Nature as Partner: How School Communities Benefit from Ecological Connections

Cynthia L. Hron

Abstract How have schools partnered with nature—as an architectural influence and pedagogical framework—to improve the campus experience for their communities? Influenced by John Dewey's web of life concepts as a position to consider the interrelations between schooling and life, this chapter explores the benefits to schools and their communities of partnering with nature to support academic, physical, and mental well-being. Dewey believed that public education had a fundamental responsibility to support young people to understand the world around them. Public-school examples in the United States are discussed, as shaped by green infrastructure initiatives; ecosystem services; biophilic design; and community hub constructs. In this context, the motivations of stakeholders to develop partnerships between schools and nature are identified and were found to relate to desires for environmentally sustainable infrastructure, developing community networks—socially and ecologically—and delivering health and wellbeing benefits for students, teachers, professional staff, and members of the broader community.

Keywords Nature · Schools · Green infrastructure · Ecosystem services · Biophilic design · Community

Introduction

What choices would we make about school facility design if we started over? Following a devasting tornado in 2007 that destroyed 95% of the town's infrastructure (Bickel, 2017) the town of Greensburg, Kansas faced this question—including the Kiowa County School District (Fig. 1). Greensburg's residents could have rebuilt their community as it had been, instead they adopted a more sustainable approach. In

C. L. Hron (✉)
164 Westwood Drive, Winfield, PA, USA
e-mail: cindihron@gmail.com

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Fig. 1 Greensburg, Kansas, following the tornado (Photo by Greg Henshall for FEMA)

the months that followed, federal[1] and state agencies helped the town establish long-term recovery goals, and the United States Department of Energy and the National Renewable Energy Laboratory joined community leaders, business owners, and residents to devise ways to integrate sustainable building practices into the town's new infrastructure. Together they formed a non-profit organization, the Greensburg Green Town, to aid development of a master plan and to procure resources to support the rebuild.

A New Vision for a Sustainable Community

By May of 2008, the community had created the Greensburg Sustainable Comprehensive Plan. This plan aimed to develop a "truly sustainable community ... that balances the economic, ecological, and social impacts of development" (United States Department of Energy, 2012, p. 10). Through this process the residents of Greensburg acknowledged the importance of the natural environment to their long-term goals and identified the need to incorporate sustainable practices into their recovery efforts. They recognised that to rebuild their town meant more than structures and that green development could provide the infrastructure needed and generate a more vibrant

[1] Federal Emergency Management Agency (FEMA) Following the devastation of the tornado, FEMA worked with Kansas State Government and the Environmental Protection Agency to draft a Long-Term Recovery Plan, finalized, and presented to Greensburg residents August 15, 2007.

Fig. 2 The Kiowa County Schools designed by BNIM Architects (Photograph by Assassi)

and liveable community; one that balanced economic recovery and growth with community health and wellbeing.

Part of this vision included the adoption of an ordinance that all city-owned buildings over 4000 square feet (371.6 sm) must be designed to Leadership in Energy and Environmental Design (LEED[2]) Platinum rating certification standards, providing a minimum 42% energy saving (United States Department of Energy, 2012). Working with BNIM Architects, stakeholders of the Kiowa County Schools district, including students, played an important role in consolidating a new school into a single location on Main Street, where shared use facilities could be made accessible for adult education and senior citizen activities (BNIM, 2010a). A large K-12 school was developed of 125,000 square feet (11,613 sm), featuring 23% renewable energy produced on site and 72% energy savings compared to typical existing schools.[3]

Today, Kiowa County Schools (Fig. 2) features an onsite wind generator, closed loop ground source heat pump and fluid cooler, and energy recovery ventilators. Buildings have been sited to take advantage of natural daylight and passive solar gains by season. Students view native prairie grasses and windmills from classroom windows, exposing them to local ecology and renewable energy production (BNIM, 2010b). Underscored by near perfect ratings for water efficiency, indoor environmental quality, innovation, energy and atmosphere, the school was LEED Platinum certified in 2011.

[2] United States Green Building Council is a non-profit organization that oversees LEED certification process and standards, based in Washington, DC.

[3] Kiowa County Schools' energy savings were featured as a case study for *Advanced Energy Design Guide for K-12 School Buildings: Achieving 50% Energy Savings Toward a Net Zero Energy Building* (ASHRAE, 2011).

Community-Informed Decision Making

The development of Kiowa County Schools cannot be discussed outside its context. It is the product of a community informed decision-making process in response to devastation by nature's forces, but also empowered by partnering with nature to rebuild infrastructure and community. School siting places the school as social centre. School building and landscape design reinforce connections to local ecology with native planting, views of Kansas prairieland in the distance and, energy and watershed practices demonstrated on campus. This example demonstrates the co-benefits of architectural influence and pedagogical framework to create a learning landscape that supports young people in understanding the world around them.

There are over 98,000 public school facilities in the United States on over 2 million acres (809,371 ha) of land (Filardo & Vincent, 2017). Public schools are uniquely situated to provide contact with nature and demonstrate community scale environmental stewardship. Studies from several disciplines support the hypothesis that contact with nature is good for people, especially children (e.g., Berman et al., 2008; Berto, 2005; Bowman et al., 2016; Danks, 2010; Dewey, 1943; Dyment & Bell, 2007; Louv, 2011; Orr, 1994; Razani et al., 2018).

