DC is fostering its hope that the benefits prevail as it

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provides a model for other cities to follow, the authors also candidly present the challenges of implementing these policies. In the final part, they discuss the implications of their findings for school gardens and sustainable learning cities more broadly. They encourage further research to gain more insights into effective ways of promoting environmental literacy and to consolidate the transferability of this model.

Keywords Garden-based learning · School gardens · Sustainability · Sustainable learning cities · Education policy

Résumé L'apprentissage en milieux informels peut-il réduire l'inégalité et favoriser la pérennité urbaine ? Jardins scolaires à Washington (États-Unis) – Le présent article explore les opportunités éducatives fournies aux écoliers par les jardins scolaires, et parallèlement leur contribution à réaliser le développement durable dans les villes. Les auteurs abordent cette démarche entamée à Washington, métropole particulièrement innovante des États-Unis. La capitale fédérale est fière de posséder deux types de législation parmi les plus progressistes, destinées à améliorer la prise de conscience écologique et à inciter les citoyens à s'engager dans la gestion de l'environnement, toutes deux s'adressant en particulier aux écoliers : la loi sur les écoles saines de 2010 (*Healthy Schools Act)* et celle de 2012 sur le développement durable dans le district de Columbia (*Sustainable DC Act)*. Ces politiques visent ensemble à favoriser auprès des élèves et des familles du district les modes de vie sains et à les sensibiliser à l'écologie, par exemple à travers des expériences éducatives enrichissantes en extérieur. L'article est organisé en trois parties. La première analyse comment Washington est devenue ville apprenante pérenne grâce à la mise en œuvre de ces politiques spécifiques. La seconde partie présente les résultats d'une étude pilote menée dans un jardin d'enfants et jusqu'à la 5^{e} année d'une école primaire située dans le quartier 8, le plus défavorisé de Washington. Dans leur analyse, les auteurs examinent les soutiens dont bénéficient les enseignants et directeurs d'écoles du district ainsi que les obstacles qu'ils rencontrent dans leurs efforts d'intégrer les jardins scolaires dans le programme et la culture de leurs établissements. Les auteurs explorent en outre les impacts du jardin scolaire sur les élèves, la communauté locale et sur les relations intergénérationnelles dans l'école et à l'extérieur, et tentent ainsi de faire la lumière sur les avantages et les défis. Si la Ville de Washington nourrit l'espoir de voir les bienfaits l'emporter puisqu'elle fournit un modèle à suivre par d'autres villes, les auteurs détaillent également en toute franchise les défis rencontrés dans l'application de ces politiques. En dernière partie, ils analysent les implications de leurs résultats pour les jardins scolaires et plus généralement pour les villes apprenantes pérennes. Ils préconisent une recherche complémentaire pour approfondir les données déjà obtenues sur les moyens efficaces de promouvoir l'initiation à l'écologie ainsi que de consolider la transférabilité de ce modèle.

Introduction

How does a school garden programme provide learning opportunities and help produce more environmentally literate students? How does a citywide school garden programme contribute to a city's sustainability efforts? This article speaks to these questions by attempting to address how school gardens provide learning opportunities for school-aged children while concurrently helping cities achieve sustainability. We analyse this process in one particularly innovative city in the United States: Washington, DC. This national capital city boasts two of the most progressive examples of legislation aimed at improving environmental awareness and inciting citizens to engage in environmental stewardship, both of which focus on school-aged children, the *Healthy Schools Act of 2010* (DC OSSE 2010) and the *Sustainable DC Act of 2012* (CoDC 2012).

Sustainability-related policies build on the extant literature on youth wellness, nutrition, environmental literacy and academic achievement. Research has found that black and poor children spend less time in activities that promote physical, cognitive and social capabilities (see particularly Bohnert et al. 2010; Fletcher et al. 2011; Hofferth and Moon 2012). At the same time, there is evidence that school gardens positively influence academic achievement (e.g. Blair 2009; Klemmer et al. 2005a; Fisher-Maltese 2013; Williams and Dixon 2013; Ray et al. 2016), nutritional habits (Nanney et al. 2006), exercise (Dillon et al. 2006) and environmental attitudes (Fisher-Maltese 2016). There is still a lack of research focusing on the relationship between school gardens and academic achievement across race and social class. Unfortunately, we, too, found it difficult to explore racial and social class differences in our pilot study due to the lack of variation in our sample school which, being located in Ward 8, the poorest part of the city, was populated predominantly by black, underprivileged students.

