CHILDREN'S GARDENS:
DESIGN, PARTICIPATION AND BEHAVIOR FOR ENVIRONMENTAL COMPETENCE

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

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February 2010

ABSTRACT

Prior children's environments behavior studies suggest that gardens may encourage health and development. Mixed evidence remains, however, as to what specific elements best allow for learning to occur within natural children's environments. It is hypothesized that children's garden designs with greater diversity, access, and exploration of "wild nature" may improve both physical development and environmental competence. Furthermore, children's participation and preferences for such spaces may influence design. Through a case study analysis, this study compares garden design processes and garden mission statement themes through outcomes of design elements and children's play behavior in relation to key indicators for environmental competence. More specifically, the independent variables of mission statement themes ("participatory design and empowerment", "accessibility and inclusiveness", "children's health" and "environmental education and interaction") are evaluated for their relation to children's participation and design features of direct natural contact, diversity of play affordances and usability. This study's findings suggest that child participation in children's gardens may be associated with direct natural elements preferred and used by children in garden designs. Furthermore, if elements are accessible and child-scaled, children's interaction with these natural spaces may be more successful. Recommendations concerning best practices among the twelve children's gardens in this post occupancy evaluation are also provided.

BIOGRAPHICAL SKETCH

Ashley Miller received her undergraduate degree from Michigan State University in Urban and Regional Planning, with a specialization in Environmental Studies. After completing her degree in Applied Research in Human Environment Relations at Cornell, she is planning to work with the University of Michigan project titled “Where Do the Children Play?”, a documentary about the benefits and applications of natural children’s environments in city planning, education and conservation efforts. Ashley hopes to contribute to the fields of urban ecology and environmental psychology through advocacy, planning and outreach in a non-profit and public sector career.

I’d like to thank my family, friends and fiancé for their continued love and support during the last two years of graduate school.

ACKNOWLEDGMENTS

I'd like to acknowledge all the teachers and advisors who lead me to this field, including Laurie Thorp, Terry Link, Roger Hart, Nancy Wells and Ann Forsyth. Their work and dedication to the issues of environmental education, sustainable design and children's environments have inspired and motivated me to pursue this topic in academia and beyond.

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LIST OF ABBREVIATIONS

AD/HD – Attention Deficit/Hyperactivity Disorder

PDE – Participatory Design and Empowerment

AI – Accessibility and Inclusiveness

CH – Children's Health

EE- Environmental Education and Interaction

GIS – Geographic Information Systems

PREFACE

This thesis grew out of my personal experiences in gardening and community development efforts in Lansing, Michigan, Ithaca, New York and New York City. From a school gardening program run by the Allen Street Community Center in Lansing, to the 4H Urban Outreach “garden club” operated by Cornell Cooperative Extension in Ithaca, volunteer experiences have pointed to the importance of hands-on environmental and health education for children’s competence. In the process, I have also learned how vacant land and underutilized land can be transformed through community greening efforts. Such experiences exemplified how children’s participation in shaping local environments also impacts health and social conditions in the process.

To further explore this topic, my graduate coursework focused on planning efforts and outcomes for accessible nature. For instance, I studied the effects of “nearby nature” experiences on children’s environmental attitudes and behaviors with Dr. Nancy Wells. Furthermore, I studied play behavior and parental attitudes about community gardens with Roger Hart and the City University of New York’s Children’s Environments Research Group. Through work with my professors, I was able to investigate environmental psychology, play behavior and city planning aspects of children’s environments in relation to healthy development and natural play spaces.

CHAPTER 1

LITERATURE REVIEW

Background

Debating child development issues inevitably runs into the perennial nature-versus-nurture question, yet there is much to learn about the nurturing benefits of incorporating the natural world into children's environments. This thesis, working within an ecological framework, evaluates whether children's garden mission statement themes are associated with the design features of children's gardening spaces for participation, natural contact, diversity of play and usability.

The child development literature recognizes three major categories of children's gardens. In the first category fall institutional or school-based spaces, such as a school garden, an outdoor classroom, or other schoolyard habitat, the primary purpose of which is to supplement a course in formal education through active gardening plots. The second category includes children's gardens in public parks or recreation areas, which focus more on non-formal education for family audiences. The third category includes children's gardens within the context of public horticultural institutions, with a combination of gardening and non-gardening activities (Miller, 2005, p. 125). Within this typology, this thesis examines children's gardens that fall into the latter two categories, which are situated in public parks and botanical children's gardens. Through this thesis, organized children's gardens are evaluated for mission statement themes, design elements and children's behavioral benefits. The results and recommendations section suggest how these findings apply to improving children's gardens and community spaces in the future.

Historical Context

Over the past two decades, children's gardens have become increasingly popular amenities in public spaces. Some would say that there is a new children's garden movement afoot. Its Progressive Era origins, which featured the Brooklyn Botanical Children's Garden and Froebel's "kindergarten" concept, were the building blocks of the nationwide School Gardening Association, which emerged during World War II as part of the larger Victory Gardens program (Crowder, 1997; McLellan, 1970). Following WWII, the children's garden movement waned as school gardens and parks were converted into playgrounds and athletic fields (Miller, 2005). As a result of this shift and the widening influence of auto-oriented planning, outdoor play became restricted by safety concerns, traffic, crime, dangerous litter, and a lack of green open space within urbanized area. Furthermore, at the beginning of the twenty-first century, major trends in child development target increasing rates of childhood obesity and the lack of stimulating natural environments due to the rise of indoor, technology-driven entertainment (Moore & Cooper Marcus, 2008). In this new era of health and environmental challenges, it seems timely that the growth of children's gardens since the early 1990s has coincided with a renewed interest in environmental education, children's physical and cognitive development in the natural world, and grassroots community spaces (Halverson et al., 2008).

Halverson and colleagues (2008) define a children's garden as "an interactive outdoor environment, designed specifically for children, which provides opportunities for learning and playful exploration through hands-on experiences with plants and the natural world" (p. 162) Such first-hand experience is an essential part of the attraction of this new type of children's environment. As new additions to many schools, parks and public horticulture areas, children's gardens fill a need for developmentally beneficial spaces that may reengage youth with the natural world (Halverson et al., 2008).

The literature addressing children's environments points to the use of gardens as an important and logical next step in the evolution of recreational and educational spaces. A children's garden combines three specific influences—playgrounds, children's museums, and children's gardening (Halverson, et. al., 2008). Building on these three traditional elements, a children's garden emphasizes play, natural interaction, and environmental learning. Direct participation makes these spaces ideal for conveying important messages to children about the role of food and nature in our everyday lives.

Understanding past research on child-nature studies provides a broad-based understanding of how children's gardens may enhance developmental outcomes. There are gaps in the research concerning evidence-based design of natural play environments, especially with respect to low-income, urban neighborhoods where obesity rates are high (Cosco, 2007). For this reason, this study will looks at how children use gardening environments and identifies features they prefer, These findings will yield implications for participatory design and behavior improvements in urban children's spaces.

The following literature review examines how child development research, child-nature research, and design participation research connect to children's garden mission statements, design, and behavior benefits. Following an analysis of key theories on environmental competence and development, children's gardens areas of focus are explored, including: *participatory design and empowerment*, *accessibility and inclusiveness*, *children's health and environmental education and interaction*. Demonstrating how these issues are addressed by design, indicators for children's environmental competence will be explored in the literature surrounding the following topics: *usability* **(**accessibility, control, legibility, safety); *physical and social development* (diversity, socialization); *cognitive development* (exploration, restoration); and *participation***.**

Children's Environments and Development Theories

Ecological studies have changed the way we look at children, their environments, and their development (Hogan, 2005, p. 25). Leaders in the field of context-dependent development such as James Mark Baldwin, Lev Vygotsky, and John Dewey have shaped sociology, psychology, and education perspectives on children's everyday experience (Hogan, 2005, p. 33). Furthermore, Bronfenbrenner's (1979) theory that incorporates the effects of settings on development have led to a shift from laboratory to real-world contexts with research specific to the person and place of the inquiry. Bronfenbrenner's life course perspective emphasizes "nested" developmental environments, including immediate personal settings (such as school, home, parks etc.) and the relations between them. Using careful observations of such naturalistic settings, Bronfenbrenner developed a systems approach for understanding not just individuals but also the interactions between larger interpersonal structures and environments.

One relevant application of the ecological concept for children's gardens is presented by Ozer (2007), who postulates that school gardens could serve as interventions in a child's "microsystems" of school, family, and community, using Bronfenbrenner's (1979) life course perspective on social-ecological phenomena. Such work suggests that, at an individual level, gardens could promote health for students in multiple "functioning areas" (academic, health, psychosocial), as well as improve norms within the overall school and community environment (Ozer, p. 847).

Environmental Competence Theories

Out of this theoretical structure, the concept of environmental affordances, or behavioral supports, links ecological models to practical descriptions of children's environmental quality (Gibson, 1983; Gibson & Pick, 2000). Affordances are defined as qualities that affect the interaction and reciprocal relationship between a child and his or her surroundings—essentially, ways in which environmental resources enable certain activities to occur and certain information to be relayed to the child (Gibson & Pick, 2000). According to Gibson (1979), this process of interaction determines the functional meaning inherent in the individual-environment relationship. Heft (1988) explains how a function-based taxonomy is more important than a form-based taxonomy when describing and evaluating the quality of children's environments. Understanding the "fit" of the environment to the person in promoting the activities and educational qualities desired is particularly relevant to studying such children's behavior settings as children's gardens (Heft, 1988). Heft draws on Barker and Wright's (1954) *behavior settings* research to assess how descriptive studies of children's outdoor play in the Midwest translate into a functional description of environmental attributes and behavior. This current in the literature stream suggests that it may be useful to provide an affordance taxonomy of children's gardens to environmental educators and landscape designers as a link between children's garden missions, design and behavior outcomes.

This argument is made clearly by Heft and Chawla (2003), especially in the chapter titled "Children as Agents of Sustainable Development: The Ecology of Competence." In this chapter, the authors theorize that for environmental qualities that promote competence, community spaces must have:

1) Affordances that promote discovery and responsive person-environment relationships (corresponding to the environmental competence indicators *exploration*, and *restoration*)
2) Access and mobility to engage affordances (corresponding to the environmental competence indicators *accessibility*, *safety*, and *control*).
3) Guided participation that supports perceptual learning and action (corresponding to the environmental competence indicators *diversity* and *socialization*).
4) Opportunities for meaningful participation in community settings (corresponding to the use of *participatory design* in creating children's gardens).

Heft and Chawla's (2003) theories draw evidence from previous studies of environmental competence and children's participation, such as the Growing Up in Cities program, which engages youth in urban planning issues. Heft and Chawla give examples such as the following description of children's behavior and participation in relation to gardening environments:

> *"In the domain of environmental change, these settings can range from those involving mostly perception-action processes (such as pressing seeds into the earth), to social settings (planning and digging the garden together with friends) and political settings (petitioning the local government to secure a children's garden)."* (Heft & Chawla, 2003, p. 208)

Environmental competence emphasizes the importance of middle childhood, the stage of child development that includes children six to twelve years of age. As mentioned by Kellert (2002), during this stage significant cognitive, affective, and evaluative development occurs, and the individual's relationship to natural environments is primarily shaped. This is also the period during which “mastering skills perceived as adult-like and gaining control over oneself and one’s environment”—the keystones of environmental competence—are developed (Eberbach, 1988, p. 16). This is a pivotal point at which fine and gross motor skills mature along with social and cognitive development. For example, children learn to understand group dynamics and reciprocal relationships through active play in local environments. The ability to handle challenges in youth and adulthood may develop in part through discovery and exploration of manipulatable, affordance-rich environments. Therefore, free play and guided exploration in gardens may be valuable in testing children’s skills and helping them to understand cause-and-effect relationships in the natural world (Eberbach, 1988).

Within the environmental competence framework, it is worthwhile to explore the contribution that children’s gardens make in terms of the providing developmentally useful environmental supports . Understanding such experience explains how interaction with built or natural elements may influence developmental outcomes. For instance, Kellert (2002) notes the importance of natural elements in cognitive, affective, and evaluative development, and stresses three kinds of environmental experience that enable this process:

- ***Direct—****natural, interactive, undisturbed nature*
- ***Indirect—****zoos, aquariums, museums, public gardens*
- ***Symbolic—****representations of nature (art, media)*

Children’s gardens may contain one, two or all three, of these types of experiences, and, given their design, they may encourage or discourage behaviors and interactions conducive to children’s health and environmental learning. Kellert (2002) poses such a question: “What features of a child’s world typically foster and facilitate the inclination to receive information, to learn and to develop?” (p. 126). Limited evidence points to direct natural contact in middle childhood, leading to emotional responsiveness to natural environments, and so it is this type of interaction with nature that is hypothesized to lead to environmental competence and identity (Kellert, 2002; Kals & Ittner, 2003). Furthermore, children's inclinations to have these types of direct experiences (Moore, 1989) may influence their behavior patterns within a garden design.

In the following sections of this literature review, child-nature studies will be explored to understand the state of evidence regarding the benefits of children's gardens and direct natural experience for environmental competence. This will be followed by an analysis of specific elements and associated competence outcomes that are identified in the literature.

Children's Garden Benefits and Missions

Miller (2005) cites several holistic development benefits in the literature connected to garden-based learning environments. The interdisciplinary nature of these spaces, involving horticulture, science and nutrition education, make children's gardens a research area ripe with implications for design, programming, education, and sustainable development. For instance, one study found the following benefits of garden-based learning through an international survey of program managers:

- Academic skills (science, math, language arts)
- Personal development (psychological and physical health)
- Social and moral development (respect for nature and culture)

- Sustainable development skills (connection between human and natural systems)
- Vocational education (skills in agriculture, natural resource management, and science)
- Subsistence skills (growing and selling garden products)
- Life skills (community service, leadership, and decision making)
- Community development (interaction and cooperation with community groups)
- Food security (hunger and nutrition improvement)
- School grounds greening (place-making and place-identity benefits) (Subramanian, 2003, p.8)

Other benefits mentioned in qualitative studies of the effects of natural environments on child development include: empowerment through participation (Subramanian, 2003); fine and gross motor skills for health; wonder and creativity through open-ended explorative play (Hart, 1997); inclusiveness through accessibility, adaptation, and integration of children with different abilities (Moore & Wong, 1997); and external community benefits (Evergreen Foundation, 2000). Such community benefits include: improved social capital, improved land ethic, improved public health, parental involvement in children's gardens, and low-cost natural environments (Evergreen Foundation, 2000). Ozer (2007), however, cites little peer-reviewed research in her literature review of school gardens, with only four rigorous scientific studies of the health and development effects of children's gardens.