Dewey's Web of Life

Over one hundred years ago, philosopher John Dewey proposed that schools had a fundamental responsibility to aid young people in understanding the larger world, prepare them for citizenship and active engagement in the social, spiritual, and intellectual aspects of community life. This meant that pedagogical practice needed to connect school to home, be experiential, and interdisciplinary. Learning needed to build on itself to construct mental models and inform decision making. Schools as social centres, he advocated, should bring people together, promote empathy, and facilitate understanding of difference (Dewey, 1902). Dewey advocated for distinctive facilities with school buildings designed in connection with the grounds to reflect each community's educational vision (Wirth & Bewig, 1968). Dewey's work co-occurred with other influential social movements and activists: the City Beautiful Movement, an architectural and landscape architecture response to deteriorating living conditions following Industrialization; Jane Adam's and Ellen Starr's Hull House, an early settlement house in Chicago offering multiple social services based on the model of Toynbee Hall in London's East End; and Colonel Francis Parker, director of the Cook County Normal School for Teacher Training, whom Dewey referred to as the *father of Progressive Education*. To Parker and Dewey, school was the training ground for good citizenship (Cooke, 2005; Gross, 2009). In essence, schools need to model the community they want to be.

Dewey's influence can be seen in many community school initiatives in the United States. The Coalition for Community Schools and the Institute for Educational Leadership advocacy groups have outlined a hopeful vision of community schools from a Deweyan perspective (Melaville et al., 2011). For a little over a century the community school movement in the United States has looked to Dewey's example of *school as social centre* (Blank et al., 2003). Common community school characteristics encompass family support centres, health and mental health services, early childhood and after school programs, adult learning, partnerships with businesses and civic groups, and shared use of facilities after school hours (Melaville et al., 2011). Expanding on the more traditional community hub characteristics are partnerships and initiatives designed to connect schools and school districts to their local ecology. Place-based education is described as immersion in local ecologies, cultures, and heritage as a foundation for studying math, language arts, and sciences (PEEC, 2004). In this way community school initiatives align Dewey's educational philosophy with experiential and interdisciplinary learning within the framework of citizenship and community life.

This chapter profiles five schools where stakeholders have made facilities design and curriculum choices that have created opportunities for students and community residents to bridge the relationship between schools and local ecology. Each example is unique to its context and provides insight into what practices are being implemented and how partnerships can be leveraged to advance schools as places to connect with nature.

Research Design

This chapter examines schools that self-identify as having green infrastructure, ecosystem services, biophilic design, and/or community hub characteristics. It also seeks to identify the stakeholders, partnerships, and design decision making processes that contribute to sustainable practices and, in turn, support health and well-being through connections to nature. Further, the chapter seeks to identify the co-benefits of school building and grounds design influenced by green infrastructure, ecosystem services, and biophilic design to forge connections between school community and local ecology.

School profiles were developed using multiple sources, including site visit data, informal interviews with school administrators and staff, project profiles created by architects, American Society of Landscape Architects (ASLA) case studies, Sustainable SITES Initiative (SITES) case studies, US Green Building Council's Leadership in Energy and Environmental Design (LEED) project profiles, Landscape Architecture Foundation (LAF, 2017) performance series, school websites, and journal articles.

Three themes related to community partnerships, focused on nature-based connections, provided a conceptual framework for developing the school profiles:

- Green Infrastructure (GI), as defined by LEED certification criteria.
- Biophilic design (Kellert et al., 2008).
- Ecosystem services, as defined by World Wildlife Fund (WWF).

Green Infrastructure (GI)

The Centre for Green Schools, a department of the US Green Building Council defines criteria for LEED certification and provides guidance and resources to schools interested in obtaining LEED certification. Their mission has three goals:

- Minimize environmental impact.
- Improve occupant health.
- Foster environmental and sustainability literacy.

In 2019, The Centre for Green Schools reported that 171 schools in the United States serving 90,000 students achieved LEED certification (Center for Green School 2020). The LEED certification process is highly structured and rigorous. A point system is employed for each credit and there are four certification levels. Projects are re-certified to maintain LEED status. A scorecard records points in each of the following categories: location and transportation; sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; and innovation and regional priority.

Biophilic Design (BD)

In his influential text, *Biophilia*, E. O. Wilson describes biophilia as being the innate tendency to focus on life and lifelike processes (1984). Before him Eric Fromm coined the term as *love of life*, and all that is alive (1973). Regarding biophilic design applications Stephen Kellert says, "Looking at biophilic needs as an adaptive product of human biology relevant today rather than as a vestige of a now-irrelevant past, we can argue that the satisfaction of our biophilic urges is related to human health, productivity, and well-being" (Kellert et al., 2008, p. 4). Kellert's approach offers a new design paradigm he calls, *restorative environmental design*, fostering biophilic design applications that encourage contact between people, nature, and the built environment. He defines six biophilic design elements and an additional seventy biophilic design attributes summarized below (Kellert et al., 2008):

- **Environmental features** include water, air, sunlight, plants, natural materials, views and vistas, façade greening, geology and landscape, habitats and ecosystems.
- **Natural shapes and forms** include botanical motifs, tree and columnar supports, animal motifs, shell and spirals, arches, vaults and domes, simulation of natural features, geomorphology, biomimicry.

- **Natural patterns and processes** include sensory variability, information richness, growth and efflorescence, central focal point, bounded spaces, transitional spaces, integrated patterns to the wholes, and fractals.
- **Light and space** includes natural light, filtered and diffused light, light and shadow, warm light, spaciousness, spatial variability, spatial harmony, inside-outside space.
- **Place-based relationships** include geographic connection to place, historic connection to place, ecological connection to place, cultural connection to place, indigenous materials, landscape features that define building form, landscape ecology, integration of culture and ecology.
- **Evolved human-nature relationships** include prospect and refuge, order and complexity, security and protection, mastery and control, affection and attachment, attraction and beauty, exploration and discovery, information and cognition.