In addition, although there is an implicit expectation that children's learning in school garden programmes will have spillover effects on family health behaviours, empirical evidence is as yet lacking. This study helps fill these gaps by examining a school garden in one urban setting – Washington, DC – where these policies are in place and supported by local government. The District of Columbia Office of State Superintendent of Education (DC OSSE) and a national organisation (FoodCorps) both provide institutional support for gardens in the public (state-run) schools. Our research set out to explore the effects of school gardens on students and their families. While we were able to find out some effects on students, data limitations, which we will later discuss, prevented us from being able to draw conclusions about the students' families.

The political constraints of teaching

The present time is a complex one with concurrent policies often rife with conflicting messages. We are still navigating in an era driven by accountability and data. The *No Child Left Behind Act of 2001* (NCLB; GoUSA 2002) left a legacy of high-stakes testing with several unintended consequences. Teachers and students

feel the impacts daily as curricula are narrowed and outdoor time, physical education and the arts are limited to focus instead on tested subjects, reading and maths, particularly in low-performing schools in urban centres. Even with reauthorisation of *The Elementary and Secondary Education Act of 1965* (ESEA; GoUSA 1965) in December 2015 and the passage of the *Every Child Succeeds Act of 2015* (ESSA; GoUSA 2015a), the focus on testing remains, although more power has been transferred back to the states from the federal government. In a type of Machiavellian[1] food chain, students are evaluated on mandated tests, teachers are evaluated on their students' test scores, and schools are evaluated on student and teacher performance. Failure to show proficiency has dire consequences at multiple levels. Interestingly, in spite of a hyperfocus on academic subjects, health and wellness policies have meanwhile also gained popularity. Former First Lady Michelle Obama has helped to shine a light on the national childhood obesity epidemic and advocated for eating healthily and for establishing school gardens. The *National School Lunch Program* (NSLP), which was introduced in 1946,[2] has been improved over the years. Lunches have become healthier, contain more fruit and vegetables, and less fat, salt and sugar. Competitive foods[3] have been limited in schools. The NSLP has been even further improved through efforts to serve produce from local farms, as well as schools' own gardens. Both federal legislation, such as the *Farm-to-School Act of 2015* (GoUSA 2015b), and local Washington, DC legislation, discussed below, support such efforts. However, the focus on academic subjects and performance on mandated tests limits success of health and wellness policies as teachers are simultaneously discouraged and encouraged to engage their students in meaningful outdoor learning experiences, such as field trips to local farms, which may take time away from extended maths and language arts blocks. Thus, school gardens are one way to diminish some of these political constraints to teaching.

School gardens as personalised, informal and outdoor learning spaces

Our study comes at a time when there is growing interest in understanding how people learn in informal settings. In the spring of 1999, the Board of the National Association of Research in Science Teaching (NARST)[4] established an ad-hoc

[1] This term is derived from the name of Italian philosopher Niccolò Machiavelli (1469–1527). His most famous book, *The Prince*, features a unscrupulous politicians who employ clever and dishonest tricks to achieve personal gain. Machiavellianism refers to these characteristics.

[2] The National School Lunch Program (NSLP) was established under the National School Lunch Act (GoUSA 1946), signed by President Harry Truman in 1946. For more information, see https://www.fns.usda.gov/nslp/national-school-lunch-program-nslp [accessed 2 Aug 2017].

[3] The term "competitive foods" refers to snacks sold to students on school campus (from vending machines or student stores) in competition with (hence the name) federally reimbursable healthy school meals served in a school's dining hall.

[4] The National Association of Research in Science Teaching (NARST), founded in 1928 and headquartered in Reston, VA, promotes, according to its own website at https://www.narst.org/ [accessed 2 Aug 2017], "research in science education and the communication of knowledge generated by the research. The ultimate goal of NARST is to help all learners achieve science literacy."

committee focused on out-of-school science education and experiential learning. The consensus policy statement (Dierking et al. 2003, issued after two years of collaboration between researchers from a variety of fields and science museum practitioners, outlined several aspects of learning that directly connect to the categories of learning our study documented in a school garden. More recently, the National Research Council (NRC) released *Learning science in informal environments: People, places, and pursuits* (Bell et al. 2009), in which learning in informal science contexts is described as

> learner-motivated, guided by learner interests, voluntary, personal, ongoing, contextually relevant, collaborative, nonlinear, and open-ended (ibid., p. 11).