The few published articles have focused on the nutrition and physical activity side of the gardening equation, while less focus has been directed on actual child interaction with environments that may produce the various benefits promoted by children's gardens. The following review of children's garden issues and design indicators relevant to environmental competence and provides a theoretical link between garden mission statements, garden design, and behavior benefits.

Participatory Design and Empowerment

One of the greatest challenges to children's gardens design is that of the authentic participation and involvement of a diverse population. Traditionally, public gardens and parks have been designed and managed by horticulturalists and landscape architects, with little user consultation (Wake, 2007). However, many gardens are aimed at encouraging environmental stewardship in the young through positive experiences and sustainable practice, therefore their engagement in the design process could be beneficial to the learning process (Wake, 2007). As instruments of a movement, children's gardens could exemplify the importance of legitimate participation in design, implementation, and organization for youth development benefits, such as self-efficacy and competence.

Participation in children's garden design may empower developmental behaviors, such as positive self-concept and competence. Qualitative gardening studies have shown improvement in children's "independence, cooperation, self-esteem, enthusiasm/anticipation, nurturing living things, pride in one's activities, and exposure to role models" (Alexander, 1995), all of which might contribute to children's feelings of accomplishment in themselves and their environments. Furthermore, empowerment theory states that "psychological empowerment is typified by an increased sense of efficacy and control, and participation in organization and processes to improve one's life" (Zimmerman, 1995, in Westphal, 1999, p. 20).

Accessibility and Inclusiveness

According to play studies, children's gardens may also help reverse the loss of "free range" in natural settings, and therefore increase positive physical and psychosocial behaviors (Moore & Cooper-Marcus, 2008, p. 156). Many barriers are imposed on children's physical activity and access to natural spaces, prompting a research movement towards "biophilic design"—promoting settings that encourage children's exploration of the natural world (Moore & Cooper Marcus, 2008). According to biophilic design principles, increasing opportunities for outdoor play may counteract the negative trends associated with sedentary, indoor-focused lifestyles.

Another issue central to children's garden development is accessibility to multiple user groups and abilities. A recent example of universal design for a natural children's environment is the Kids Together Park in Cary, North Carolina, where a post-occupancy evaluation was performed by Moore and Ringhaert (2005). In this study, the universally designed space was assessed for what worked and what did not as a setting similar to a children's garden. The space under study was meant to foster positive social interaction in a natural and recreational area, by including play equipment, paths, plantings, and public art. The evaluation of the park included interviews with disabled children and family members. The dense, diverse design of the space allowed for community interaction, which was reflected in the large proportion of activity that occurred at the primary pathways, composite play structures, and gathering areas. The lessons from this site that are useful to children's garden design are the emphasis on community, with shelters and gathering areas, and the diverse user needs provided in close proximity to traditional play areas, encouraging inclusion and maximum physical challenge (Moore & Ringaert, 2005).

Children's Health

Issues related to the participation of low-income and disenfranchised groups in children's gardening are important, given the accessibility of such spaces to urban neighborhoods. Community gardens and school gardens are examples where children's gardening has contributed to nutritional knowledge and exercise in urban areas, such as is seen in studies of the California school system. A study of 338 students there found that such gardens increased weekly physical activity sessions from 4.9 to 5.2 times per week and increased consumption of fruits and vegetables from 3.44 to 3.78 servings (Twiss et. al, 2003; Ozer, 2007). Furthermore, girls and minority groups are most affected by the childhood obesity epidemic and, therefore, the creation of attractive and accessible children's gardens for these groups may increase their use and activity (Cosco, 2007).

Environmental Education and Interaction with Nature

A final area of issues pertaining to children's gardens involves a focus on sustainability and environmental quality. Given the educational focus of gardening, many facilities emphasize natural building practices and even environmental remediation through design. For instance, rain gardens, composting, wetlands, organic vegetables, native plantings, and green building principles are incorporated into many children's garden designs for functional and educational purposes. Teaching basic ecological principles that involve the water cycle, plant growth, and sustainable food systems, children's gardens create tangible connections to environmental action and community health. Direct and indirect effects of ecological design have been observed in past studies to create "a long-lasting deeply held environmental ethic . . . to connect with nature in profound ways" (Miller, 2005, p. 34). In combination with health and participation factors, children's garden may provide children with an introduction to important sustainability issues through environmental design.

Environmental Competence Design Indicators

Table 1, which displays children's environmental studies, indicates the importance of environmental competence through specific design elements. The following section will investigate how children's environmental behavior research has focused on key competence indicators as well as on possible implications of children's garden design.

The most important features for environmental competence are laid out in the Trancik and Evans (1995) article, "Spaces Fit for Children: Competency in the Design of Daycare Center Environments." Some environmental characteristics and recommended design outcomes include:

- **control** (found in flexible, safe and appropriately challenging play)
- **restoration** (found in "bird's-eye view" vistas and refuges)
- **diversity** (found in interactive materials for construction, manipulation and physical activity)
- **exploration** (in diverse natural settings)
- **legibility** (including appropriate adjacencies and circulation between activities and interpretive signs and symbols)
- **safety** (through clear boundaries, accessibility, and siting issues)

(Please see Table 2 for design characteristics associated with environmental competence headings.)

The following in-depth analysis focuses on specific design features recommended for these core environmental competence indicators.

Table 1: Children's gardens issue research.

	Direct Natural Contact		Affordances		Usability			Participation
	Exploration	Restoration	Socialization	Diversity	Control	Accessibility/ Safety	Legibility	Participatory Design
CHILDREN'S GARDEN THEMES								
Participatory Design and Empowerment	Preference for Direct Natural Contact in Environmental Schoolyard (Moore, 1989)		Children's Competence A Functional Approach to Participation (Heft & Chawla, 2003)					Children's Design Preferences (Eberbach, 1988; Lekies et al., 2008)
Accessibility and Inclusiveness					Scale (Eberbach, 1988)	Universal Design Features in Natural Children's Space (Moore & Ringhaert, 2005)Boundaries (Moore et al., 1997)	Wayfinding (Trancik & Evans, 1995; Moore et al., 1997; Eberbach, 1988)	Greener Voices Model - Ladder of Children's Participation in Garden Design, Implementation, and Organization (Lekies et al., 2007)
Children's Health		Improved Anxiety, Depression and Behavioral Problems with Nearby Nature (Wells & Evans, 2003)	Social Dramatic Play in Green Space (Kirkby, 1989; Faber Taylor et al., 1998)	Diverse Physical Affordance for Physical Health (Fjortoft & Sageie, 2000; Bell & Dyment, 2007; Moore & Cooper Marcus, 2008; Cosco, 2007, Lui et al., 2007)		Safe Challenge Guidelines (Moore et al., 1997)		
Environmental Education and Interaction	Direct Natural Contact and Emotional Affinity, Moral Reasoning, Environmental Behavior (Kals & Ittner, 2003; Wells & Lekies, 2006)	Attention Restoration in Nature (Faber Taylor, Kuo & Sullivan, 2001; Wells, 2000)		Diverse Landscape Ecology for Construction/ Manipulation (Fjortoft & Sageie, 2000)	Loose Parts (Nicholson, 1971)		Interpretation (Eberbach, 1995)	Children's Participation in Revisioning Natural Schoolyards (Malone & Trantor, 2003)

Physical Development and Social Development: Environmental Affordance Diversity

Research on children's environments feeds a growing current in the literature on children's play space and the importance of diversity and natural elements on social interactions and physical activity. Gibson and Pick's (2000) discussion of affordances may explain how diverse play environments affect children's developmental behavior through active learning of layouts, objects, and events. In a study of outdoor preschool spaces, diverse play behaviors were found to be highest in environments full of rich vegetation combined with compact manufactured settings (Cosco, 2007). Moore (1989) also observed children's preferences for natural play space before and after a traditional schoolyard was reconstructed as an "Environmental Yard." He found more positive child feedback for the natural settings, as well as supportive systematic observation and behavior-mapping data on these children's natural space preferences (Moore, 1989). Such research underscores children's attraction to biotic elements, known as "biophilia" or "love of life or living systems" (Wilson, 1993). Rationales for this preference include the rich affordances and "loose parts" that nature provides, allowing opportunities for encounters with complexity and manipulation that are so important to physical and social development (Trancik & Evans 1995; Evans, 2006).

Other studies have begun to connect green play space, design, and physical activity. Grahn et al. (1997) compared indoor and outdoor day care programs on standardized child development measures, finding that children who played in the wooded spaces were sick less often, and exhibited better fitness levels and gross motor skills (cited in Moore& Cooper Marcus, 2008). In a cross-sectional neighborhood-level study, the amount of vegetation in relation to a child's home acted as a buffer against overweight tendencies (Lui et al, 2007). Of the 7,334 subjects aged three to eighteen years, a decreased risk of obesity (measured by the body mass index or BMI) was found among children with increased vegetation levels (measured by Geographic Information Systems or GIS) within two kilometers of their homes in high urban density areas (Lui et al., 2007). Such evidence points to the developmental impacts children's gardens can have through physical play and discovery. Furthermore, research about what specific elements afford these benefits may help to describe more fully the design process and outcomes of successful children's environments (Chawla & Heft, 2002).

A study by Bell and Dyment (2007) surveyed 59 Canadian schools conducting schoolyard greening in which teachers, administrators, and parents observed changes in children's behavior. Questions concerned the amount of physical activity (defined as vigorous, moderate, or light physical activity), the quality of physical activity (active, imaginative, constructive, etc), and open-ended responses to the exploration of the natural world, social health, and cognitive development. In an assessment of the four types of environments found in schoolyards, the following physical activities were reported:

Turf—84% vigorous, 65% moderate, 26% light

Asphalt—67% vigorous, 56% moderate, 47% light

Play Structure—50% vigorous, 66% moderate, 45% light

Green—38% vigorous, 41% moderate, 55% light

These data point to a more varied distribution of play behaviors in the green areas, perhaps suggesting that more social and sensory play occurs in such areas. As evidence of this, respondents reported that greened schools appeal to a wider group of children (90%) and feature more varied activities (85%). Others surveyed said greened school yards promote more active play (82%), more imaginative play (83%), more constructive play (59%), experiential learning (82%), exploration of the natural environment (84%), and a strengthened link between play and cognitive development (82%; Bell & Dyment, 2007). The link between the physical, social, and cognitive development indicators in biophilic design is clearest in the following quote:

> *"On green school grounds, trees, shrubs, rocks and logs define a variety of places to jump, climb, run, hide and socialize. Moveable, natural materials such as sticks, branches, leaves and stones provide endless opportunities to engage in imaginative play, such as building shelters and huts—an appealing and almost universal experience of childhood."* (Dyment & Bell,, 2007, p. 958)

In another study using GIS, Fjortoft and Sageie (2000) also compared children's free play in settings with varied vegetation and topography. The researchers found that the affordances of diverse playscapes, in terms of landscape ecology and geomorphology, provided the physical requirements for certain play functions. For instance, "The areas for climbing trees were dominated by pine trees (34%), deciduous trees (28%) and mixed pine and spruce (20%)" (p. 93), while symbolic play was dominant with deciduous trees (38%) and shrubs (87%). Furthermore, construction play was dominant among shrub vegetation, where hiding and building activities were common. In conclusion, diversity is a key element in children's exploration of the natural environment, enabling cognitive and physical play. In this experimental study, the children's motor fitness improved in the diverse natural environments compared with a control group ($p<.01$).

The book *Play for All Guidelines: Planning, Design and Management of Outdoor Play Settings for All Children* (Moore, Goltsman, & Lacofano, 1997) provides further evidence of diverse children's recreation spaces, including gardens. This seminal work, produced by and for planners and landscape architects, describes specific design guidelines and developmental outcomes for play spaces. The recommendations most relevant to children's gardens are: graduated challenge in equipment; diverse terrain; interactive equipment; natural wildlife areas; child shelters; safety features (barriers, surveillance areas); accessible garden areas (with scaffolding and scale considerations); coherent, paved pathways; open space for games; dramatic play structures; refuge areas (such as crawl spaces and child-sized vegetation for hiding); sand/digging areas; child art; and water play. To incorporate such elements in children's gardens, settings that provide upper-body challenge (climbing trees, swinging rope, etc.), balance settings (bridges, walls, etc.), coordination judgment (stepping stones, ladders), and other gross motor play settings can provide the safe, diverse affordances important to environmental competence and children's health (Moore et al., 1997).

Social play behavior is also affected by the diversity of natural elements. A behavioral study by Kirkby (1989) looked at the success of natural versus manufactured refuge structures on children's preferences, play behaviors (measured through behavior mapping) and drawings. In a two-stage study of 79 children, they found that dramatic play accounted for 68 percent of sample use for a natural refuge and 42 percent of sample use for a built refuge. This shows a clear preference for dramatic play with natural spaces.

Faber Taylor et al. (1998) also performed a study of children's social play in 64 outdoor public housing spaces in Chicago, Illinois. The research found that more social play occurs in high-vegetation spaces than in low-vegetation spaces. For instance, two times the number of children were observed playing in spaces with many trees than in spaces with few trees (M=.95 vs. M=.49), and more creative forms of play were observed in high-vegetation spaces. Furthermore, groups of children in green spaces had greater access to adults than did children in barren spaces.

Cognitive Development: Direct Natural Exploration and Restoration

As evidenced in child-nature studies, there are clear connections between experiential, natural play and impacts on cognitive development in such environments. For instance, Kals and Ittner (2003) and Kellert (2002) support the theory of environmental identity through direct natural exploration through development of the following:

- Knowledge—cognitive development
- Emotional affinity—affective development
- Moral reasoning —evaluative development

In a study of children in three groups of school children (one a control group, one with direct experience in natural education, and one in classroom-based education) the direct experience group was linked with greater emotional affinity for nature-based issues and moral reasoning (Kals & Ittner, 2003). Significant items included positive valence emotions, such as fascination, which were especially significant in direct experience groups and associated with increased knowledge. While knowledge alone is important, the addition of emotional and moral reasoning can strengthen the experience-action connection to the development of environmental competence.