Ecosystem Services (ES)

Ecosystem services are the benefits that people get from nature. Since the Millennium Ecosystem Assessment (MA) was published in 2005, other studies have been published with alternative interpretations of how to both define and value ecosystem services. One response to the MA is the observation that the report needs to be more interdisciplinary in scope and address human well-being as an ecosystem service (Carpenter et al., 2006). A more recent study found an interest in defining intrinsic values as they relate to human-nature relationships (Flint et al., 2013). The MA provided the foundation on which the World Wildlife Fund (WWF) Living Planet Report 2016 defines four categories on how ecosystem services can be understood and identified:

- **Provisioning** products derived from nature: food, raw materials, fresh water, genetic, pharmaceutical and chemical resources, fertilizer, fodder, and energy;
- **Regulating** services provided by nature: air quality, climate regulation, water regulation, erosion regulation, water purification and waste treatment, disease and pest regulation, pollination, moderation of extreme events;
- **Cultural** services provide benefit to support mental and physical health, and include recreation and ecotourism, aesthetic values, spiritual and religious values; and
- **Supporting** services include photosynthesis, nutrient cycling, and soil formation.

Case Studies of Nature as a Partner

Following are four case studies of public schools in the United States. The schools are representative of urban, suburban, and rural locations. Each of the case studies demonstrate features of biophilic design, ecosystem services and community hub

Table 1 Case study overview

School	Type	Years	Students	GI	BD	ES	CH
Kiowa County Schools	Rural	K-12	433	X	X	X	X
Louis B. Nettlehorst School	Urban	K-8	700		X	X	X
Discovery Elementary	Suburban	K-5	591	X	X	X	X
Green School of Baltimore	Urban	K-5	150		X	X	X
Chester A. Arthur School	Urban	K-8	251		X	X	X

GI green infrastructure, *BD* biophilic design, *ES* ecosystem services, *CH* community hub

characteristics. Two of the case studies: Discovery Elementary and Kiowa County Schools (described earlier) represent new construction and significant green infrastructure as part of the school building and campus design. Three of the case studies work with existing infrastructure to achieve their missions: Nettelhorst School; Green School of Baltimore; and Chester Arthur School. Table 1 provides an overview of the five case studies.

Louis B. Nettelhorst School, Chicago

The outward appearance of Nettelhorst School is visually rich with exterior artwork, murals, linear gardens, chicken coop, and outdoor classroom along the perimeter of the building at the corner of Evanston and Broadway in the Lake View neighbourhood of Chicago. Bright colours and foliage standout against the historical masonry building. There are two Works Progress Administration restored murals in the school's art collection, and several other artworks, inside and out, by local Chicago artists. Some of these projects were created in collaboration with Nettelhorst students.

History Established in 1892, the school is housed in an historical building designed by J. J. Flanders. In 1911, Arthur F. Hussander designed an addition to the school, and in 1937 a three-story wing was added to accommodate 2,200 students. Over the years Nettelhorst School has struggled with facilities conditions, declining enrolments, and academic achievement (Bachrach, 2012). The recent turnaround of the school is credited to an initiative that gathered parents, teachers, and community leaders to renew Nettelhorst School and revitalize the neighbourhood (Wilson, 2011).

Sustainability Initiatives Nettelhorst School is part of Chicago Public School's Sustainable Community School Initiative that encourages a place-based approach in which schools' partner with community-based agencies to support academic achievement, health and social services as well as encourage community and parental engagement (Oakes et al., 2017). The outdoor classroom employs the Nature Explore model, a data informed design, with curriculum resources and educator workshops.

School Community Benefits Nettelhorst School strives to be the centre of its community through contact with nature that facilitates topophilia and biophilic predispositions through community engaged programming inclusive of arts expression and urban centred gardening practices open to all residents every day, evenings, and weekends, while at the same time focusing on students with resources for health, social services, and academic attainment. Afterschool programming and adult education are offered. Expectations for students, families, and the school community are to take care of yourself, take care of others, and take care of our environment. In this way Sustainable Community Initiative schools become, or are enhanced to be, hubs of their communities.

Partners of Nettelhorst's program commented: "The Nettelhorst School has taken an important leadership role in a profoundly needed initiative to connect young children with nature, setting a wonderful example for education centres across the country," Susie Wirth, the Arbor Day Foundation. "Architecture for Humanity Chicago was thrilled to collaborate with The Nettelhorst School to design the concepts that would ultimately lead to the Outdoor Classroom. The space created allows for imagination and learning beyond the narrow borders of the lot, entices the community to participate, and provides a unique educational opportunity that should be modelled across Chicago Public Schools,"—Katherine Darnstadt, Architecture for Humanity Chicago (Nettelehorst School, n.d.).

Discovery Elementary School

Arlington, Virginia is a growing suburb near Washington, D.C. Discovery Elementary is an example of recent construction in response to population growth. The design of Discovery Elementary is focused on energy costs but considers every aspect of the building and grounds as a tool for learning.

Sustainability initiatives VDMO Architects worked with CMTA Consulting Engineers to create a net zero energy plan for Discovery. The school proudly displays an axonometric graphic of the school design and energy dashboard in the lobby. The siting of the building works with the existing hilly topography facilitating stormwater sequestration on site. Impressively, the roof is covered with 1706 photovoltaic panels and includes a roof top classroom with demonstration panels that illustrate energy production. The interior school design uses nature references, with technology and space exploration themes. The cafeteria includes a vertical garden that grows green leafy vegetables used in the cafeteria and demonstrates seed to plate concepts. Floor to ceiling windows flood the space with natural light and provide views to campus gardens.

The district created a new position to ensure the building functions as designed: Energy and Stormwater Program Manager. Responsibilities of this position encompass all forty facilities of the Arlington Public School district. It is a goal of the district for the rest of the school buildings to move towards greater energy efficiency.