Moreover, students who engage in informal learning settings are found to be more likely to view themselves as scientists as a result of participating in informal learning environments (ibid.).

A school garden falls under the broad definition of an informal learning environment (Bell et al. 2009), although museums are more commonly described in the literature. Learning experiences in these informal contexts are characterised as learner-motivated, interest-based, voluntary, open-ended, non-evaluative and collaborative (Falk and Dierking 2000; Griffin 1998; Rennie 2007). Philip Bell et al. (2009) summarise the importance of these settings,

> Informal environments can be powerful environments for learning. They can be organised to allow people to create and follow their own learning agenda and can provide opportunities for rich, social interaction. While this potential is often only partially fulfilled, research that illustrates experience in informal environments can lead to gains in science knowledge or increased interest in science (ibid., p. 311).

Major national organisations have shown support for informal science learning opportunities as a means to improving science literacy. Importantly, in order for future generations to address serious environmental issues, both in-school and out-of-school resources must be tapped (AAAS 1993; NRC 1996).

These findings regarding informal learning settings gain importance in considering the fact that minority and poor students are less likely than their more advantaged peers to engage in activities that align with academic achievement and view themselves as scientists and other professions, such as public servants or teachers. Consequently, minority and poor students may be less likely to pursue science, technology, engineering and mathematics (STEM) careers (Fenichel and Schweingruber 2010; see also Lareau 2002). A report from the National Academy of Sciences (Bell et al. 2009) notes that experiences in informal settings can improve science learning outcomes for groups that are historically underrepresented, such as women and minorities. As a result, major national organisations have shown support for informal science learning opportunities as a means to improve science literacy and address serious environmental issues (AAAS 1993; NRC 1996).

The role of education is also noted by scholars who look specifically at environmental engagement. In a book chapter entitled "Youth participation in local

environmental action: an avenue for science and civic learning?", Tanja Schusler and Marianne Krasny note that participation in local environmental activities can "contribute to positive learning experiences for some youth but not for others" (Schusler and Krasny 2008, p. 280), and that "[t]he engagement of individual youth and the depth of their learning may vary widely" (ibid., p. 268). It is unclear, however, what exactly explains the variation in experiences the authors note. One potential way to analyse this variation is to look at school gardens, which provide an increasingly common setting as an informal learning environment (Bell et al. 2009; Fisher-Maltese 2013). The idea is not actually new; John Dewey, one of the Progressive Era's central figures,[5] already saw the utility of gardening in education at the beginning of the 20th century. In *Schools of Tomorrow* (Dewey and Dewey 1915), Dewey and his daughter detailed several experimental schools that incorporated active learning through nature study and working school gardens. They concluded that school gardens incorporate best-practice pedagogy into instructional practice through participation in real-life activities. More recently, school gardens have become a popular tool for environmental education initiatives (Skelly and Zajicek 1998; Waliczek and Zajicek 1999), and over 3,000 school gardens are currently being cultivated across the United States for educational purposes (NGA 2010). In the District of Columbia alone, there are over 120 working school gardens (Kang 2016).

So-called "garden-based learning" programmes have been found to have numerous positive effects on students. Academically, studies note that garden-based curricula improve the academic achievement of students (Blair 2009; Dirks and Orvis 2005; Klemmer et al. 2005a, b; Smith and Mostenbocker 2005; Fisher-Maltese 2013; Williams and Dixon 2013). A synthesis of garden-based learning research 1990–2010 prepared by Dilafruz Williams and Scott Dixon in fact shows positive impacts on direct academic outcomes for all students (irrespective of their ethnicity, socioeconomic background etc.) with the highest positive impact on science, followed by maths and language arts (Williams and Dixon 2013). Given these findings, it is conceivable that the informal learning setting of school garden programmes has the potential to play a role in decreasing the racial test score gap and the lack of ethnic minority students in science fields (see Ray et al. 2016).