Wells and Lekies (2006) also explore the influence of direct natural experience on later environmental behaviors through a longitudinal study of 2000 adults, eighteen to nineteen years old. They found that childhood experiences with "domesticated nature" (e.g., gardening, caring for plants) had marginally significant direct and indirect effects on environmental behaviors. Furthermore, experience with "wild nature" had a direct effect on behavior, while environmental education alone had no effect. These findings might explain why Kals and Ittner (2003) also found no significant effects for environmental education alone on moral reasoning behaviors. Perhaps prolonged experiential learning, combined with emotional affinity, could have positive impacts on the traditional environmental education model in places like children's gardens.

Beyond environmental education, there may be a link between children's gardens and psychological outcomes. There are several studies documenting the effects of green space on attention and restorative outcomes. These findings may have implications for children in low-income, high-stress environments, as well as those suffering from behavioral problems. For instance, in a study of cognitive restoration, views of nature from public housing had positive concentration effects for girls, though no conclusive findings were identified for boys (Faber, Taylor, et al., 2000). Finally, a study of nature effects on Attention-Deficit/ Hyperactivity Disorder (AD/HD) showed children with greater access to green play spaces had decreased symptom severity with greater access to green play space (Faber, Taylor, Kuo, & Sullivan, 2001).

A similar study by Wells (2000) looked at 17 children from low-income families participating in a housing relocation program. A pre-post evaluation tested attentional capacities before and after the move to detect changes in cognitive functioning associated with changes in the naturalness of the home. The naturalness change score explained 19 percent of the variance in post-move attention scores, given that new home environments had significantly greater natural character than the original housing. Wells (2000) states the need for additional research into:

> *" . . . what types of play activities are most restorative for children and what environments support such play. For instance, given that 'being away' (S. Kaplan & R. Kaplan, 1983) is one component of a restorative experience, perhaps play that involves make-believe or the 'transformation' (Suransky, 1982) of trees into space ships, and rocks into turtles, for example, would be more restorative to children. Further research might also explore what types of landscape design would facilitate such play.* (Wells, 2000, p. 792)

Beyond attention studies, Wells and Evans (2003) found that rural children with more nature (i.e. green views, grass rather than concrete yard, plants) near their home scored lower on maternal ratings of anxiety, depression, and behavioral disorders. This cross-sectional study of 337 children looked at a Stressful Life Events Scale and the Children's Scale in relation to a naturalness scale for home environments. Results showed an interaction effect of nature with stressful life events, such that nature buffered the effects of stressful life events on children's psychological distress. Furthermore, there was a main effect of nature on children's global self-worth, and a nature by stressful life events interaction effect on global self-worth.

Usability: Safety, Accessibility, Control, and Legibility

Usability is a term used to describe how successful children's gardens achieve universal design in terms safety, accessibility, control, and legibility features for all user groups (Moore & Ringaert, 2005). Usability is critical to including broad stakeholders from all age, ability, and socioeconomic groups.

Safety, balanced with accessibility and control, permits children freedom of movement and development of both physical and mental confidence as hazards are reduced but risks children choose to undertake are provided. Boundaries, edges, and adjacencies should be considered not only to differentiate activity settings, but also to provide the social comfort of enclosure and safety that children need (Moore et. al., 1997). Preventing unsafe land uses, such as heavy traffic, near children's gardens may also improve the use and accessibility of a garden by residents in surrounding neighborhoods. In addition, provisions for supervision of these boundaries, and control over who enters and leaves a children's garden, will provide the sense of safety parents need to allow some child autonomy in children's gardens—a central tenet of the principle of safe challenge (Eberbach, 1988).

Like diversity and exploration in children's environments, control is linked to a child's ability to shape and access spaces that provide a sense of ownership and autonomy. To enable this process, children's environments researchers suggest providing child-scaled playscapes and "loose parts" (Nicholson, 1971), allowing children the freedom of movement and creativity to alter and interact with the environment. Child-scaled environments help to generate children's sense of control by creating safe opportunities for exploration (Moore et al., 1997). Furthermore, defensible space and territorial range are also affected by the amount of control children have on their safe access to and independence in play environments (Moore et al., 1997).

Eberbach's (1988) design guidelines for children's gardens also include a section on child-scaled and child-possessed spaces, recommending enhanced sense of control through the environment. For instance, she observes:

> *"…larger-than-life dimensions are frightening, so it is no wonder that small, cozy hideaways where control is more easily exercised appeals to children."* (Eberbach, 1988, p. 56).

These principles can be applied to garden design of pathways (18–24 inches wide), elevation change, vegetated structures (five-foot clearances), raised beds (18–24 inch high, 18 inches wide) and other places at which children directly engage with the environment (Eberbach, 1988). These measurements, fit for the average five year old, can be applied to garden assessment, along with the provision of loose parts (toys, tools, sand, etc.), as indicators of child-controlled space.

Moore et al. (1997) lay out site design guidelines which, like those found in Evans and Trancik (1995), cite legibility and coherence through interpretive wayfinding and signage as key considerations for environmental competence. The Moore et al. study points specifically to spatial orientation through siting and landmarks that create visual identity and pathways that encourage exploration of diverse play settings. Multisensory cues are also mentioned as a means of transferring information about a space to a child, reinforcing the child's innate need for experiential learning. Furthermore, Eberbach (1988) emphasizes the need for children's garden interpretation that is non-verbal, by including such elements as symbolic topiary and color-coded areas, so that all ages can participate in the learning and exploration process.

Beyond wayfinding and legibility, interpretation of key garden lessons—such as sustainability, healthy eating, and plant and wildlife science—can also be influenced by affordances for adult-child interaction. Heft and Chawla's (2003) suggest learning through guided participation, such as interpretive signage, living exhibits, models and displays. Eberbach (2005) explored these interpretive children's garden examples in regards pollination education at the Phipps Conservatory Discovery Garden in Pittsburgh, Pennsylvania. Her findings were that parents used supplemental models and virtual displays to explain detailed pollination processes that simplified and visualized processes that could not be observed, while using the real living plants (with a magnifying glass) to explain cause-and-effect relationships that occurred in real time with flowers, bees, and butterflies (Eberbach, 2005). This type of guided explanation is important for child information retention, and allows for experiential learning to occur outside of formal programming.

Children's Participation: Design, Implementation and Organization

The beneficial outcomes of participatory design processes have been documented in a variety of contexts ranging from schools to local parks and children's gardening (Hart, 1997). For instance, a study in Australia by Malone and Trantor (2003) looked at children's use of and preference for natural features through children's participation in the re-visioning of school grounds. The program resulted in a positive view of school grounds and a sense of belonging where the "stimulus-seeking" child could find ownership in natural play settings (Malone & Trantor, 2003).

While most studies of participatory design have focused on the built environment, the value of participation in the design of natural spaces—gardens in particular—is increasingly evident in the literature, especially since the goals of children's gardens are to support physical, social, and psychological development (Wake, 2008). At this point, most research has focused on adult participation and opinions; the potential for children to participate in design is under-examined (Wake, 2008).

Greener Voices, a school garden program in New York and Pennsylvania, has sought to support previous research on the benefits of children's participatory design in the garden. A study by Lekies et al. (2007) on this program found that children's participation resulted in "increased feelings of competence and ownership . . . improved visibility in society . . . fostering of important decision making and critical thinking skills needed throughout life, and utilization of the unique contributions of this age group" (p. 518). This specific study used Hart's ladder of participation (1997) to evaluate the level of student involvement in school garden projects. Degrees of participation included: 1) manipulation, 2) decoration, 3) tokenism, 4) assigned but informed, 5) consulted and informed, 6) adult-initiated with shared decisions with children, 7) child-initiated and directed, and 8) child-initiated with shared decisions with adults (Hart, 1997; Lekies, et. al., 2007, p. 519). This hierarchy of levels of participation is based on Arnstein's (1968) ladder of citizen participation, which was adapted to children's engagement in local environmental change (Hart 1997). At the lower three rungs of the ladder, children are not expressing opinions and cannot influence the garden program direction. At higher levels of participation, children are given substantial influence on the design and implementation process, contributing to goals, outcomes, and experiences of the program agenda (Lekies et al., 2007).

Another example of a participatory approach is the Children's Garden Consultants initiative at Cornell University. Led by Lekies, Eames-Sheavly, Wong, and Ceccarini (2008), this study engaged teenagers in the process of researching children's garden design and programming through surveys and presentations with adult gardening experts. Their resulting suggestions for better garden design included:

- Smaller-scale design
- Safe play areas

- Accessibility
- Elements such as mazes, waterfalls, slides, enclosed areas, covered structures and butterfly gardens, bridges, plant sculptures, stage areas, fish ponds, animals, hanging vines, and free play areas.
- Avoid plastic, manufactured and amusement park features
- Avoid major roadways

Yet another example of the participatory process in children's garden design is the Longwood Gardens masters thesis project, in which 178 first- through fifth-grade students were asked "what is a garden?" The students then drew and interpreted drawings of the important features. The results in terms of children's responses included a variety of ornamental (flowers, trees), functional (fruits and vegetables) and combined gardens. The majority of students favored ornamental (47%), with the next favorite being combined (33%) and the least favorite being functional (33%). Such aesthetic interpretation may be difficult to quantify, although individual elements clearly favored plant life (98%), animals (27%) and water features (21%), followed by buildings, pathways, fences, plant labels, garden tools, people, trellis, bridges, scarecrows, and statues (Eberbach, 1988). These findings appear to contrast with those of studies of related environments, such as adventure playgrounds and "phenomenal" landscapes, defined as those unstructured natural environments that encourage exploration in the neighborhood environment (Eberbach, 1988). For instance, Moore and Young (1978) found that, among eight to twelve year olds' cognitive maps of phenomenal landscapes, the favorite places children mention are trees, lawns, creeks/streams, tall grass/weeds/leaves, rocks, fish/aquatic life, flowers, gardens, and wild birds. Why do children prefer the wild, direct experience of unstructured neighborhood environments, yet picture gardens as more ornamental and untouched?

Is this a result of their experience, and the focus of many public children's gardens on formal environments where "touching flowers, running down paths and climbing trees" is discouraged (Eberbach, 1988, p. 39)? As the Longwood Garden study emphasized, there are many reasons this may be the norm. The inaccessibility and formal nature of public gardens may prevent more phenomenal landscape qualities and direct natural contact. In essence, children's developmental needs for environmental competence are best met when age-appropriate elements are considered. Eberbach's (1988) recommendations, which correspond with Trancik & Evans's (1995) and Heft & Chawla 's(2003) competence theories, include:

- **Diversity** of developmental affordances for varying physical, social and cognitive levels
- Scale environments for child **control** of spaces, including interactive parts
- Encourage **place identity** through child possession of manipulatable environments
- Create aesthetically pleasing, challenging, and **complex** elements that reflect child preferences and participation
- Encourage **exploration** through plants and loose parts
- Provide privacy and **restoration** through refuge points that improve independence and competence
- Provide **social participation** through gathering spots
- Encourage child autonomy in **accessible** sites through the least-restrictive garden environment possible through **safe** transportation, surveillance, and location factors
- Create **legible interpretation** of garden information appropriate to children (symbols, enhanced adult/child interactions, themes, etc.; Eberbach, 1988)

These guidelines provide the basis for the selection of themes in this thesis that involve wider participation, design, and behavior outcomes throughout multiple children's gardens. In the methods section, greater detail will be provided about the specific features and environmental competence benefits that will be explored through garden surveys, visits, and behavior-mapping measures.

Research Aims and Research Questions

From this background and literature review, the following research aims emerged:

> *Aim 1: Describe characteristics (e.g., age, size, organizational context, and mission statement themes) of children's gardens in the Northeast and Midwestern United States.*
>
> *Aim 2: Examine whether children's garden* ***mission statement themes*** *are reflected in participation (design, implementation, and organization) and design features (direct natural elements, affordance diversity, and usability) for* ***environmental competence****.*
>
> *Aim 3: Understand the relationship between children's garden* ***design features and children's use of gardens****.*

The following research questions were formulated to address Specific Aims 1–3, as articulated above. These research questions addressed the environmental psychology and developmental health implications of this research:

Research Question 1: What are the characteristics of children's gardens in the Northeast and Midwest (e.g., age, size and organizational factors)?

Research Question 2a: Do children's gardens with mission statements that include ***participatory design and empowerment themes*** *exhibit greater* ***children's participation*** *and design features, including* ***direct natural elements (e.g., ponds)****?*

Research Question 2b: Do children's gardens with mission statement themes that include ***accessibility and inclusiveness*** *exhibit greater* ***usability elements (e.g., scale, accessibility, legibility and safety elements)?***

Research Question 2c: Do children's gardens with mission statement themes that include ***children's health*** *exhibit design features with a* ***diversity of affordances?***

Research Question 2d: Do children's gardens with mission statements that include themes of ***environmental education and interaction*** *exhibit design features that include* ***direct natural elements?***

Research Question 3a: Is the ***proportion of direct natural elements*** *in design reflected in children's* ***preference for direct natural contact (behavioral density)?***

Research Question 3b: Is the ***affordance diversity*** *in design reflected in* ***diversity of children's play (behavioral diversity)?***

In the following methods section, these aims and questions will be explored in the context of children's gardens observations and surveys. The end result is an assessment of best practices and elements for grassroots gardens to consider when involving children's participation in school and neighborhood contexts.

Conclusion

Prior children's environments behavior studies suggest that spaces like gardens may encourage health and development. Mixed evidence remains, however, as to what specific elements best allow for this learning to occur and which support positive environmental and health behaviors. It's hypothesized that biophilic design with greater diversity, access, and exploration of "wild nature" may improve both physical and environmental behaviors. Furthermore, children's participation and preferences for such spaces may influence design. This report will attempt to look at this question from an exploratory standpoint, describing the elements that support environmental competence leading to healthy, sustainable behaviors.

CHAPTER 2

METHODS

This observational study is designed to describe play behavior and preferences within public children's gardens elements among children, and to examine how these behaviors and preferences are related to a) garden elements and b) different mission statement themes and children's participation in the design process. In order to discover whether garden spaces have any special attributes for children, garden designs will be systematically compared based on mission statement themes relation to garden elements and behaviors linked to children's environmental competence in the literature.