School Community Benefits The biproducts of Discovery Elementary School's focus on energy conservation and sustainability infuses the curriculum. Place-based relationships and evolved human-nature relationships can be identified in and around the school facility. Ecosystem services include all native vegetation, energy provisioning, regulating services, especially water runoff and infiltration, supporting services include indoor and outdoor gardening and cultural services. Alternative commuting options are promoted with expanded bike racks and preferential parking for vehicles using alternative fuel sources (Fig. 4). Biophilic design is referenced in signage, shape, and pattern motifs throughout the building. The interactive dashboard displays energy use in real time and accumulates data that students can use to help make informed choices. The LEED gold (2018) plaque is displayed nearby, and Discovery is one of the largest buildings in the world to receive Zero Energy certification from International Living Futures Institute and New Buildings Institute. Discovery has a MS4 permit (2014), Municipal Separate Storm Sewer System and Minimum Control Measures (MCM) Best Management Practice (BMP) policy in place, all runoff is infiltrated on site through terraced bioretention using native vegetation (Fig. 3). Discovery Elementary School was completed under budget, providing for supplementary community amenities like additional restrooms and enlarged gym space. The solar array alone represents a savings of $100,000 (USD) per year for the district (United States Department of Energy, 2017).

Green School of Baltimore

The Green School of Baltimore is tucked into a neighbourhood setting of row houses, adjacent a public middle school, and a Catholic church. The facilities are modest and homey. The play yard is centred around and shaded by the oldest tree on campus, a Cherry, and bordered by recently planted Dogwoods. To one side of the building is an outdoor gathering area with gardens, picnic tables and terraced seating. Signage on the front gates lets visitors know that this space is a Certified Wildlife Habitat, approved by the National Wildlife Federation.

History The public charter school is in its second home having spent two years as a tenant in the nearby middle school along with another charter school. The Green School currently occupies a three-story brick building, formerly a convent. The repurposed building is surrounded by lush vegetation (Fig. 5). An oversized fig tree sits prominently at the corner of the building, storied for its Italian origins in the area.

Sustainability Initiatives The nature-based curriculum promotes engagement with the natural world with the goal of lasting environmental stewardship. Green School works with Next Generation Science Standards as a supplement to their environmental programming. Each grade is programmed around age-appropriate environmental concepts, for example: kindergarteners are the *Pollinators*, first grade: *Terrapins* and fifth grade: *Organic Gardeners*. The curriculum works with inquiry

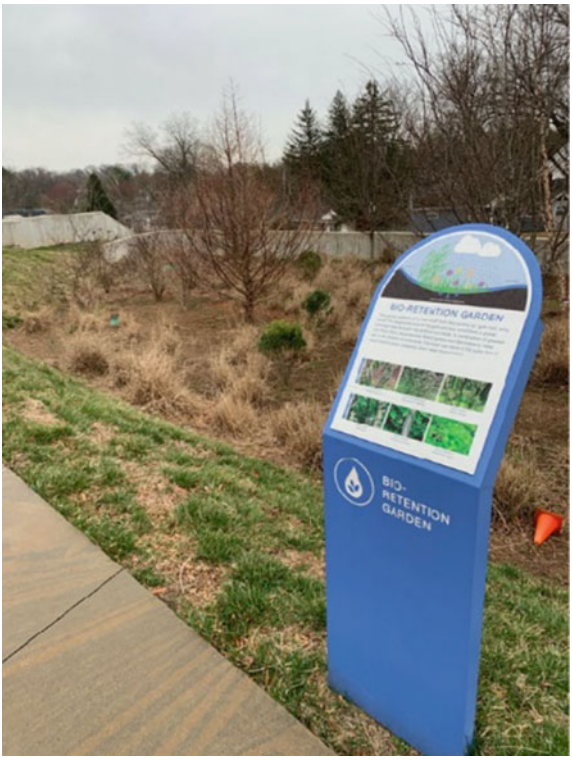

Fig. 3 Discovery Elementary bioretention area

based, web of life concepts that demonstrate increasingly complex structures as students advance.

Green School partners with community organizations such as Belair-Edison Neighbourhoods Inc., Blue Water Baltimore, Chesapeake Bay Foundation, Maryland Zoo, Baltimore Orchard Project, and Living Classrooms Foundation (Fig. 6). These partners collaborate to provide funding for and support of specific projects and curriculum goals.

School Community Benefits School administrators have collaborated with horticulturalists and neighbours for maintenance of the schoolyard tree inventory and gardens. Key biophilic features of this schoolyard are native and culturally significant plants and trees, natural materials, views, botanical motifs, sensory variability, filtered and diffused light, place-based relationships, and evolved human and nature relationships. Ecosystem services are demonstrated in native vegetation, pollination, cultural services related to physical and mental health. Community connections include encouragement of bike commuting and programmatic liaisons with partners, neighbours, and nearby parks.

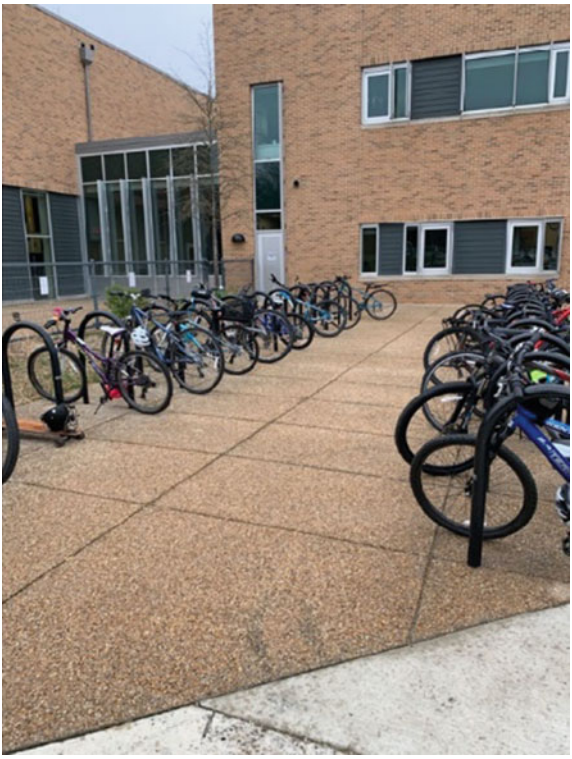

Fig. 4 Bike parking

Chester A. Arthur School

Chester Arthur School is in the Graduate Hospital neighbourhood of Philadelphia, a neighbourhood with limited options for outdoor recreation or contact with nature.