"Garden-based learning" programmes also have positive effects beyond classroom academic achievements. Research has found that school gardens improve nutritional habits by encouraging children to eat more vegetables (Lineburger and Zajiceck 2000; Nanney et al. 2006), increase students' environmental awareness (Skelly and Zajicek 1998; Waliczek and Zajicek 1999; Fisher-Maltese 2013), provide an opportunity for exercise (Dillon et al. 2006), and advance social and emotional growth (Waliczek et al. 2000; Fisher-Maltese 2013). In fact, one of us (Fisher-Maltese 2013) found that a garden-based science curriculum for second-graders on insects resulted in a number of beneficial applications, including science learning, cross-curricular lessons in an authentic setting, a sense of school

[5] The Progressive Era (c. 1890–1920) was characterised by widespread social activism and political reform across the United States. Philosopher and educational reformer John Dewey (1859–1952) was a proponent of *progressive* education which promoted hands-on experiential learning, collaborative projects etc.

community, and positive shifts in attitude towards nature and working collaboratively with other students.

Studying school gardens in Washington, DC

Washington, DC presents an eminent example of a sustainable learning city. As we already mentioned in our introduction, this particularly innovative metropolis boasts two of the most progressive examples of legislation aimed at improving environmental awareness and inciting citizens to engage in environmental stewardship: The *Healthy Schools Act of 2010* (DC OSSE 2010) and the *Sustainable DC Act of 2012* (CoDC 2012). Strategically, both policies focus on the future of the capital city: school-aged children. In the next paragraphs of this section, we will discuss each Act in turn.

The *Healthy Schools Act of 2010* was unanimously passed by the City Council of the District of Columbia in August 2010. The Act aims to "improve the health, wellness, and nutrition of the public and charter school[6] students in the District of Columbia" (DC OSSE 2010). The *Healthy Schools Act* calls for an Environmental Literacy Plan for the District, which would bring environmental education, including meaningful outdoor learning experiences, to school-aged children in the District of Columbia. Building on the momentum for urban agriculture, local foods and school gardens, the Act formally provides resources to support school garden programmes that have been initiated by teachers and principals throughout the District. According to the website of the District of Columbia Office of the State Superintendent of Education (DC OSSE), "OSSE's School Gardens Program team assists schools in building and maintaining school gardens and provides training and technical assistance to teachers in utilising school gardens as a teaching tool" (DC OSSE 2014a). One of the major components of the programme involves the distribution of competitive grants that support the creation and maintenance of school gardens as part of the schools' curricula and broader programmes. According to the DC OSSE *District of Columbia Healthy Schools Act of 2010 Farm-to-School & School Gardens Reports*, July 2012–July 2016 (DC OSSE 2013, 2014b, 2015, 2016), 45 grants have been distributed throughout the District since 2012.[7] It is notable that some schools have been awarded grants for more than one cycle. Although DC OSSE has been conducting its own assessment of these gardens, little is known about the impacts of the programme on the students participating in the school garden programme and their families.

[6] In the United States, public schools are state-run schools, and charter schools are publicly funded independent schools established by teachers, parents, or community groups.

[7] Because there were four two-year funding cyles (2012–2016), and some schools received grants during more than one cycle, 45 grants have been distributed to 33 schools. This information was obtained through personal communication with Sam Ullery, School Garden Specialist, Office of the State Superintendent of Education (OSSE).

School gardens are being cultivated all over the District of Columbia.[8] Figure 1 shows the distribution of active school gardens for all grade levels in Washington, DC during the period 2012–2015. The large dots present all active school gardens in 2015. The green stars indicate schools that were supported through grants from DC OSSE, the yellow stars indicate schools that were supported through the national FoodCorps programme,[9] and the red triangles indicate schools that were supported by both programmes. The map on the left presents the distribution of school gardens by the percentage of black residents across Washington, DC and the map on the right presents the distribution of school gardens by median household income in the neighbourhood. As the maps illustrate, Washington, DC is highly segregated by race and income. At the same time, school gardens seem to be relatively evenly distributed throughout the city's eight Wards. These characteristics, along with the policy context, made Washington, DC an ideal location to conduct this study of school gardens as a tool for sustainable learning.