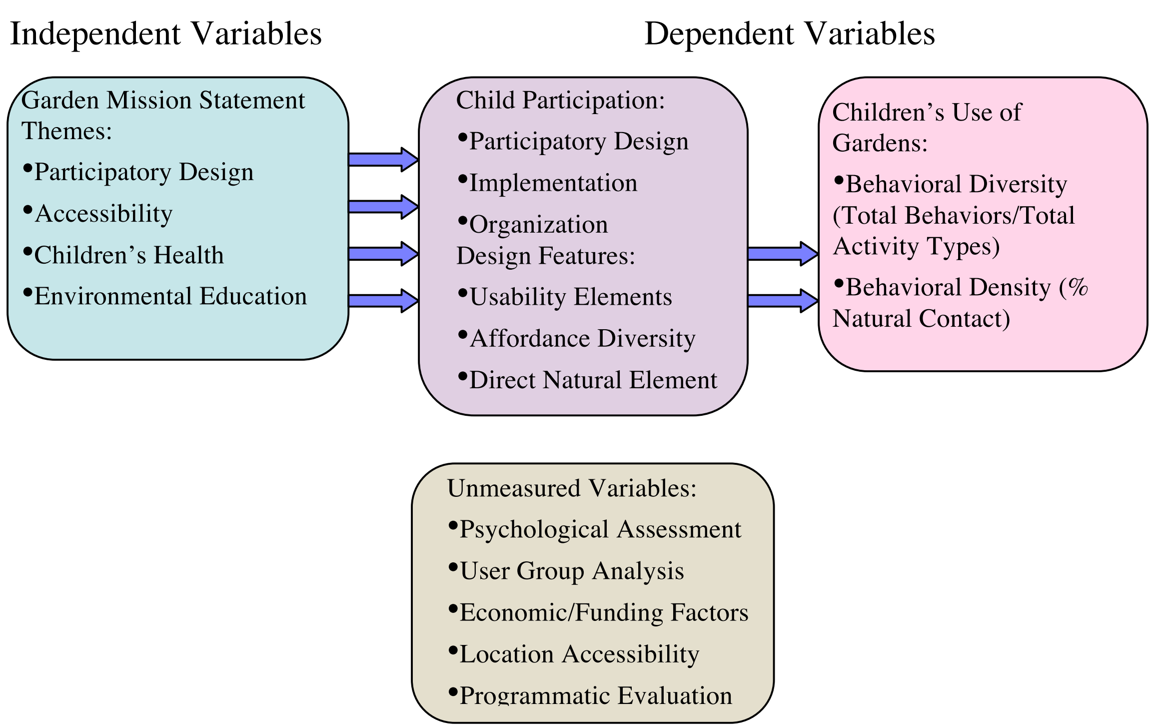


Figure 1: Constructs and measure diagram.

There are other factors not included in this framework that could be considered, including psychological measures of children's competence and place identity (such as the Pictoral Scale of Perceived Competence and Social Acceptance for Young Children, Harter & Pike, 1984) as well as some assessment of user groups, location factors (proximity to schools, daycare centers, multifamily housing), economic conditions (funding,admissions) and programmatic evaluation. Given that this study sought to understand implications of design on a broad scale for children's gardens, the focus instead looked at how features and children's participation affect behaviour and development according children's environments theories.

Settings and Participants

The 20 children's gardens to which surveys were sent were all located within approximately one days drive (500 miles) of Ithaca, New York. Through this survey, garden managers described the extent to which mission statement themes and children's participation in design of gardens were characteristic of the garden where they worked, and whether certain elements (see Appendix A) were present. At five of these gardens (three with children's participation, two without), I observed a total of 47 children, ages six to twelve, and 23 children ages two to five. All children that entered the play area with their parents after the decision to start the research were selected for observation. The parent or guardian was then approached to obtain permission and to record the child's age and gender. The children were then observed from a distance for a total of six minute "snapshots" at the beginning of each five minute sessions. The total observed population description is provided below.

Table 2: Behavior study population description.

	Total Children:	Total Boys:	Total Girls:	2 to 5	6 to 12
Brooklyn Botanical Garden - Discovery Garden	12	3	8	3	9
Buffalo and Erie County Botanical Garden - Children's Garden	15	9	6	7	8
Cleveland Botanical Garden - Hershey Children's Garden	16	12	4	7	9
Ithaca Children's Garden	16	8	8	2	14
Michigan 4-H Children's Garden	9	4	5	2	7

Constructs and Measures

Independent Variables

The independent variables include the garden mission statement themes of: 1) participatory design and empowerment, 2) accessibility and inclusiveness, 3) children's health and 4) environmental education and interaction.

Children's Garden Mission Themes

A brief exploratory survey of children's garden personnel was conducted to understand mission statements and obtain permission for design inventory and child use observations(see Appendix A). Children's garden mission statement themes were an independent variable in this study. The focus was four themes identified through a literature review of key children's garden objectives: **1. participatory design and empowerment** (Eberbach, 1988; Hart, 1997; Wake, 2007), **2. accessibility and inclusiveness**, (Cosco, 2007; Moore & Ringaert, 2005), **3. children's health** (Malone & Tranter, 2007; Ozer, 2007) and **4. environmental interaction and education** (Miller, 2005, Moore, 1989). Mission statement themes were measured using a survey e-mailed to garden managers or educators at twenty children's gardens (described above). The garden personnel were asked to indicate which of the four themes were included in their mission statements.

Dependent Variables

The dependent variables are measured with garden reported child participation survey, garden design inventory and observed child behaviors. The constructs that are measured include: 1) garden participation (design, implementation and organization) 2) usability (accessibility, safety, control, legibility), 3) affordance diversity (physical diversity and socialization affordances), and 4) direct natural elements (exploration and restoration affordances) 5) behavioural density (percent use of elements) and 6) behavioural diversity (total behaviours divided by total activities). These constructs are measured with garden reported child participation survey, garden design inventory and observed child behaviors. These constructs relate to aims and research questions established in the literature review.

Children's Participation in Garden

In the children's garden survey completed by the garden managers or educators 17 items measured three aspects of garden participation: **participation in design**, **participation in implementation**, and **participation in organization of the garden**. This instrument was a based on Lekies and colleagues' (2006) tool used in the Greener Voices program. Statements were rated on a one to five scale, with one being low participation and five being high participation. Table 3 summarizes the three subscales: 1) garden design (4items), implementation (4 items), and organization (9 items). An aggregate participation variable was created by averaging the 17 items and each subscale was scored by averaging the relevant items.

Table 3: Children's participation instrument (Lekies et al., 2006) administered to garden personnel. Subscales indicated by color code: design, implementation, organization.

The children/youth participate in discussions regarding the project	1	2	3	4	5	N/A
They are informed about the issues facing the project	1	2	3	4	5	N/A
They participate in project planning	1	2	3	4	5	N/A
They participate in project decision making	1	2	3	4	5	N/A
They contribute to problem solving	1	2	3	4	5	N/A
They serve in leadership roles	1	2	3	4	5	N/A
They carry out project activities	1	2	3	4	5	N/A
They take initiative in carrying out project activities	1	2	3	4	5	N/A
They make financial decisions about the project	1	2	3	4	5	N/A
They participate in advisory committees	1	2	3	4	5	N/A
They assume responsibility for carrying out the ongoing tasks of the project	1	2	3	4	5	N/A
They develop publicity about the project	1	2	3	4	5	N/A
They share information with other community groups about the project	1	2	3	4	5	N/A
They prepare written reports about project activities	1	2	3	4	5	N/A
They train new participants	1	2	3	4	5	N/A
They evaluate project activities	1	2	3	4	5	N/A
They report to project funders	1	2	3	4	5	N/A

The Physical Environment: Garden Design Inventory

This is an exploratory measure that was developed for this study using an inventory element checklist grouped by affordance categories, direct natural element categories, and usability elements (see Appendix D). M. Miller's (2005) checklist was used for the garden manager survey and inventory methodology, utilizing his literature-based garden elements research.

Affordance Diversity Index

The affordance diversity index provided an assessment of the variety of environmental supports in each children's garden (Heft, 1988). This variable was measured using an on-site inventory of features. Eleven affordance types (shown in Table 4) were recorded.

Table 4: Affordance types assessed in on-site garden inventory

, 1) flat, relatively smooth surfaces
2) relatively smooth slope,
3) graspable/detached objects,
4) attached objects
5) non-rigid attached object,
6) climbable feature,
7) aperture,
8) shelter,
9) moldable material,
10) water,
11) social interaction space.

Based on the tally of affordances, diversity was calculated by taking the number of each type of affordance (e.g., 5 attached objects, 8 smooth slopes, 3 water) and using the Simpson's Diversity Index (Eck & Ryan, 2009) to assess the garden's divergence from equaprobability (equal numbers of affordances). Based on Simpson's Diversity Index (which was initially developed to measure ecological diversity), a high diversity index number represents low diversity of environmental supports; a low diversity index number represents high diversity of environmental supports.

$$H' = -\sum_{i=1}^{R} p_i \log_2 p_i$$

Simpson's Diversity Index

For example, two gardens with four support characteristics – attached objects, shelter, moldable material and water – might have different distributions, with one garden containing 25% of each and the other 97% of one and 1% of three affordances. The garden with 25% of each would have a low diversity index number because the distribution of each type is equal – the garden with the 97% distribution would have a high diversity index number, indicating less affordance diversity.

Direct Natural Element Average

Within each garden, four types of natural contact elements (as identified by Kellert, 2002) were assessed. These range from the most natural (direct natural elements) to the least natural (built or non-natural elements). Definitions are below:

Table 5: Natural contact element definitions.

Direct Natural Elements: An element that recreates or maintains a relatively wild or natural setting and allows for barrier free contact with natural materials (woods, digging areas, wildflower areas, meadow, wetland, etc.). These places include areas for touching, observing, being surrounded by nature, and manipulating/interacting with nature (Gyllenhaal & Garibay, 2001)
Indirect Natural Elements: An element that requires human maintenance and guided participation to interact with natural processes (all cultivated areas, sustainability elements – green roofs, composting, etc.) (Kellert, 2002).
Symbolic Natural Elements: An element that represents nature but does not directly engage with a natural system (sculpture, art, models, interpretive signage, etc.) (Kellert, 2002).
Non-Natural Elements: An element that does not associate with natural systems (playground equipment, seating, buildings, etc.) (Moore et al., 2007).

An average score for amount of natural contact was assessed using a weighted ranking system (direct natural contact elements=4, non-natural elements=1), with the total number of each type added and divided by total number of elements. This system was based on a rating system developed at the Morton Arboretum which used a similar approach to understand high and low levels of natural contact (Gyllenhaal & Garibay, 2001). All inventory measures were conducted with on-site analysis, supported by photo documentation.

Usability Elements

Children's garden elements were tallied as usability elements when they met the following criteria:

> **Control Elements** (child scale, personalized elements -i.e. child art),
> **Safety Elements** (surveillance areas, boundaries, amenities), and
> **Legibility Elements** (interpretation and wayfinding).

Also recorded were internal and external accessibility elements, reported by garden managers. These included: ADA approved elevations, raised beds, paved pathways, bus access, walking/biking access, mass transit access and car access. The sum of all these elements together formed the usability element count per garden.

Children's Use of Gardens

Behavior mapping was conducted in five gardens to measure children's use of the gardens. The two specific variables of interest were **behavioral diversity and behavioral density**. A short interview was conducted with the parent to obtain children's ages and genders before starting observations (see Appendix B). The behaviour schedule (Hart & Madorrell, 2003) was used to assess behavioural diversity, while garden-provided maps were used to assess behavioural density (see Appendix C).

Child observations occurred during five minutes intervals using a systematic behavior mapping methodology (Sanoff & Coates, 1971). The observer recorded locations of children on a map of the garden area along with an associated element inventory sheet to record the quantitative features of the site such as time, date, etc. Every five minutes the locations and actions of the children are represented on a map with indicated symbols for a snapshot of children's use (e.g. Appendix C). The observer's location was chosen from a vantage point where all parts of the garden space could be observed and only moved when necessary to maintain sight of the child. After 15 minutes, the observation session ended, and two observations were taken at each site (for every ½ acre).

Children's Behavioral Diversity

Behavioral diversity is the ratio of behavioral density and the number of activity types at a particular place. A low ratio indicates that a setting is "ambiguous", in that its cues for certain behaviours are less proscribed. In essence, the more flexible the affordances an area provides, the more diverse the behaviors. According to Sannoff and Coates (1971), ambiguous spaces bring out the investigatory reflex (e.g. exploration) permitting more creative and unplanned behavior

This construct was measured by observing the total number of different behaviors observed at a garden and recording their activity locations using a tested behavior schedule and a garden map (Hart & Madorell, 2003). All observation tools were tested for reliability in 2003 and again in 2008, with 86% and 84% interobserver reliability respectively (see sample behavior map, Figure Y). Following this data collection, behavior diversity was measured using Sanoff and Coates (1971) method of dividing behavioral density (number of activity points on a map) by total number of behaviour types (active play, sensory play, etc.).

Table 6: Summary of environmental indicators, constructs and measures for children's gardens.

Environmental Competence Indicators	*Constructs for Environmental Competence*	*Survey*	*Design Inventory*	*Child Use Observation*
All	Mission Statement Themes	√		
Participation	Participation Average	√		
Exploration, Restoration	Direct Natural Elements Average		√	
Diversity and Socialization	Affordance Diversity Index		√	
Accessibility, Safety, Control, Legibility	Usability Elements	√	√	
Diversity, Socialization	Behavioral Diversity – Total Behavior Types Divided by Total Behaviors			√
Exploration, Restoration	Behavioral Density - Percent Use of Direct Natural Contact Elements			√

Children's Behavioral Density

Behavioral density is the total frequency of all types of activities at a place (Sannoff & Coates, 1971). The behavior map assessed the behavioral density as percent use of children's play in natural element areas (measured in the previous design inventory), providing a measure of preference for certain elements in the children's garden and suggesting which type of natural contact is preferred by children (Moore, 1989).

CHAPTER 3

RESULTS

This chapter presents the results of the survey, garden design inventory, and behavior mapping case studies to address the aims of describing children's gardens contexts, evaluating mission statement themes, assessing children's participation, and observing the physical environment and children's use of gardens.

Garden Descriptions

Aim 1: Describe characteristics (e.g., age, size, organizational context, mission statement themes) of children's gardens in the Northeast and Midwestern United States.

In order to address research aim 1, surveys were mailed to personnel at twenty children's gardens in the Northeast and Midwest. Of the twenty gardens surveyed, 12 responded from New York, Ohio, Michigan, Illinois and New Jersey. Answers concerning the context, design process and resulting garden elements helped to describe the history and characteristics of contemporary children's gardens.