History The schoolyard project at Chester Arthur School is the result of collaborative efforts of Friends of Chester Arthur, SALT Design Studio, The College of New Jersey's Centre for Excellence in Science, Technology, Engineering and Mathematics (STEM) Education, The University of New Hampshire's Stormwater Centre, The Philadelphia Water Department, Neighbourhood Transformation Initiative, School District of Philadelphia, and financial support from William Penn Foundation.

Friends of Chester Arthur provided seed money to get the Graduate Hospital neighbourhood project going and commissioned SALT Design to do a pre-construction site assessment in 2016. The assessment found the grounds to be 99% impermeable (Fig. 7). SALT Design referred to it as an *ecological desert* and identified that all the stormwater runoffs went into Philadelphia's combined sewer system.

Sustainability Initiatives Stormwater management components of the project were designed in accordance with the Stormwater Retrofit Guidance Manual, a product of the Philadelphia Water Department to manage 28,000 gallons, or 1 inch of stormwater for a 24-h rainfall event. SALT Design's concept created a learning

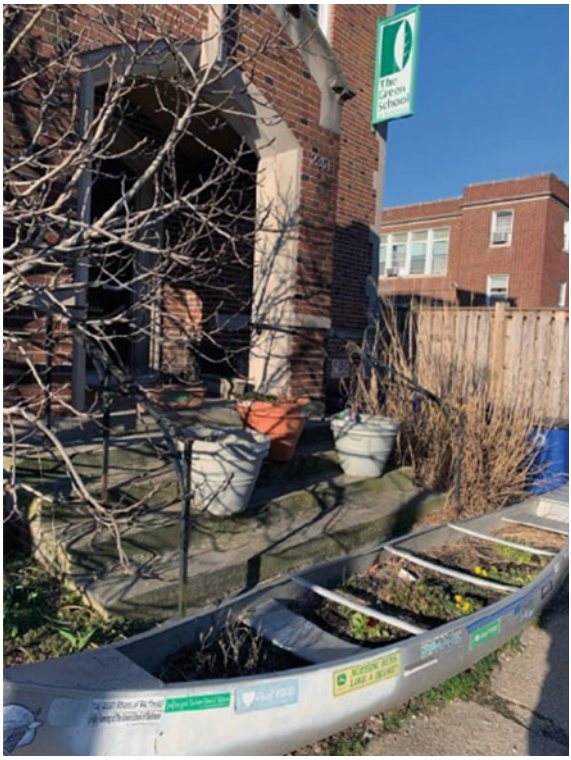

Fig. 5 Green School of Baltimore planting area

lab that divides the site into four sections: *Habitat Lab*, *Systems Lab*, *Motion Lab*, and *Energy Lab*.

School-Community Benefits The new design addresses stormwater management with STEM curriculum to be explored as an outdoor laboratory, green space, and public gathering for the community. A post-construction site assessment completed in 2017 found that Chester Arthur School has become a living hub for the community. The Landscape Performance Series assessment outlines how the new outdoor learning environment is a model for transforming traditional public schoolyards. The findings show that noise levels are reduced from 87 to 81.5 decibels, temperature of the playground is down by 7.2 °F, and site use by all user groups is up.

SALT Design used protocols defined by System for Observing Play and Leisure Activity in Youth (SOPLAY) and System for Observing Play and Recreation in Communities (SOPARC) as part of their post-occupancy research assessment. Observation of children's play indicates that during school hours site use has increased by 128%, and site use after school hours has increased by 157%. The study classifies type of play by gender, and as sedentary, moderate, and vigorous as defined by SOPLAY and SOPARC. All types of play for boys and girls have increased according to the study (Pevaroff et al., 2017).

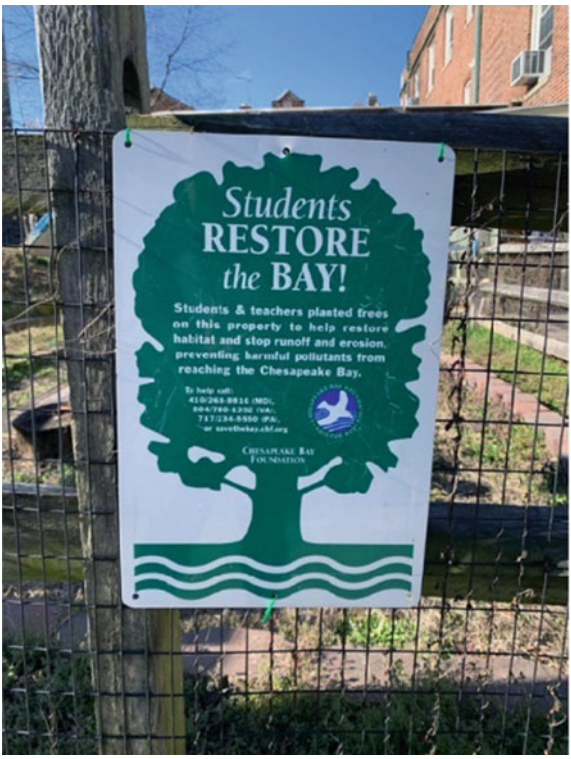

Fig. 6 Partnerships

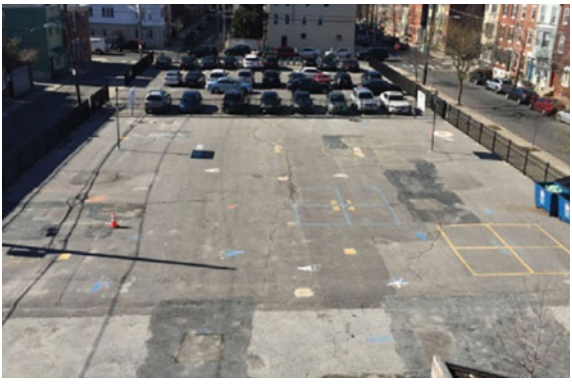

Fig. 7 Chester Arthur Street schoolyard project before (Photograph by SALT Designs)