The second policy is the *Sustainable DC Act of 2012* (CoDC 2012), which was amended and signed into law in July 2014. According to the Sustainable DC Mayor's Order, the Act aims to make the District of Columbia, "in one generation, the healthiest, greenest, and most liveable city in the United States" (Gray 2013). The amendment, the *Sustainable DC Omnibus Amendment Act of 2014* (CoDC 2014), which comprises seven components, is perhaps best known for banning Styrofoam in the District.

Research design and methods

The analysis we present in this article is based on a pilot study of a garden-based curriculum which uses a school garden as an informal setting in Washington, DC. The research team included ourselves, Carley Fisher-Maltese (Principal Investigator), Dana R. Fisher (Co-Investigator) and Rashawn Ray (Co-Investigator). Our team was complemented by one educator from a non-profit organisation called Kid Power, one volunteer from another non-profit organisation called FoodCorps, and the Grade 5 students' regular classroom teacher. Data were collected through participant observation in a classroom during lessons before and after the students spent time out in the garden, along with a pre-test post-test assessment of the garden-based curriculum. The study was carried out in in one fifth-grade classroom[10] of a sample school located in a poor (100% eligible for free and reduced lunch), predominantly black (97% Black, 3% Latino) K-5 elementary school in Ward 8 of Washington, DC. The school is considered a low-performing school (in 2013–2014, 73% of the students were below proficient in maths and 80%

[8] For pictures of some of these school gardens, visit DC OSSE's extensive collection at https://www.flickr.com/photos/dcschoolgardens/sets/ [accessed 25 August 2017].

[9] For more information on the national FoodCorps programme, see https://foodcorps.org/ [accessed 25 July 2016].

[10] Children in the United States start kindergarten (K) at age 5, then progress to primary school (Grades 1–5) at age 6. These first stages of education are often collectively referred to as K–5. Our Grade 5 participants were 10 and 11 years old.