The first part of the survey examined general characteristics of the garden, including garden size, context, management, and age. The respondent's professional position was also recorded. Sixteen percent of respondents (two) were garden directors, 33.3 % (three) were educators, 33.3% (four) managers, 8.3 % (one) designers, and 8.3% (one) answered "other" (i.e. director of education).

As summarized in Table 7, the physical size of the gardens ranged from 300 square yards to 4.5 acres, with an average size of two acres. It is important to note that gardens supported primarily through charitable donations (i.e. Erie Botanical Gardens and the Ithaca Children's Garden) or by larger foundations or public investments (Lena Meijjer Children's Garden and Cleveland Children's Garden) represent what is possible at both the low and high end of the funding scale and physical design. The average age of the gardens was 8.9 years, with a range from 1 year (Erie Buffalo Botanical Garden and Gaffield Children's Garden) to 23 years (Ruth Rea Howell Children's Garden).

The majority of the responding gardens were associated with botanical gardens (eight, 66.7%), while the rest were made up of arboretums (three, 25%), parks (two, 16.7%), educational facilities (one, 8.3%), and stand alone gardens (one, 8.3%). Given this wide range of contexts, another question of interest was the management of the garden. Most were run as non-profit institutions (nine, 75%), while several gardens mentioned university affiliations (three, 25%) and public institutions such as parks departments (two, 16.7%) as organizational partners. Several respondents mentioned multiple types of associations to make a garden possible, including a combination of public, private and non-profit support. Given this background, it was assumed that the gardens' mission statements and design participants would reflect a broad range of stakeholders and educational goals both within the boundaries of the gardens and in the outreach to surrounding communities. This proved to be true, with many gardens providing free admission on select days, implementing learning gardens in schools and community spaces, and hiring youth to maintain and teach lessons.

Survey respondents were asked to indicate whether or not each of the following four themes was part of the gardens' mission statement: 1) participatory design and empowerment 2) accessibility and inclusiveness 3) children's health 4) environmental education and interaction. To validate these responses, a second researcher was asked to rate each of the gardens' mission statements as one of four themes, resulting in a fair Kappa agreement score of .46 (see Limitations section). As summarized in Table 7, 4 respondents (33%) indicated participatory design was part of their mission; five respondents (42%) included accessibility as part of mission; fou

Table 7: Key descriptive characteristics of children's gardens surveyed (n=12).

* PDE – Participatory Design and Empowerment; AI – Accessibility and Inclusiveness; CH – Children's Health; EE- Environmental Education and Interaction

	Acres	Opening Year	Type	Mission Statement Themes*			
				PDE	AI	CH	EE
Brooklyn Botanic Garden	0.3	1996	Botanical Garden		√		√
Camden Children's Garden	4.5	1999	Other - Stand Alone			√	√
Erie and Buffalo Botanical Garden	0.06	2008	Botanical Garden	√	√	√	√
Gaffield Children's Garden	1.75	2008	Botanical Garden	√	√		√
Hershey Children's Garden	0.5	1999	Botanical Garden				√
Inniswood Sisters Garden	3	2002	Botanical Garden, Park			√	√
Ithaca Children's Garden	3	1999	Park	√			√
Leila Arboretum Children's Garden	1	2003	Arboretum				√
Lena Meijer Children's Garden	3.5	2004	Botanical Garden				√
Michigan 4-H Children's Garden	1	1993	Botanical Garden, Educational Facility, Arboretum	√	√		√
Morton Arboretum Children's Garden	4	2005	Arboretum				√
NYBG Ruth Rea Howell Family Garden	1.5	1986	Botanical Garden		√	√	√

respondents (33%) included children's health and all 12 respondents included environmental education (EE).

Stakeholder participation in the design process was another key interest of this study. Although only four of the twelve gardens indicated that "participatory design" was part of their mission statement, responses indicated that stakeholders are quite involved. Of the gardens surveyed, 100% involved educators, 91.7% involved horticulturists, and 83.3% involved landscaped architects in the creation of their designs. Furthermore, 33.3% involved college students, 16.7% involved high school students, 58.3% involved elementary students, and 8.3% involved preschoolers. Also mentioned was the involvement of volunteers, community members, and other staff and supporters (41.7%). Of particular interest to this study is the involvement of elementary school students aged six to twelve, given this is the group whose attitudes and values towards nature are developing most in terms of environmental interaction (Kellert, 2002). The relation between mission statements and participation is examined further in research aim 2.

Case Studies

The second approach to addressing research aim 1 was to conduct qualitative case studies of the gardens in addition to the survey. In the following pages, the origins, design methods, and design results are briefly described for each of five gardens for which in-depth behavioral studies were conducted. This is followed by more succinct descriptions of seven additional gardens.

Michigan State University 4-H Children's Garden

Origins - The very first children-only themed garden began in 1993 in East Lansing on the campus of Michigan State University. The project was begun by a passionate and visionary botanist and horticulturist, Jane Taylor, who observed the lack of interaction and child-friendly gardens in all European and U.S. botanical gardens. Working at the university with a developmental scientist, Jane began to plan a garden specifically for preschool ages and older, with the help of Jeffery Kacos, Division of Campus Park and Planning, and Deborah Kinney, University Landscape architect.

The first major issue in the development of the garden was the participation and input of young children, about which there was very little research in the design field. To solve this, Jane and colleagues involved the on-campus child development

Figure 2: Child vegetable plots.

department pre-school class in the design process. Their reasoning was that for kids to use a garden, they must be engaged through first-hand experience of the garden, not second-hand, such as most symbolic environmental imagery such as kids' books and TV. Furthermore, young children do not have the ability to discriminate between information sources (such as TV, cartoons, poetry, etc.) and therefore, the design process would have to be aware of responses that may range from completely imaginary to completely reality based. Given these two starting points in child development, researchers proceeded to involve children in the participatory process.

Design Methods - This design methodology included sixty children between three to five years old at the Michigan State University elementary school. Children came from diverse ethnicities reflecting the international graduate student population that attended the university. Researchers used an open-ended storybook with pictures and employed a question format about a grandfather planting a garden. Children were asked to fill in the blanks in the story with what they would want in the garden. Some patterns were observed, such as repeated mention of food production, planting, watering, weeding and harvesting. This reflected a good knowledge base about the fundamentals of what a garden was, and confirmed designers and horticulturalists plans for abundant flowers and vegetables in the garden. Other items mentioned by the kids, included areas for active physical play, images from children's books and TV, and other fantasy characters, such as Beatrix Potter's Peter rabbit.

Design Results - The result of this process was a garden that encompassed fantasy, storybooks, and food gardens. For instance, some areas include the cottage garden (reflecting nursery rhymes) the enchanted garden (for fairy tales) and the dinosaur garden. Beyond these themed areas, dwarfed fruit trees, raised vegetable gardens, a

Figure 3: "Monet Bridge" and pond.

maze, a science garden, international gardens, musical gardens and an amphitheatre were added to attract school groups and others interested in horticulture based curriculum. There is an emphasis on first-hand sensory experience that supports a young child's need for small informational cues that build on each other over time. Eventually, these experiences form generalized patterns in the child's brain that in turn create expectations for future environmental experiences. It is hypothesized that using familiar cues (such as story characters) with first-hand experience (children's garden) helps to build complex concepts like environmental knowledge (Whiren, 1995).

The pioneering example of the 4-H Children's Garden exhibits how youth can contribute broad ideas mixing fantasy and reality, and their participation may contribute to the design of more effective learning environments. As the garden expands to include child designed vegetable plots, such experiential learning may expand for greater environmental competence. (Albright, personal communication, April 13, 2009; Taylor, personal communication, April 20, 2009; Whiren, 1995)

Cleveland Botanical Garden – Hershey Children's Garden

Origins - The Cleveland Botanical Garden Hershey Children's Garden, opened in 1999, represents a multi-faceted effort to bring natural interaction for children to the urban environment. With the help of a committee of trustees led by Debra Hershey Guren, staff, garden designers, horticulture experts and 100 children, the Hershey

Figure 4: Tree house.

Foundation supported the creation of this whimsical, child-centered landscape.

Design Process - At the beginning of the design process, a consensus was reached by the design committee that no overly designed, manicured, or inauthentic spaces were desired. Instead, the adult visioning session revealed the following as guiding aims: a sense of “magical realism”, plenty of “teachable moments” and a curiosity and love fore plants and nature. With these three goals in mind, a discussion and consultation session began, led by Herb Schaal, landscape architect with Eckbo, Dean, Austin and Williams (EDAW), and the participation of local school children. When asked to draw what they would want in an ideal garden, the top responses were: apple trees, flowers, tree houses, ponds, and birds. Using this brainstorming session, the committee, designers and local artists set to work creating plenty of child-scaled environments with emphasis on two major themes: 1) wild natural areas and 2) horticultural discovery areas. Plant selection was also a major concern, with special concern for varieties that interest children, with maximum fragrance, color, and multi-seasonal appeal, as well as native, drought tolerant plants from local nurseries (Heffernan, 2004).

Design Results - The final design was a captivating garden with both cultivated education areas around food, plants and sensory interaction, and a more uncultivated nature exploration area to engage the imagination. In the naturalized area, woodland

Figure 5: Mulberry "forest" and gathering area.

area, a mulberry "fortress" for hiding, a natural Ohio prairie, bird blind, pond and tree house all represent local environments. In the horticultural areas, a miniature cottage, maze, vegetable path, dwarf orchard, compost area, dinosaur garden, digging pit, water pump and scroungers (recycled) garden all teach how human-plant interactions work. Finally, artist designed insect gate and four season fountain welcome guests to the space (Steffen, personal communication, April 11, 2009; Heffernan, 2004).

Brooklyn Botanical Garden – Children's Garden and Discovery Garden

Origins - The Children's Garden was the first plot-based program established in a botanical garden in 1914, followed by the Discovery Garden's creation over 80 years later in 1996. The garden is located adjacent to a popular park in Brooklyn, and easily accessible by subway. With Tuesdays and Saturdays free, the garden also is economically accessible to families throughout New York. Both gardens contribute to

Figure 6: Bamboo waterway.

children's understanding of the natural world, serving both traditional plant based education and free play. Together, the gardens represent a broad range of natural activities and experiences in an urban environment.

Design Process - The story of the Brooklyn Botanical Gardens began with Ellen Eddy Shaw, a school teacher with a vision for the benefits of garden-based learning for urban children. After establishing the original children's garden program, she incorporated several incentives and mentor positions for children as they grew. She empowered them with an awards system for exceptional gardening work, and starting the Junior Instructor Program to both deal with the overwhelming applicants to the garden, as well as give older children a chance to teach their skills to newcomers. This program is now known as the Garden Apprentice Program, and it, like the Children's Garden Program, stands as a model of children's participation in maintaining and building garden space.

Figure 7: Topiary maze.

Design Results - The Discovery Garden was an outgrowth of the growing experiential learning movement in museums and schools, encouraging children's education through play. "Discovery Carts" were first introduced in 1995 to engage children in hands on exploration and experiments with plants and natural materials, which later resulted in the popular "Nature's Toys" exhibit in the garden. The area promotes direct contact and manipulation of natural objects, whether that is plants, water, wood, or other materials. Essentially, the Discovery Garden, designed by landscape architects and influenced by educators, reflects the missing pieces of the Children's Garden (vegetable plots). A naturalized woodland area, bamboo waterway, bamboo forest and rock garden all encourage movement, adventure play, exploration and hands-on manipulation of the environment. Adjacent to the Children's Garden plots, sensory beds and a meadow encourage touch, smell, sight, butterflies and birds to be explored with signage and binoculars. Hidden spaces under a mulberry tree, in a spider maze, a toddler lawn and a rainbow garden provide calming areas for children to safely get lost in the space. This garden's story is one of an inclusive and interactive space that encourages children of all ages and abilities to benefit both guided and self-directed learning (Smith, personal communication, April 25, 2009; Brooklyn Botanic Garden website, 2009).

Ithaca Children's Garden

Origins - The Ithaca Children's Garden was begun by three women passionate about children's gardening - Harriet Becker, Mary Alyce Kobler and Monika Roth. Beginning in 1997, the three formed a partnership with Cornell Cooperative Extension as a non-profit organization.

Figure 8: "Growing Gardens" entrance.

To realize their idea, inspired by the Michigan 4-H Children's Garden, the women organized an advisory committee to include educators, gardeners, parents, landscape designers and city officials. This helped with fundraising and brainstorming as to how the Ithaca Children's Garden should be designed. It was decided that to gain community support and momentum, CCE would pilot educational gardening programs throughout Ithaca. With educational programming established, site selection began, and a 3 acre parcel within a city park was selected as an accessible site to downtown and the Cayuga Lake waterfront.

Design Process - Two separate children's garden design sessions were held – one with children and parents, and one with local horticultural enthusiasts. The first involved 50-60 community members, and involved children's drawings and murals. The

Figure 9: Straw bale "troll house" and wetland.

second meeting involved about 30 community members and involved a 3D modeling and visioning event, in which a more formal timeline for implementation of a master plan was created. Furthermore, there was a design contest for the discovery gardens along the garden's "serpentine path" that are today still in construction phases.

Cornell University's involvement was led by two Cooperative Extension specialists – Marcia Eames-Sheavly and Monika Roth, both who are involved with local food and garden-based learning initiatives throughout Tompkins County. Their input was critical in the design and visioning process. The final design was based on community meetings and was formally drafted by landscape architect Rick Manning and several local artists in the community.

Design Result - As a result, the garden has involved a wide diversity of stakeholder groups, and educational programming has included many diverse users, from toddlers

Figure 10: Children with "Gaia the Turtle" statue (Ithaca Children's Garden website, 2009)

to elementary and high school ages. Environmental education, healthy eating, afterschool clubs and special events celebrate the design of the space, from the "Growing Gardens" to the symbolic "Gaia the Turtle" and wetlands.

The slow growth of the garden has allowed for continuous creative additions from the community (like the recent straw bale "troll house") so that design and programming evolves with the needs of the users. Another design solution has been to allow greater volunteer ownership and personalization on site (volunteer stepping stones, or a signature on one of the shed murals). The Ithaca Children's Garden provides a realistic model for a start-up garden design that includes a broad stakeholder group in its continuing design (Becker, personal communication, November 10, 2009).