Pre-construction asphalt coverage of the site was 91.4% and post-construction coverage is 54.3% (LAF, 2017). New plantings have improved overall habitat, affording opportunities for exposure to diverse ecological systems. The Landscape Performance Series reported an addition of 21 deciduous canopy trees, 27 shrubs, and over 3,000 perennials, grasses, and bulbs to expand native habitat resulting in

Fig. 8 After (Photography by Sahar Coston-Hardy)

additional numbers of birds, insects, and mammal sightings by 350%. Philadelphia Water Department maintains the stormwater infrastructure system inclusive of plant and soil health monitoring.

The biproducts of the participatory stakeholder design process resulted in creation of native habitats that produce ecosystem regulating services and place-based design responses that enable ecological and cultural connection to place facilitating biophilic tendencies (Fig. 8). Use by students and adult residents on the weekends has increased, demonstrating desire for green spaces in this high-density urban neighbourhood. Chester Arthur Schoolyard project has encouraged connectivity and neighbourhood liaisons.

Scaling Up Partnerships with Nature

In addition to the above case studies, partnering with nature has been scaled up to address district, city, regional, and even national applications. These examples further exemplify how concerned individuals, educational professionals, school administrators, non-profit organizations, and municipal authorities can catalyse to implement change in their schools.

The Boston Schoolyard Initiative This initiative transformed 88 schoolyards between 1995 and 2013, with sustainable development that promoted experiential learning, environmental stewardship and placed the school at the centre of community life. The initiative reached more than 30,000 students, created 32 outdoor classrooms, planted 200 trees, added 100 garden beds, provided professional development for 850 teachers, reclaimed 130 acres of asphalt, and turned 25 acres of asphalt into green space. School principals reported significant increase in student physical activity, improved behaviour, and greater cohesion with parents and community. The new schoolyards are open for before and after school programs, summer camps, and for community residents (Boston Schoolyard Initiative, 2018). The initiative established the Boston Schoolyards Funders Collaborative and included the Office of the Mayor

of Boston, Boston Public Schools (BPS), the BPS Wellness officer, Boston Department of Neighbourhood Development, Boston Basic City Services, Edwards Ingersoll Browne Fund, Boston Community Centres, and Boston Parks and Recreation Department.

Space to Grow: Greening Chicago Schoolyards This initiative works with underserved neighbourhoods and engages students, families, and residents, to transform underutilized schoolyards into green spaces for students and community. They focus on replacing asphalt with playgrounds and green spaces that attract community to gather while at the same time mitigate urban flooding. Space to Grow is a public–private partnership between Chicago Public Schools, the City of Chicago Department of Water Management, Metropolitan Water Reclamation District of Greater Chicago, Healthy Schools Campaign, and Openlands, together they have completed 34 schoolyards since 2014. The partnership leveraged financial investments from two water agencies charged with designing green infrastructure to absorb storm surge. Government agencies contribute to the cost and have developed an intergovernmental agreement that defines the role of each partner. The partnership is co-managed by Healthy Schools Campaign, whose mission is to make schools healthier places for children, and Openlands, whose focus is to connect people with nearby nature as part of their everyday lives. This partnership extends past implementation of new schoolyards into professional development, community events, workshops, and curriculum development to guide teachers on how to best utilize their new campuses (Bowman et al., 2016; Openlands, 2021; Space to Grow, 2021).

Community Design Collaborative This organization connects communities with volunteer designers to enable residents to express the vision they want to see in their neighbourhoods. Since 2003 Community Design Collaborative has facilitated 18 preliminary schoolyard designs with the School District of Philadelphia and the Philadelphia Water Department. Together they have addressed a state and federal mandate to mitigate flooding and manage stormwater to protect natural waterways. Many schools lots in the City of Philadelphia are asphalt covered and create significant stormwater runoff sending pollutants into waterways. Partnering with the Philadelphia Water Department, the School District has been able to leverage funds to transform schoolyards into permeable spaces through removal of asphalt and introduction of biodiverse vegetation. This work has transformed parking lots and paved spaces into rain gardens, green roofs, living laboratories with porous paving and shade trees helping the Water Department reach its goals towards Green City, Clean Waters Plan while providing access to nature to thousands of students. Moreover, these spaces add to urban open green spaces available to residents after school hours (Community Design Collaborative, 2015; Green City, Clean Waters Plan, 2011; Philadelphia Water Department, 2021). Community Design Collaborative has published guidelines: Transforming Philadelphia's Schoolyards, with case studies and practical advice for creating green schoolyards.

Green Schoolyards America This initiative is dedicated to the transformation of schoolyards from asphalt covered space into park-like green campuses that enable learning and well-being while supporting ecology and resilience of surrounding

communities. Green Schoolyards America is part of the living school ground movement and has partnered with Oakland Unified School District in California and The Trust for Public Land in a pilot study of five schools. The initiative prioritized schools in low income areas and provided inclusive design engagement activities resulting in asphalt removal, garden additions, outdoor classrooms, and diverse plantings. Schools in the study received professional development through Green Schoolyards America's Principal's Institute. Green Schoolyards America has also taken on a critical role in response to the COVID 19 pandemic. During the summer of 2020, the organization mobilized educators, school administrators, designers, public health experts, garden professionals, and others in weekly meetings to develop a set of guidelines to address the needs of schools to reopen safely and advance outdoor learning spaces as *Plan A* in the return to school. Moreover, guidelines for leveraging partnerships for use of adjacent green space, street spaces, local, regional, and state parks were developed. This series of meetings culminated in the Covid 19 Outdoor Learning Library of downloadable resources, available on their website (Green Schoolyards America, 2021).