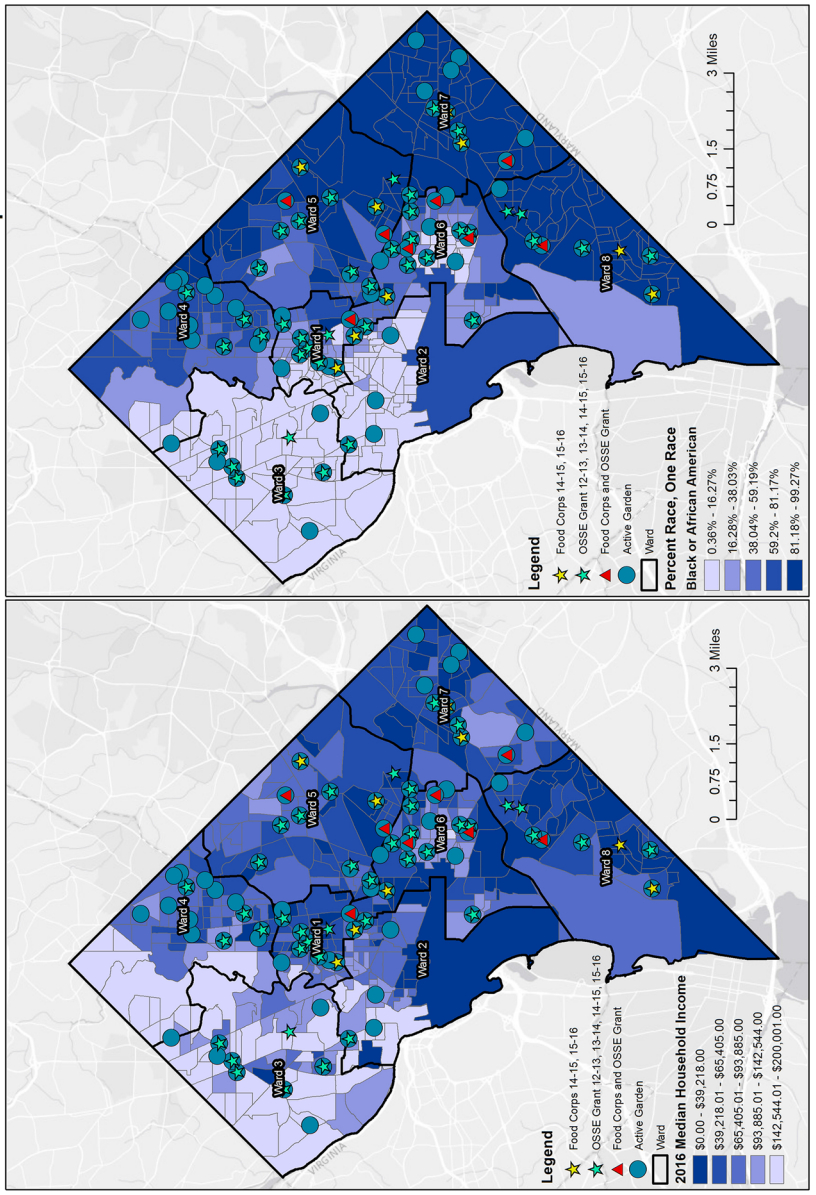

Fig. 1 Maps of school gardens in the District of Columbia. Source: Authors

were below proficient in reading); many students have since left to attend local charter schools in the city. Initially, the entire twenty-student class ($n = 20$) of fifth-grade students who were learning in the garden participated in our study;[11] however, only 10 verifiable students took both the pre- and post-tests. Fifth grade was selected because in Washington, DC students at that point in their education take a standardised Partnership for Assessment of Readiness for College and Careers (PARCC) test[12] in the areas of science and health. We felt that starting our pilot project with fifth grade would give us the best chance of capturing the effects of elementary-education exposure to a garden-based curriculum. The school garden consisted of several raised beds surrounded by mulched paths and a chain-link fence.

The science and nutrition garden-based curriculum in place at this particular school since 2015 was designed by the partner non-profit organisation, Kid Power, and is called "Veggie Time".[13] Garden-based lessons were taught once a week for 45 minutes from September to November and then from January to March. Lessons were facilitated by an educator from Kid Power and a FoodCorps fellow, who was placed at the school for one year to help with the school garden. The garden is located adjacent to a blacktop (tarmac) area and picnic tables. The blacktop had previously had several basketball hoops, but the principal had them removed prior to the study to discourage destructive teenagers from loitering on the property after school hours.

Our pilot study entailed the collection and analysis of multiple types of data to gain insights into the ways in which school gardens operate as a gateway to reducing race and class inequalities and how they impact healthy behaviours and academic achievement. To understand impacts on academic achievement, nutrition and physical exercise, we designed and administered pre-/post-tests to assess science and nutrition content knowledge and student attitudes towards the garden, the environment and being physically active. Pre-tests were administered the same week the curriculum was initiated (September 2015), and post-tests within one week of curriculum completion (May 2016). Pre-/post-tests included a total of 8 questions, some of which were multiple choice and some of which were open-ended. Students were given as much time as they needed to complete the test. It took most approximately 20 minutes. The questionnaires, which asked for factual knowledge as well as personal attitudes, were designed to elicit students' understanding of plants, measurement (e.g. size of the raised bed, space between

[11] While the gardening sessions were not mandatory for all fifth-grade students, they were mandatory for students whose teacher decided to participate. Our sample class therefore included both students who might already have had an interest in gardening and students who did not.

[12] For more information about the PARCC test, see https://parcc.pearson.com/ [accessed 23 August 2017].

[13] For more information about Veggie Time, see http://www.kidpowerdc.org/our-programs/the-veggietime-project [accessed 3 August 2017].

Table 1 Sample of questions from our pre-/post-test

Measure	YES	SOMETIMES/MAYBE	NO
I like eating vegetables			
I like spending time in the school garden			
I help cooking food at home			
It is important that my school has a garden			
I know how to take care of the garden			
Learning how to garden is important			
I eat things grown in the school garden			
I like working with other students in the garden			
I will try new foods at least once			
I read the nutrition label on foods I eat			
I throw all my trash in a trash can when I am outside			
I think it is important to be physically active (play, sports, run, jump rope, etc.)			

seeds or plants), decomposers, ecosystems, and healthy eating and exercise habits. While we did obtain responses from the students to the questions about behaviour included in the pre- and post-tests (Table 1), one limitation of the study is that actual observations of behaviour were limited to anecdotal evidence, and to references in field notes taken by members of the research team took during garden lessons.