The Buffalo and Erie Botanical Children's Garden

Origins The Buffalo and Erie Botanical Gardens represents one of the newest examples of a children's garden, whose growing space and educational programming have been shaped by the successes of the past two decades. Generous contributions and volunteer hours from local community groups have constructed many features of the garden given its limited funding.

Figure 11: Water pumps and digging area.

Design Process - Lynn Wieser, Director of Education for the garden, visited the 2005 National Youth and Children's Garden Symposium in Atlanta, Georgia, and was inspired by Sharon Lovejoy's presentation on children's gardens: "Multidisciplinary and interactive learning in a children's discovery garden should be fun while empowering kids with a sense of ownership" (Lovejoy, 2005). This became the mission of the new children's garden which opened in 2008.

Figure12: Vine arbor

Design Results - Key considerations in the design of this garden were the following: multisensory environments, interactive learning components, accessibility, safety, natural materials and diverse appeal. The notes from the 2005 symposium also reflect a commitment to

children's participation in the development of the garden, though this has not yet been a part of the design process (Weiser, personal communication, April 20, 2009).

The Sister's Garden - Inniswood Metro Gardens - Survey and Design Inventory

The Inniswood Metro Gardens provide an example of a city run parks system with a memorialized space to its benefactors, Grace and Mary Innis. The sister's donated the 121 acre park to the metro system, and the Children's Garden was

Figure 13: Willow arbor.

designed in their honor. The garden was designed by landscape architects, with the assistance of horticulturists, educators, garden volunteers and members. Children also influenced the design of this space, by carrying out garden design activities, participating in discussions about the design and informing the community about the space.

The resulting space involves a combination of Ohio folklore and local habitats. A broad history of local culture is explored from the Entry and Country garden, celebrating the Innis sister's rural life and agriculture of central Ohio, to the Native American Story Maze, Circle Maze and Turtle Mound, educating about the region's indigenous peoples. A Secret Garden, Wetland Garden, and Trellis Cave also provide hidden spaces and natural habitats for children to explore (all information from site visit).

Ruth Rea Howell Family Garden – New York Botanical Garden –Survey

The Ruth Rea Howell Family Garden is an interactive, plot and theme garden in the Bronx. This originally began as a Children's Gardening program, like that of the Brooklyn Botanical Garden, and has evolved into its current program area starting in 1986. The Family Garden allows families to have their own plots and enjoy themed gardens, ponds, meadows and bean tunnels. Some of the newest additions include a carnival garden, seashore garden, candy garden, salsa garden and sunflower house. Additionally, children's admission is $1, and local parents only $5, with several free days, including Wednesdays and Saturdays. In this way, the garden is inclusive and accessible to many groups throughout New York (New York Botanical Garden website, 2009).

Camden Children's Garden - Survey

The Camden Children's Garden serves a large metropolitan area with a mission "to provide horticultural related, recreational and educational opportunities for residents of all ages of the City of Camden and the Deleware Valley"(Camden Children's Garden, n.d.). The Camden City Garden Club, started in 1985 as a grass-roots effort to build community gardens in Camden, and soon grew to encompass school programs and at-risk youth job training. This led to the creation of the garden in 1993 as a "horticultural playground", including a Dinosaur Garden, Maze, Tree

House, Picnic Garden, CityScapes Garden, Storybook Gardens and the Fitness Garden (Camden Children's Garden). Furthermore, a Carousel, Train and the Spring Butterfly Ride provide amusement-park like attractions. An amphitheatre, indoor butterfly house and potting shed round out the activities here. This is a comprehensive tourist attraction for the region which has supported youth development, job creation and waterfront redevelopment in the process (Camden Children's Garden website, 2009).

Gaffield Children's Garden - Matthai Botanical Gardens – Survey and Design Inventory

The Gaffield Children's Garden is another university sponsored garden that relied heavily on the input of college students and elementary aged students to influence the design of this new and still evolving garden. Construction began in 2008 and will be completed in 2010 for the 1.75 acre site. University of Michigan landscape architecture professors and students led the effort to include focus groups about children's favorite places and activities. Children from 2nd through 6th grade classes mentioned secret spaces, tree houses, and vegetable planting areas as their preferences. Using their input, landscape architecture professors and a masters student completed concept drawings in 2006, including 16 gardens with heavy emphasis on direct natural exploration, digging, and hands-on construction. The current development includes a "growing gardens", entry tunnel, "fairy knoll" and maze, and

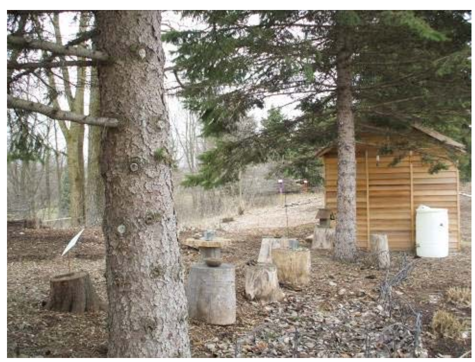


Figure 14: Fairy and troll knoll.

future areas include a ‘builders garden”, orchard grove, sensory garden, “secret spaces”, amphitheatre, tree house and animal habitat hiking trail. This garden represents a trend toward natural interaction and manipulation that the environmental psychology field has promoted for children’s spaces (Weiss, personal communication, April 20, 2009).

Leila Arboretum Children’s Garden – Survey and Element Inventory

Figure 15: Cereal garden.

The Leila Arboretum Children’s Garden is an outdoor classroom that serves the Battle Creek school district and families in surrounding areas. Only 60 miles from the Michigan 4-H Children’s Garden, this space provides multiple examples of local culture, lessons on children’s health, plants and literacy, as well as sculpture and murals from regional artists and students alike. Educators and horticulturists were the major contributors to the design, including consultation with the 4-H garden’s Jane Taylor. Several youth contributions included painted pavings, stepping stones and a large dog sculpture of reclaimed branches from the surrounding arboretum. Some of the themed areas include: a “healthy me” garden, cereal garden, native “four winds” garden, potting bench, sundial, butterfly garden, caterpillar garden, climbing area, ABC garden, grape arbor, maze, storybook garden, fairy garden, game area, teaching pavilion and cupola. The Leila Arboretum Children’s Garden is not open to the general public except on special event days, but provides a frequent school field trips and regularly scheduled classes (Jones, personal communication, April 13, 2009).

Frederick Meijer Gardens and Sculpture Park – Lena Meijer Children's Garden – Survey and Design Inventory

This five acre garden opened in 2004 is another example of the Michigan children's garden movement. Elementary and college student input at the initial design process, much like that of the Cleveland Hershey Children's Garden, resulted in a large, fully-handicap accessible facility. EDAW landscape architect Herb Schaal

Figure 16: "Kid-Sense Garden"

led the project, adding unique features to the site such as the "Great Lakes Garden" and water play area, a "Rock Quarry" with local fossils, and the "Kid-Sense Garden", with areas devoted to plants for the five senses. A " Story Telling Garden" and "Tree-House Village" complete with brail signs engages all visitors in the Great Lakes' natural heritage. A large interior wetland provides wildlife education and observation, with moveable carts for experiential learning guided by Play Activity Leaders (site visit and Frederick Meijer Gardens website, 2009).

Morton Arboretum Children's Garden – Survey and Design Inventory

Origins - The Children's Garden at Morton Arboretum opened in 2005 with a purpose to provide hands-on learning through an outdoor museum setting in the Chicago suburb of Lisle, Illinois. Planned by the Hitchcock Design Group, which specializes in exhibit work, the garden has a clear mission to let children "explore, learn, play and celebrate in nature" (Johnson, April 11, 2009; Gyllenhaal & Garibay, 2001). In the initial design stages, eight-year-old children were interviewed, and administrators, educators and horticulturists were consulted. The resulting elements included a grotto and stream, "wonder pond", "curiosity garden", "tree finder grove", playgrounds,

Figure 17: "Tree Finder Grove"

flower models, giant's garden (large scale plants), a tree house and windmill garden. Following several years of use, the garden underwent a design evaluation by an outside consultant, with several important findings. Children interviewed between 10 and 11 years of age revealed that the garden allowed for safe, fun adventures, with memorable areas including the water, animals and climbing structures. When observations were conducted, children were found to have high levels of physical, social, intellectual and emotional engagement with areas that provide direct contact with nature. In the consultants' recommendations, these areas (like the grotto and stream and wonder pond), benefited from high experimentation, conversation, and observation, which could be supplemented by greater interpretive materials in the built areas, like the playground, flower model area, and tree house. Separating direct experience from interpretive materials was key for children to engage their senses and interact with the natural spaces. Such integration of natural areas near to built areas might improve the gardens mission to connect natural affinity with nature learning.

Table 8: Key findings from qualitative interviews and survey.

Environmental Competence Indicators	*Design and Participation Features*	*Exemplary Children's Gardens*	*Key Qualitative Findings*
Exploration, Restoration, Diversity	Direct Natural Elements; Diverse Affordances	Ithaca Children's Garden, Gaffield Children's Garden, Inniswood Sister's Garden, Brooklyn Botanic Discovery Garden, Hershey Children's Garden	Provide continuous wild spaces that allow for uninterrupted exploration and restoration in hidden, manipulatable environments. Place popular natural affordances together (natural materials for construction, water and dirt for manipulation) for a diversity of passive and active play.
Participation, Socialization, Diversity	Indirect Natural Elements; Participatory Design, Implementation and Organization; Diverse Affordances	Ithaca Children's Garden, Gaffield Children's Garden, Michigan 4-H Children's Garden, Brooklyn Botanic Discovery Garden, Hershey Children's Garden, Ruth Rea Howell Family Garden	Provide child designed vegetable plots and projects in programmed spaces. Encourage non-programmed activities in themed gardens with manipulatable areas ("repotting stations", multisensory area plants for touching, hearing, smelling) and interactive "loose parts" for discovery (hand pumps for watering, root view cabinets at child level).
Legibility (Wayfinding, Interpretation), Diversity, Socialization	Symbolic Natural Elements; Usability Elements; Diverse Affordances	Inniswood Sister's Garden, Hershey Children's Garden, Ithaca Children's Garden, Leila Arboretum Children's Garden, Morton Arboretum Children's Garden, Lena Meijer Children's Garden, Camden Children's Garden	Encourage interpretive signage where horticultural elements, sustainability elements, and other learning objectives need clear instruction. Allow symbolic play and learning to occur with climbable or interactive sculpture that connects to the horticultural and wild areas.

Table 8: (Continued)

Usability (Accessibility, Control, Safety)	Non-Natural Elements; Usability Elements	Michigan 4-H Children's Garden, Morton Arboretum Children's Garden, Leila Arboretum Children's Garden, Lena Meijer Children's Garden	Integrating safety features that are inconspicuous (hidden fencing and surveillance areas) may help children to build competence and autonomy. Furthermore, remembering natural materials and child scale is key.

Garden Mission Statements Analysis

Aim 2: Examine whether children's garden ***mission statement themes*** *are reflected in a) participation (design, implementation and organization) and b) in design features that foster* **environmental competence** *(direct natural elements, affordance diversity and usability)*

To address research aim 2, the association of mission statement themes with: a) children's participation, and with b) design features including amount of direct natural elements, usability and affordance diversity, were analyzed using the two-group means comparison t-test. First, the relation between the mission statement themes of "participatory design and empowerment" and children's participation in design, implementation, and organization was evaluated based on a survey administered to the 12 gardens in the study. Second, an on-site garden design inventory was used to assess the relation between mission themes and design features for environmental competence characteristics at 10 gardens (e.g. direct natural elements, usability and affordance diversity).

Mission Theme a: Participatory Design and Empowerment

Research Question 2a: Do children's gardens with mission statements ***including participatory design and empowerment themes*** *have greater*

children's participation *and design features including* ***direct natural elements (e.g. ponds)****?*

Table 9 presents the comparison of mean participation level (in design, implementation and organization) for children's gardens with and without "participatory design and empowerment" in their mission statement themes. Despite the modest sample size, the trend suggests that children's gardens with "participatory design and empowerment" (PDE) themes in their mission statement have greater child participation (ages 6 to 12) than gardens without PDE in their mission statements. Specifically, (on a scale of 1-5), greater children's **design participation** was reported by staff at garden's with mission statement themes of participation and empowerment (2.38) than by those without that theme (1.47). Similarly greater **implementation participation** by children was reported at gardens with PDE mission themes than without (1.75 v. 1.19) as well as greater **organizational participation** (1.28 v. 1.03). Lastly, scores for these three types of participation were averaged, showing an overall higher level of participation reported among children at gardens with PDE mission statement themes (1.65) than without such themes (1.17).

Table 9: Mission Statement Theme: Participatory Design and Empowerment – Relation to children's participation reported by garden personnel

Main Construct	**Participation Type**	**Yes (n=4) X(sd)**	**No (n=6) X(sd)**
Participation (1=Low, 5=High)	1) Design Participation	2.38 (.95)	1.47 (1.11)
	2) Implementation Participation	1.75 (1.06)	1.19 (.69)
	3) Organizational Participation	1.28 (.99)	1.03 (.73)
	Total Participation Average	1.65 (.87)	1.17 (.74)

In addition to the association found between mission statement themes and reported participation, a greater mean number of direct natural elements and indirect natural element was also found among gardens with PDE in the mission statement than among those without. As shown in Table 10, in three of the five comparisons differences were in the predicted direction (highlighted in Table 10),. This trend suggests that children's gardens that have "participatory design and empowerment" (PDE) themes in their mission statement have a greater **direct natural element** average (6.75) than gardens without PDE in their mission statements (6.50). Similarly a greater number of **indirect natural elements** were observed in gardens with PDE mission themes than without (13.75 v. 12.17). Moreover, the more built elements (symbolic and non-natural) were higher among the gardens without PDE in their mission statements. Lastly, averaging the scores (4=direct natural; to 1=non-natural) of all elements in the garden showed an overall higher mean in gardens with PDE mission statement themes (2.44) than without such themes (2.21). None of these comparisons were statistically significant given the small sample size, and the large standard deviations suggest high amounts of error. Overall, though, the trends appear to be in the predicted direction.