Discussion

The above case studies show that the motivations for and the methods used to partner with nature vary for schools depending on their circumstances. Schools whose mission it is to provide greater contact with nature take a pedagogy first approach often incorporating biophilic design holistically. In these instances, school buildings are repurposed by modifying the original design to accommodate garden spaces and nature references inside and out to support curriculum. For example, Louis B. Nettelhorst school has capitalised on its long history, art and architectural presence, and parental determination for neighbourhood revitalization. By working with parents and partnering with neighbours, local, and regional non-profit agencies, they were able to incorporate nature-based curriculum which served to enhance community identity and urban environmental stewardship. Similarly, Green School Baltimore made a commitment to promote nature concepts in their curriculum through modifications to their facilities with modest means. They enabled biophilic tendencies with a holistic model using nearby nature and organizational partnerships. Chester Arthur School leveraged a partnership with Philadelphia Water Department to address STEM education and urban flooding resulting in expanded outdoor learning opportunities and added green space to the urban neighbourhood. Kiowa County Schools rebuilt in response to natural disaster. The choices made by residents of Greensburg, Kansas, highlighted their local ecology through LEED certification process that became the standard for all new buildings in the rural town. Schools that pursue LEED certification motivated by energy savings have good reason to do so, with reports indicating that savings are substantial. Discovery Elementary School working with VDMO Architects, designed Discovery to be a net zero school. Further, schools like Discovery can serve as an example of the numerous benefits of investing in green

infrastructure that go beyond energy efficiency to form a whole school learning environment tied to local ecology. For example, Discovery Elementary made energy use tangible to students with an interactive energy dashboard. Moreover, the district recognized and adapted its maintenance practices in response to the new net zero facility by employing a full-time energy and storm-water manager to the staff, demonstrating an evolving understanding of sustainable maintenance practice.

Conclusion

School communities connecting with their local ecology can experience multiple benefits. Initially, schools may pursue green infrastructure and certification primarily as a way of reducing energy costs. Green infrastructure can produce valuable energy offsets for schools with the resources to invest. The benefits of integrating green infrastructure also include opportunities to incorporate biophilic design and enable ecosystem services that extend beyond the school grounds. For example, schools that incorporate bioretention into their design include native vegetation, siting, and terrain preservation to achieve those goals, which supports regional habitat and pollination. Moreover, the school communities profiled have formed interdisciplinary partnerships with municipal authorities, local and regional parks, conservation organizations, green infrastructure technologists, environmental educators, and community residents to strengthen the connections to their local ecologies which in turn support academic, physical, and mental well-being. Community centred schools partnering with municipal water authorities demonstrate benefits of shared green spaces and environmental stewardship through stormwater sequestration. Likewise, schools incorporating nature through pedagogy have implemented biophilic design by adding gardens and nature references that promote community involvement through stewardship activities that address provisioning, supporting and cultural ecosystem services which further promote social cohesion. The community school movement has demonstrated the importance of new roles like the community facilitator who acts as a liaison between the school and social service agencies. Similarly, partnerships with nature demonstrate the need for new and or evolved staff roles to enhance and strengthen connections between schools, communities, and local ecology. The co-benefits of this pursuit support green infrastructure by making sure schools are operating as designed and by incorporating biophilic design, facilitating ecosystem services, and improving community cohesion through ecological connections. Schools partnering with nature: support web of life concepts, advance understating of ecosystem services, and demonstrate environmental stewardship with benefits for the entire school community and beyond.

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References

American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). (2011). *Advanced energy design guide for K-12 school buildings, achieving 50% energy savings toward a net zero energy building.*

American Society of Landscape Architects. (2017). *Designing our future: Sustainable landscapes.* Retrieved March 23, 2022, from https://www.asla.org/sustainablelandscapes/index.html

Bachrach, J. S. (2012). Louis Nettelhorst School. *Chicagology.* Rand McNally. https://chicagology.com/?s=nettelhorst+school

Bickel, A. (2017, May 3). Greensburg has made great progress in 10 years, but population is still low. In A. Mannette (Ed.), *The hutchinson news between 2002–2017*. https://www.amannette@gannet.com

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*(12), 1207–1212.

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*, 249–259.

Blank, M. J., Melaville, A., & Shah, B. P. (2003). *Making the difference, research and practice in community schools.* Coalition for Community Schools, Institute for Educational Leadership. Retrieved March 23, 2022, from https://community-wealth.org/content/making-difference-research-and-practice-community-schools

BNIM Architects. (2010a). *Kiowa County Schools*. Retrieved March 23, 2022, from https://www.bnim.com/project/kiowa-county-schools

BNIM Architects. (2010b). *Kiowa County Schools*, Landscape. Retrieved March 23, 2022, from https://www.bnim.com/project/kiowa-county-schools-landscape

Boston Schoolyard Initiative. (2018). http://www.schoolyards.org/about.over.html

Bowman, N., Adelmann, J., & Davis, R. (2016). *Green schoolyards: A growing movement supporting health, education and connection with nature.* Healthy School Campaign, Openlands.

Carpenter, S. R., DeFries, R., Dietz, T., Mooney, H. A., Polasky, S., Reid, W. V., & Scholes, R. J. (2006). Millennium ecosystem assessment: Research needs. *Science, New Series, 314*(5797), 257–258.

Center for Green Schools. (2020). *Getting started with LEED*. Retrieved March 23, 2022, from https://www.usgbc.org/leed

Community Design Collaborative. (2015). *Transforming Philadelphia's schoolyards*. Retrieved March 23, 2022, from https://cdesignc.org/guides/schoolyards

Cooke, F. (2005). Colonel Francis W. Parker: His influence on education. *Schools: Studies in Education, 2*(1), 157–170. http://www.jstor.org/stable/10.1086/589166?seq=1

Danks, S. (2010). *Asphalt to ecosystems: Design ideas for schoolyard transformation.* New Village Press.