Second, building on research by Susan Adams et al. (2007) which uses grocery receipt data to study the influences of economic constraints on food choices and behaviours, we also investigated how family food purchases change (or not) after students have participated in the school garden curriculum. We asked participating households to submit copies of grocery receipts to determine whether or not a student's participation in a school garden curriculum could influence the health and wellness decisions of heads of households. Before students entered the garden for the first time, researchers asked them for their parent's grocery shopping receipt from any of the local major supermarkets where food items were purchased for a

given time period. After the students had completed their last gardening class in the curriculum, we once again collected a parent's grocery store receipt where food items were purchased over the course of the curriculum. The objective of collecting grocery receipts was to determine what effect the school garden has on the food purchases of families. Our study assessed the degree to which children's learning about food and health in school gardens influences how their families eat at home and what they purchase at grocery stores.

Data analysis

We put the grocery receipts through a receipt scanner, and then analysed the caloric content of the purchased foods to compare whether families were potentially eating healthier. Our pre-/post-tests primarily assessed science and nutrition content knowledge, but also contained questions that measured attitudes towards gardening and the environment. We analysed the pre-/post-test data using a rubric we had developed ourselves. Using a statistical software called STATA, we conducted paired sample *t*-tests on the pre-/post-tests.

Results

Regarding the grocery receipts, unfortunately only two families submitted receipts before and after the school garden sessions. As a result, we were unable to assess these data fully.

Our pre-tests and post-tests were administered to all participating students (n = 20). However, only 12 students took both the pre- and post-tests, and 2 students did not put their names on their post-tests, limiting the number of usable data (n = 10). Questions were categorised as either "knowledge" questions (6 questions; maximum total score = 26) or "position" questions, which described attitudes or opinions (2 questions; maximum agreement = 23, maximum disagreement = 89). Due to the reverse coding in both variables, low answers indicate greater agreement and positivity.

The pre-test assessment was conducted at the beginning of the curriculum in September 2015. The results of the assessment suggested that the students had a general level of knowledge about food and nutrition, with the 10 participating students earning a 54 per cent average on the knowledge component of the pre-test. Interestingly, when shown pictures of different kinds of fruit and vegetables and asked to circle which grow locally, all of the students answered that bananas grow in Washington, DC. This surprising finding confirmed the suspicion that students lack knowledge about where their food comes from, and specifically what kinds of fruit and vegetables grow in their local area. Interestingly, in terms of attitude, the students started the curriculum with a relatively positive position on environmental awareness.

The post-test assessment was conducted after the garden-based curriculum was concluded in spring 2016. Although most students in the class completed the curriculum, their scores on the *knowledge* component of the assessment did *not*

increase. In fact, the class earned a 45 per cent average score; the overall scores went down, indicating that the students did not show student learning gains. However, despite this decline in scores, the differences in scores before and after the garden-based curriculum were not statistically significant. A paired *t*-test did not yield positive significant pre/post differences for the knowledge questions on the test (pre-test: M = 14.5, SD = 2.7; post-test: M = 11.3, SD = 3; $t(9) = 0.03$, $p = 0.49$ (two-tailed), $d = 8$).

In contrast to the knowledge questions, the *position* questions, which measured environmental attitudes, did go up. Students' level of engagement and enthusiasm seemed to increase as a result of participating in the school garden lessons. In several responses to questions about environmental attitudes on the post-test, students' position scores indicate an increase in environmental awareness (the average score went up from 1.4 to 1.1). In this case, a paired *t*-test did yield positive results. However, the results were not statistically significant for the position questions on the test (pre-test: M = 40.3, SD = 7.4; post-test: M = 38.1, SD = 12.2; $t(9) = 0.34$, $p = 0.37$ (two-tailed), $d = 8$). It is worth noting that these results' lack of statistical significance is due, in part, to the small number of participants (n).

Conclusions

As mentioned at the beginning of this article, our pilot study set out to answer two research questions: (1) How does a school garden programme provide learning opportunities and help produce more environmentally literate students? and (2) How does a citywide school garden programme contribute to a city's sustainability efforts?