Table 10: Mission Statement Theme: Participatory Design and Empowerment – Relation to direct natural elements

Main Construct		**Subconstruct**	**Yes (n=4) x(sd)**	**No (n=6) x (sd)**
Direct Natural Element Means (55 possible elements)	Built ←→ Natural	1) Direct Natural Elements	6.75 (4.27)	6.5 (2.35)
		2) Indirect Natural Elements	13.75 (4.99)	12.17 (4.26)
		3) Symbolic Natural Elements	4.25 (3.30)	6.33 (2.94)
		4) Non-Natural Elements	11.25 (4.11)	15.66 (4.27)
		Direct Natural Contact Average (1=Low, 4=High)	2.44(.20)	2.21 (.29)

Mission Theme b: Accessibility and Inclusiveness

*Research Question 2b: Do children's gardens with mission statement themes including **accessibility and inclusiveness** have design features including **usability elements (e.g. control, accessibility, legibility and safety elements)?***

Table 8 presents the mean counts for usability elements (control, safety, legibility and accessibility elements). Three of the seven subconstruct comparisons were in the predicted direction (highlighted in Table 11). Usability elements of control (child scale) (7.11), internal accessibility (2.40) and external accessibility (3.00) were more prominent in gardens that had the mission statement theme of "accessibility and inclusiveness" than in those that did not (6.50, 2.14 and 2.63 respectively) (see Table 11).

Table 11: Mission Statement Theme: Accessibility and Inclusiveness – Relation to relevant design elements

Main Construct	**Specific Design Elements**	**Yes (N=4) X(sd)**	**No(N=6) X(sd)**
Usability Elements Means (55 Possible Elements)	1) Control (Child Scale)	7.00(1.41)	6.50(3.74)
	2) Control (Personalization)	.00(.00)	1.75(1.66)
	3) Safety (Fences, Security, Surveillance Areas, Health Amenities)	5.50(.71)	7.38(1.92)
	4) Legibility (Interpretive Elements)	1.00(1.41)	3.38(1.19)
	5) Legibility (Wayfinding Elements)	.50(.71)	1.38(1.60)
	6) Internal Accessibility (Universal Design Elements)	2.40(.55)	2.14(1.21)
	7) External Accessibility (Transportation Elements)	3.00(1.41)	2.63(1.06)
	Total Usability Elements	23.75(7.76)	24.17(5.12)

Overall, when measured by counting total elements, the gardens with the mission statement theme of "accessibility and inclusiveness" did not differ substantially from the gardens without accessibility themes in their mission statements; the mean was only slightly lower for gardens with the mission statement "accessibility and inclusiveness"(23.75) than those without (24.17). These findings are not statistically significant, and four of the seven indicators were in the opposite direction, suggesting inconclusive findings.

Mission Theme c: Children's Health

*Research Question 2c: Do children's gardens with mission statement themes including **children's health** have design features with a **diversity of affordances?***

Table 12 presents the data of the affordance diversity index and observed counts for each affordance type (indicating a greater distribution of the 11 affordance categories) for gardens with and without the "children's health" mission statement theme. Design features with a diversity of affordances are linked to support of healthy physical development (fine and gross motor skills) and social development (social dramatic and social cooperative play) (Hart, 1997). Therefore it was expected that gardens with mission statement themes related to health might have more diverse element features that encourage the broadest range of activities. However, contrary to expectation, the affordance diversity index (0=equally diverse affordances, 1=no diversity) was not lower among gardens that included mission statement themes of "children's health" (.54) than among those without "children's health" themes (.35). Note that a lower affordance diversity index represents a more equal distribution of environmental supports, which is preferred for physical and social development. These data are inconclusive given the disproportionate number of gardens in each category (N=2 for gardens with "children's health" mission statement theme verses N=8 for gardens without).

Table 12: Mission Statement Theme: Children's Health – Relation to relevant design elements

Main Construct	Subconstruct	Yes (N=2) X(sd)	No(N=8) X(sd)
Affordance Diversity Means (55 Possible Elements)	1) flat, relatively smooth surfaces	4.00 (1.41)	5.25 (2.12)
	2) relatively smooth slope	1.50 (2.12)	2.75 (1.39)
	3) graspable/detached objects	3.00 (2.83)	3.75 (1.91)
	4) attached object	12.5 (.71)	12.5 (5.15)
	5) non-rigid attached object	8.00 (1.41)	9.25 (5.12)
	6) climbable feature	2.50 (2.12)	4.25 (2.49)
	7) aperture	3.50 (2.12)	4.87 (.64)
	8) shelter	3.00 (2.83)	5.88 (2.42)
	9) moldable material	.50 (.71)	1.37 (1.19)
	10) water	3.00 (1.41)	2.50 (1.20)
	11) social interaction space	3.50 (2.12)	4.37 (2.14)
	Affordance Diversity Index	.54 (.34)	.35 (.18)

Mission Theme d: Environmental Education and Interaction

Research Question 2d: Do children's gardens with mission statements including ***environmental education and interaction*** *have design features including* ***direct natural elements?***

All children's gardens responded positively, indicating the presence of the mission statement "environmental education and interaction." Thus, a comparison of gardens with and without the theme was not possible. Direct natural element average was the dependent variable design features for this mission statement. The mean score for direct natural element overall was 2.30 (4=direct natural; to 1=non-natural)) with a standard deviation of .27. The highest score on this measure was 2.62, the lowest 1.80.

Children's Use of Gardens

Aim 3: Understand the relationship between children's garden ***design features and children's use of gardens****.*

In order to address research aim 3 concerning the relation between designs and children's use of gardens, five gardens were selected from the larger group. These gardens had to meet the following criteria to be selected for a behavioral analysis:

- A garden map was provided
- The garden gave permission for a behavior study

The following behavior maps and analyses focus on measures of behavior density (percentage of child behaviors engaged in direct, indirect, symbolic and non-natural contact) and behavior diversity (total behaviors divided by total activity types) to address research aim 3.

The behavior maps represent the raw data for the Ithaca Children's Garden, Buffalo and Erie Botanical Children's Garden, Michigan 4-H Children's Garden, Cleveland Botanical Hershey Children's Garden and Brooklyn Botanic Discovery Garden. Each contains six observational snapshots (at 5 minute intervals) with symbols representing adults (orange), boys (blue), girls (pink), two to five year olds (light colors), six to twelve year olds (dark colors), active play (triangles) and passive play (circles) observations.

Ithaca Children's Garden

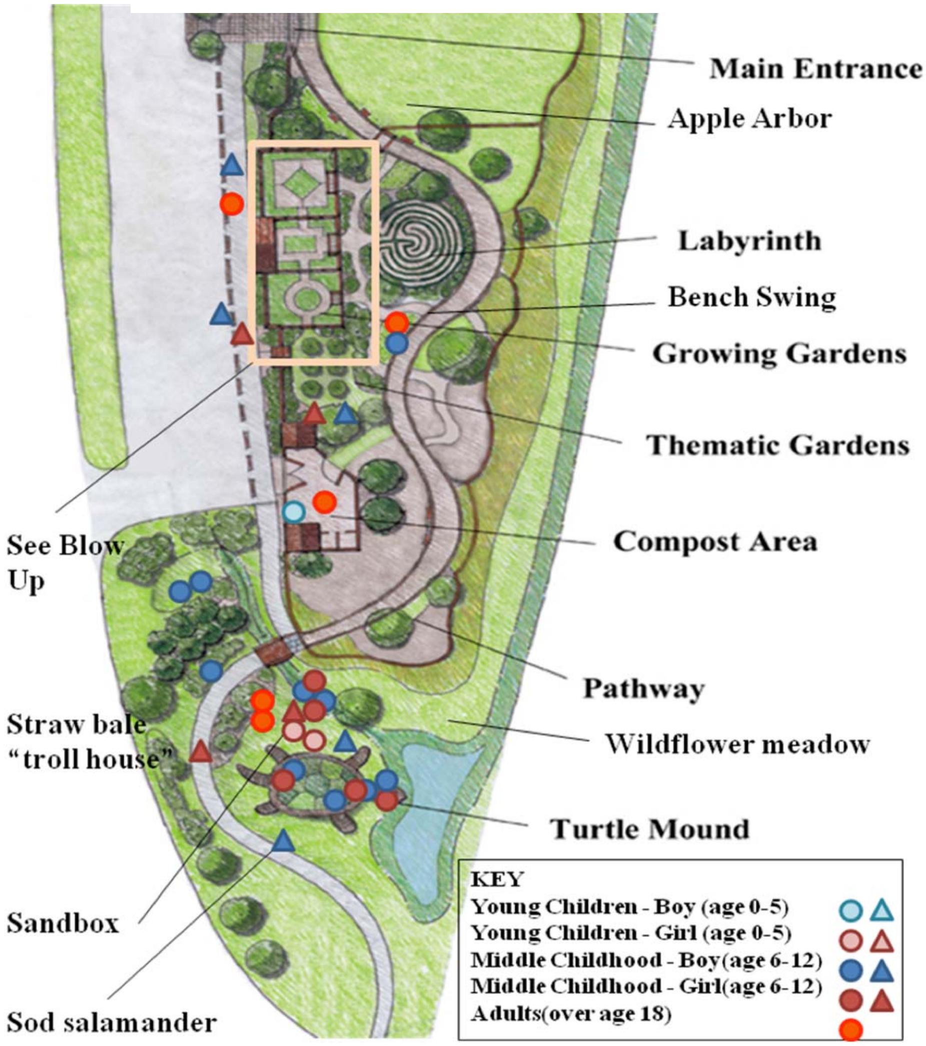


Figure 18: The Ithaca Children's Garden behavior map in Ithaca, New York (Manning, 2004).

The Ithaca Children's Garden has clearly defined horticultural areas ("growing gardens") and naturalized areas ("turtle mound" and wetland). The "growing gardens" area was excluded from observations to avoid a garden programming bias, since this study was primarily focused on free play. For reference, this area also included digging, watering, hiding and running activities within the context of gardening, weeding and plant discovery.

Buffalo and Erie Botanical Gardens – Children's Garden

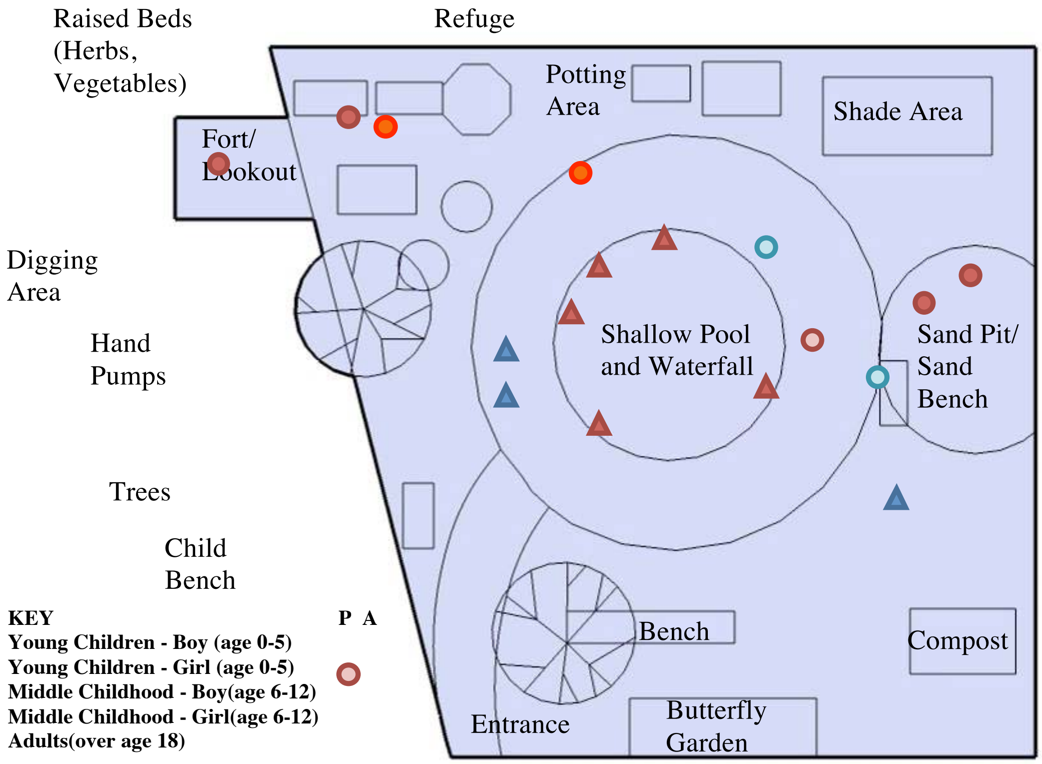


Figure 19: The Erie Botanical Children's Garden in Buffalo, New York (map made by Ashley Miller).

The Buffalo Children's Garden is the smallest of the observed gardens (.06 acres), and therefore has concentrated observations that may have been more dispersed in a larger garden. This garden provides an example of how behavior is impacted when limits on space and budget necessitate smaller and fewer elements. Clearly, water and digging areas still draw the greatest child activity, whether in a small space like the Buffalo Children's Garden, or a large one like the Ithaca Children's Garden.