Dewey, J. (1902). The school as social center. *The Elementary School Teacher, 3*(2), 73–86.

Dewey, J. (1943). *The school and society*. University of Chicago Press.

Dyment, J. E., & Bell, A. C. (2007, December). Grounds for movement: Green school grounds as sites for promoting physical activity. *Health Education Research, 23*(6), 952–962.

Filardo, M., & Vincent, J. M. (2017). *Adequate & equitable U.S. PK–12 infrastructure: Priority actions for systemic reform.* 21st Century School Fund, Center for Cities + Schools, National Council on School Facilities, and Center for Green School.

Flint, C. G., Kunze, I., Muhar, A., Yoshida, Y., & Penker, M. (2013). Exploring empirical typologies of human-nature relationships and linkages to the ecosystem service concept. *Landscape and Urban Planning,* 120, 208–217. Retrieved March 23, 2022, from https://www.centerforgreenschools.org/sites/default/files/resource-files/pk12-infrastructure-priority-actions-report-executive-summary.pdf

Friends of Chester Arthur. (2020). *The schoolyard: Redefining outdoor learning and play at urban schools*. http://www.friendsofchesterarthur.org/schoolyard-revitalization

Fromm, E. (1973). *The anatomy of human destructiveness.* Holt, Rinehart and Winston.

Green Schoolyards America. (2021). *COVID-19 Outdoor Learning Initiative.* https://www.greenschoolyards.org/covid-learn-outside

Gross, M. (2009). Collaborative experiments: Jane Adams, Hull House and experimental social work. *Social Science Information, 48*(1), 81–95. https://doi.org/10.1177/0539018408099638

Kellert, S. R., Heerwagen, J., & Mador, M. (Eds.). (2008). *Biophilic design: The theory, science and practice of bringing buildings to life*. Wiley.

Landscape Architecture Foundation. (2017). *Landscape performance series.* https://www.lafoundation.org/what-we-do/research/landscape-performance

Louv, R. (2011). *The nature principle, human restoration and the end of nature-deficit disorder*. Algonquin Books.

Melaville, A., Jacobson, R., & Blank, M. J. (2011). *Scaling up school and community partnerships: The community schools strategy.* Coalition for Community Schools, Institute for Educational Leadership. http://www.communityschools.org/ScalingUp/. Accessed 23 Mar 2022.

Millennium Ecosystem Assessment. (2005). *Living beyond our means: Natural assets and human well-being*. Island Press.

Nettlehorst School. (n.d.). Retrieved March 23, 2022, from https://www.nettelhorst.org/

Oakes, J., Maier, A., & Daniel, J. (2017). *Community schools: An evidence-based strategy for equitable school improvement.* National Education Policy Center. Retrieved 2020. http://nepc.colorado.edu/publication/equitable-community-schools

Openlands. (2021). https://www.openlands.org

Orr, D. (1994). *Earth in mind, on education, environment, and the human prospect*. Island Press.

Pevaroff Schuh, S., Buck, S., & Jacobs, A. (2017). *Chester Arthur Schoolyard. SALT design studio. Landscape Performance Series.* Landscape Architecture Foundation. https://www.landscapeperformance.org/case-study-briefs/chester-arthur-schoolyard

Philadelphia Water Department. (2011). *Green city, clean water plan.* https://water.phila.gov/green-city/

Philadelphia Water Department. (2021). *PWD schools, education and outreach.* Retrieved March 23, 2022, from https://www.phila.gov/water/educationoutreach/Pages/PWDSchools.aspx

Place-based Evaluation Collaborative (PEEC). (2004). *Promise of place: What is place-based education?* Accessed June 2020. https://promiseofplace.org/what-is-pbe/what-is-place-based-education

Razani, N., Morshed, S., Kohn, M. A., Wells, N. M., Thompson, D., Alqassari, M., Agodi, A., & Rutherford, G. W. (2018). Effect of park prescriptions with and without group visits to parks on stress reduction in low-income parents: SHINE randomized trial. *PLoS ONE, 13*(2), e0192921.

Space to Grow. (2021). *Greening Chicago schoolyards.* https://www.spacetogrowchicago.org/about/about-space-to-grow/

Sustainable Sites Initiative. https://www.sustainablesites.org

Trust for Public Land. (2019). *Schoolyards: The park access solution that's hiding in plain sight.* Retrieved March 23, 2022, from https://www.tpl.org/schoolyards

United States Department of Energy. (2012). *Rebuilding it better: Greensburg, Kansas, high performance buildings meeting energy savings goals.* Retrieved March 23, 2022, from www.eere.energy.gov/deployment/greensburg.html

United States Department of Energy. (2017). *Zero energy is an A+ for education: Discovery elementary*. Retrieved March 23, 2022, from www.zeroenergy.org

United States Green Building Council. (2022). *Green building leadership is LEED.* Retrieved March 23, 2022, from https://www.usgbc.org/leed

Wilson, B. (2011, January). Nettelhorst elementary school's remarkable turnaround. *Chicago Magazine.* https://www.chicagomag.com/Chicago-Magazine/January-2011/Nettelhorst-Elementary-Schools-Remarkable-Turnaround/

Wirth, A. G., & Bewig, C. (1968). John Dewey on school architecture. *Journal of Aesthetic Education, 2*(4), 79.

World Wildlife Fund. (2016). *Living planet report 2016*. Retrieved March 23, 2022, from https://www.worldwildlife.org/pages/living-planet-report-2016

Cynthia L. Hron is a landscape designer, artist and independent researcher originally from California and now based in Pennsylvania, USA.