With a limited sample size and results showing that students' scores in factual knowledge went down from pre- to post-test, our findings were not consistent with what we had hoped. It emerged that several challenges are creating barriers, preventing the positive intentions of school gardens at the institutional level from being realised at the classroom level. One main challenge we faced during this study was a lack of parental cooperation in terms of providing data for the research project. Unlike research sampling adults, conducting studies with children involving data collection components inside and outside of schools is fraught with problems for researchers. In addition to liaising with parents to explain the importance of a particular study, such as ours, bureaucracy operates as a barrier to data collection. As noted above, the students were engaged in the school garden and enthusiastic about having an outdoor, personalised learning space to study plants, different kinds of fruit and vegetables. Researchers need to think of more innovative ways to connect with parents to gain consent and participation in studies with multiple parts and a variety of data and variables.

Another issue is the fact that the intervention was particularly low dosage in that students only went out to the garden once a week for 45 minutes, and missed certain weeks for a variety of reasons (e.g. weather, school holidays, and the teacher's decision to devote time to academic content outside of the garden curriculum). Such

a low level of exposure to garden-based learning is presumably not enough to effect a significant measurable impact.

Finally, teacher participation was a challenge. As mentioned above, teachers have a multitude of pressures to balance, and the period in the garden led by the FoodCorps volunteer was viewed by the students' regular teacher as time to catch up on work or work with struggling students (who then had to miss their gardening session). The teacher frequently did not accompany her students to the garden session, which suggests that she did not integrate the lessons in the garden into her broader curriculum. Moreover, it suggests that she will not be implementing the lessons on her own in the future in the absence of the FoodCorps volunteer or Kid Power educator.

In spite of the above-mentioned limitations, we believe there is are lessons to be learned and insights to be gained from this pilot study. Clearly, future research is necessary to fully understand the associated challenges and to determine the specific reasons why, as suggested by some of the existing research we discussed in the introduction of this article, school gardens do seem to matter for academic achievement and other health and lifestyle-related outcomes. Obtaining information through collecting grocery receipts that must transfer from parents to students to teachers over the course of time may not be ideal. Researchers can, however, interview students and administer surveys to determine what was being eaten at home before immersion in the school garden compared to family meals following exposure to the garden-based curriculum.

Washington, DC as a model city

This research contributes to understanding one way in which we can create more environmentally literate citizens, namely through school gardens that educate young people. It also demonstrates how a city-wide school garden programme can contribute to a city's sustainability efforts, which involve progressive legislation, such as the *Healthy Schools Act of 2010* (DC OSSE 2010) and the *Sustainable DC Act of 2012* (CoDC 2012). Our findings speak to decision makers who want to engage more diverse populations in civic and environmental activities. In addition, these findings provide insights into a potential leverage point (garden-based learning in schools) to reduce the racial gap in standardised testing. These findings also contribute to our understanding of better ways to engage members of ethnic minorities and socioeconomically disadvantaged individuals in environmental participation. Although many school garden programmes in Washington, DC and other cities include participation by parents and community members, we did not observe multiple generations of family or community members participating in our sample school. It is likely that such participation is more limited in a poor community such as Ward 8 where we conducted our research. Future research is also needed to explore ways to engage families and communities from these kind of neighbourhoods in cities' sustainability plans.

This pilot study has broader impacts than the school garden programme in Washington, DC. The research team has worked with the DC Office of the State Superintendent of Education (DC OSSE), which is providing access to garden

assessments and test score data gathered in studies carried out across the District of Columbia. DC OSSE plans to facilitate the dissemination of the study's findings on the effect school gardens have on environmental engagement to relevant stakeholders. In this regard, dissemination will go beyond presentations at academic conferences and articles in academic journals to also include addressing a broader, more policy-oriented audience. Our hope is that, in spite of the study's modest conclusions, it can be used as a springboard for additional research which can better capture the benefits of garden-based learning which are often cited in anecdotal evidence from school garden programming, as well as the rationale behind the kind of extensive institutional backing being accorded to school gardens in the District of Columbia. Moreover, as the Deputy Superintendent of DC OSSE commented in a telephone conversation, this project has potential broader impacts on the school garden movement in the United States. In her own words, it "could serve as a model for national policy and research on the issues of school gardens and their relationship to student achievements, families, and the surrounding community" (personal communication). In other words, a fuller evidence-based understanding of the impacts of the DC school garden programme on students and their families would provide important insights for stakeholders involved in the rapidly growing number of school gardens in the United States, and potentially also in other parts of the world. Research such as this pilot study contributes to policy discussions about how to address barriers to environmental participation among all children, and is particularly relevant to policy interventions targeted at the most disadvantaged children.

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