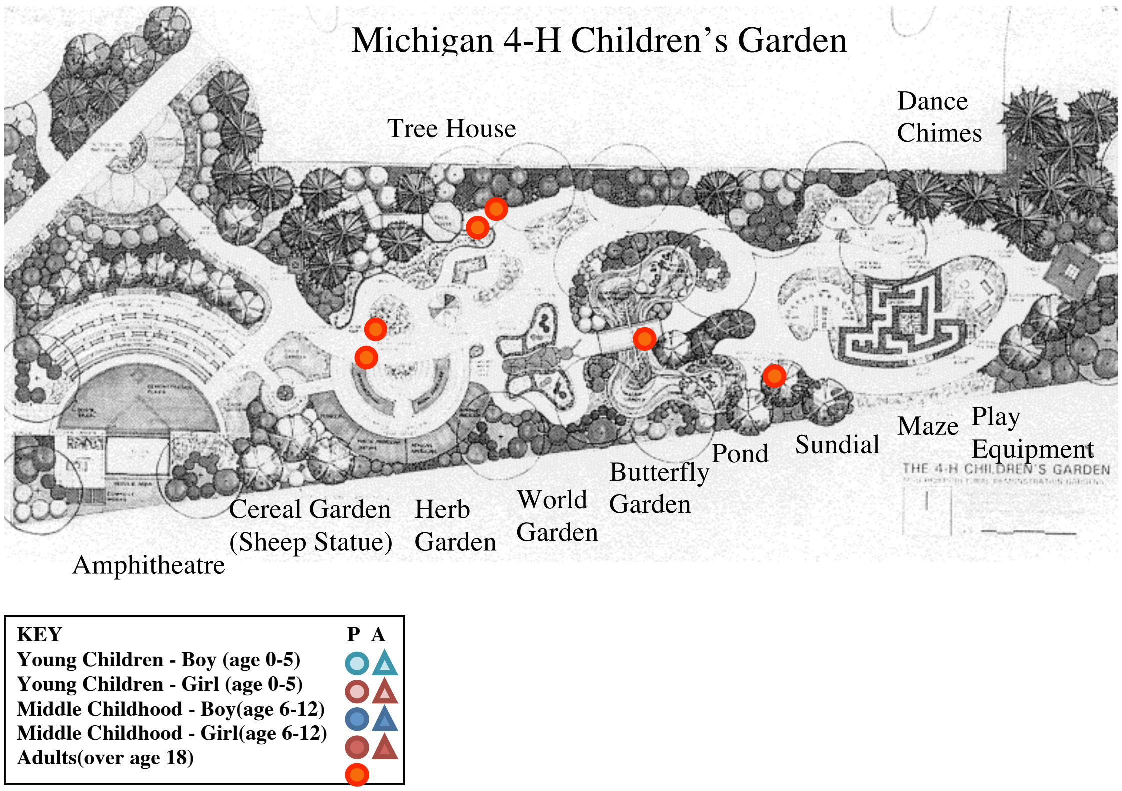


Figure 20: The Michigan 4-H Children's Garden behavior map in East Lansing, Michigan (map, Whiren, 1995).

The Michigan 4-H Garden, as one of the original examples of the "discovery" garden model, shows the success of symbolic and interactive elements. Statues, ponds, hand pump fountain, mazes, sundials and interactive musical elements all proved successful for their flexible and familiar elements. For instance, moveable and responsive parts (jumping chimes) and familiar symbols (lamb statue, Alice in Wonderland maze, tree house etc.) show behavioral density for children's play.

Cleveland Botanical Garden – Hershey Children's Garden

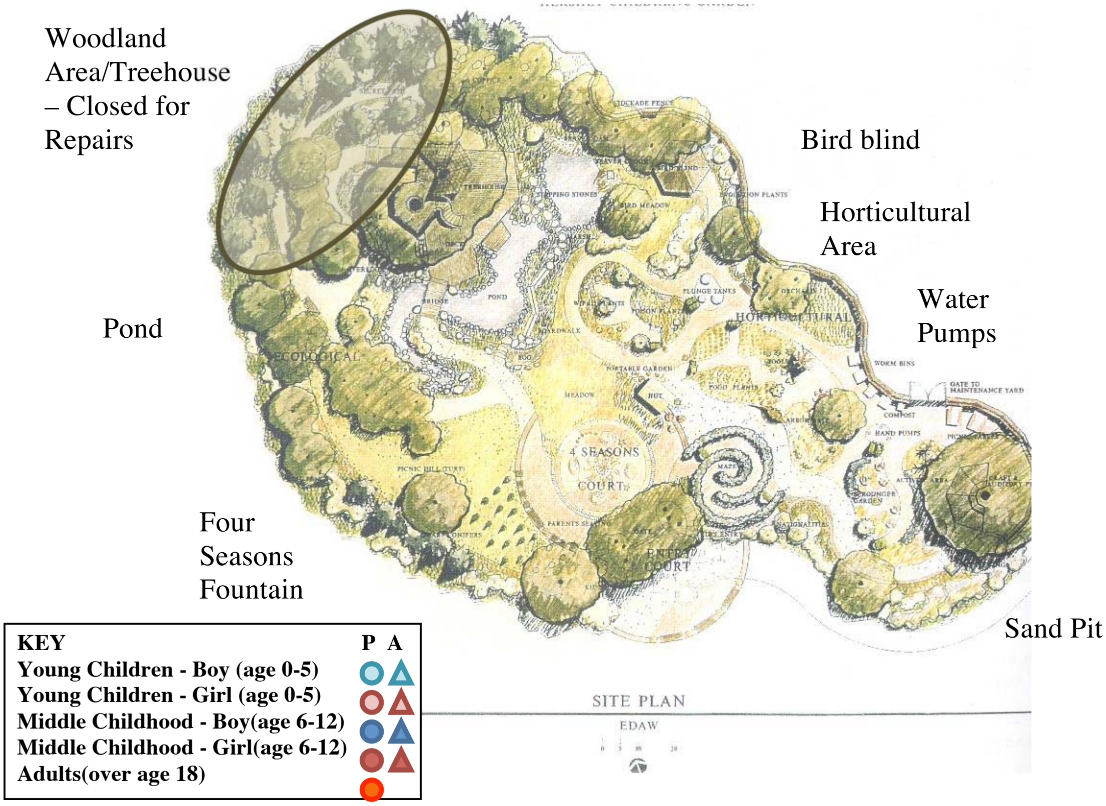
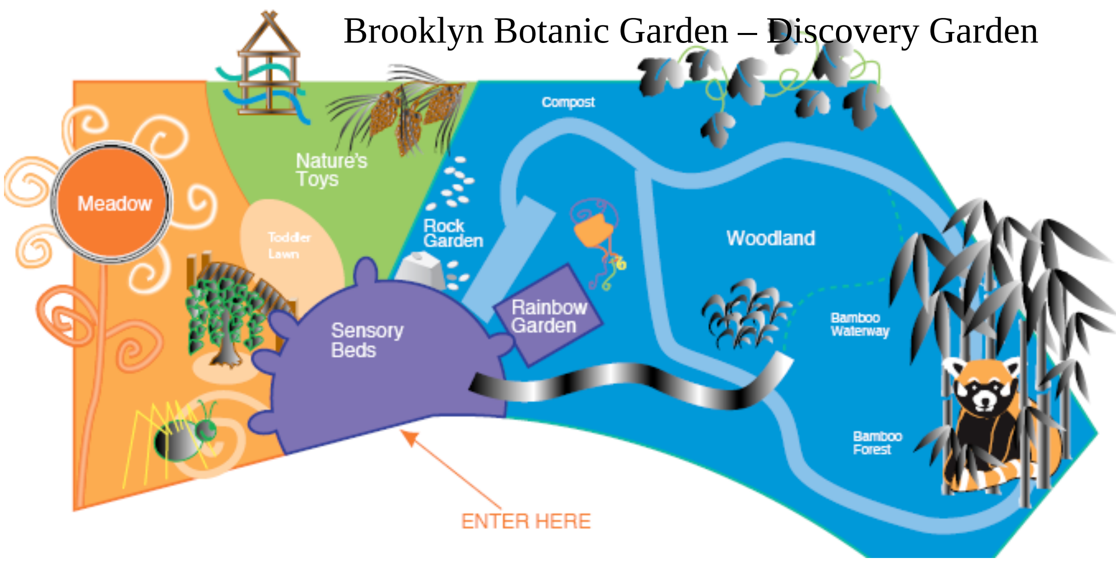


Figure 21: The Hershey Children's Garden behavior map in Cleveland, Ohio (map, Heffernan, 2004).

A large portion of the Hershey Children's Garden was closed for repairs during the observation period (gray oval), which may have obscured the results. The garden is split into an ecological discovery area (left half of the garden) and a horticultural instruction area (right half of garden). Clearly, a large number of children were found in the water and digging areas of the horticultural half, though the tree house and surrounding woodland are usually a popular attraction, according to staff observations. Additional observations when the garden is fully open would provide a more accurate snapshot of children's preferences and behaviors.



KEY **P A**
Young Children - Boy (age 0-5)
Young Children - Girl (age 0-5)
Middle Childhood - Boy(age 6-12)
Middle Childhood - Girl(age 6-12)
Adults(over age 18)

Figure 22: The Brooklyn Botanic Garden Discovery Garden in Brooklyn, New York (map provided by Director of Education, Marilyn Smith).

The Brooklyn Botanic Discovery Garden is split between horticultural exploration (left half of garden) and naturalized areas (right half of garden). The split between these areas was roughly equal, with clustering around water elements ("bamboo waterway" area) and a digging and potting area ("nature's toys" area). The children's garden vegetable plots (located directly to the left of the "meadow") were excluded from observations because of a garden programming bias on activity.

Behavior Density

Research Question 3a: Is the ***proportion of direct natural elements*** *in design reflected in children's* ***preference for direct natural contact (behavioral density)?***

As summarized in Table 13, on average, 50% of elements were direct natural and indirect natural elements, and 50% were symbolic natural and non-natural elements across gardens. This information was critical as a measure to correlate with behavioral density (measured through contact with direct – wild nature, indirect - horticulture, symbolic – nature art and signage, and non-natural elements). Furthermore, this proportion of element types was statistically correlated with the preference for element contact to understand how design aligned with behavior.

Table 13: The percentage of natural elements for all gardens in the study.

Garden studied; # of elements	Direct Natural Elements	Indirect Natural Elements	Symbolic Natural Elements	Non-Natural Elements
Brooklyn Botanic Garden (43)	21%	35%	12%	33%
Erie and Buffalo Botanical Children's Garden (28)	7%	46%	7%	39%
Gaffield Children's Garden (36)	33%	28%	6%	33%
Hershey Children's Garden (45)	20%	31%	24%	24%
Inniswood Sister’s Garden (39)	18%	33%	21%	28%
Ithaca Children's Garden (34)	24%	32%	26%	18%
Leila Arboretum Children's Garden (46)	13%	37%	9%	41%
Lena Meijjer Children's Garden (35)	9%	23%	9%	60%
Michigan 4-H Children's Garden (46)	11%	46%	9%	35%
Morton Arboretum Children's Garden (36)	14%	17%	19%	50%
Mean	**17%**	**33%**	**14%**	**36%**
Standard Deviation	**8%**	**9%**	**8%**	**12%**

Following the assessment of element type distribution, observations of children's behavioral density revealed that on average, the majority of behaviors occurred within indirect natural contact elements (35%) (Table 14). In the Ithaca Children's Garden and the Buffalo and Erie County Botanical Garden, the percentage of contact with direct natural elements (37% and 43%, respectively) exceeded the percentage contact with indirect natural elements (11% and 40%, respectively). Therefore, the majority of behaviors occurred with horticultural or mediated natural contact (such as the use of hand pumps to extract water, or green roofs to teach children about natural building materials). Also, the indirect natural contact was accompanied by adult interaction and guidance, while the direct natural contact areas were most often for free play. Some indirect natural contact areas, such as vegetable gardens, were not included in observation because they were used primarily for programmed activity (such as the case with the Brooklyn Botanical Garden and the Ithaca Children's Garden) and this study was of children's free play and use of elements.

In conclusion, direct natural contact and indirect natural contact combined were observed 69% of the time on average, while symbolic natural and non-natural contact were observed 31% of the time (Table 11). This is in contrast to the percentage of these element categories, which, shown in Table 14 , vary considerably between gardens.

Table 14: The percentage of children's contact with as "Direct" "Indirect" "Symbolic" and "Non-Natural" elements in each garden.

	Direct Natural Contact	Indirect Natural Contact	Symbolic Natural Contact	Non-Natural contact
Brooklyn Botanical Garden - Discovery Garden	40%	45%	0%	15%
Buffalo and Erie County Botanical Garden - Children's Garden	43%	40%	0%	17%
Cleveland Botanical Garden - Hershey Children's Garden	30%	37%	22%	11%
Ithaca Children's Garden	37%	11%	26%	26%
Michigan 4-H Children's Garden	19%	43%	7%	31%
Mean	**34%**	**35%**	**11%**	**20%**
Standard Deviation	**10%**	**14%**	**12%**	**8%**

Direct natural contact (measured by behavioral density) is theorized to be important for children's affective and evaluative development for environmental competence in children's gardens (Kellert, 2002; Kals & Ittner, 2003). Considering "environmental education and interaction" was in all gardens' mission statements, it was assumed that a strong correlation would be found between proportions of observed natural contact and proportions of natural elements. In an analysis of Pearson correlations between direct natural elements and direct natural contact, design did not prove to correlate with the behavioral density measure (r=.114, p=.855). Furthermore, no significant correlation was found for the presence of indirect natural elements and observed indirect natural contact (r=.206, p=.740). In contrast, a significant correlation was found between symbolic natural elements and symbolic natural contact with these areas (r=.948, p=.014) while no significant correlation was found for non-natural contact and elements (r=-.040. p=.949).

Behavior Diversity

*Research Question 3b: Is the **<u>affordance diversity</u>** in design reflected in **<u>diversity of children's play (behavioral diversity)?</u>***

A behavior diversity measure (total behaviors divided by total activity types) was collected to corresponded to affordance diversity measures (environmental supports).

Table 15: Summary of behavioral diversity (total behaviors/total activity types), affordance diversity index (0=most diverse, 1=no diversity), and direct natural element average (4=direct natural; to 1=non-natural).

	Child Use of Gardens	Element Inventory	Element Inventory
	Behavioral Diversity	Affordance Diversity Index	Direct Natural Element Average
Brooklyn Botanical Garden - Discovery Garden	5.00	0.64	2.44
Buffalo and Erie County Botanical Garden - Children's Garden	6.00	0.82	2.21
Cleveland Botanical Garden - Hershey Children's Garden	3.38	0.18	2.47
Ithaca Children's Garden	2.45	0.29	2.62
Michigan 4-H Children's Garden	7.00	0.48	2.33

A modest, though non significant, correlation was found between behavioral diversity and the affordance diversity index (r=.669, p=.217). Between direct natural element average and behavioral diversity, however, a fairly strong correlation was found (r=-.862, p=.060, where negative correlation is in the hypothesized direction). This suggests a relationship between natural contact and diversity of play.

CHAPTER 5

DISCUSSION

This study's findings suggest that child participation in children's gardens may be associated with the elements preferred and used in garden designs. Furthermore, if elements are accessible and child-scaled, children's interaction with these natural spaces may be more successful. The following discussion highlights such key findings in support of the three aims, and presents limitations, implications, recommendations and future research directions.

Key Findings

Aim 1: Describe characteristics (e.g., age, size, organizational context, mission statement themes) of children's gardens in the Northeast and Midwestern United States.

Research aim 1 sought to answer the research question "*What are the characteristics of children's gardens in the Northeast and Midwest (e.g., age, size and organizational factors)?*". Nine out of twelve gardens were built in the last ten years, reflecting the recent growth and development of this children's environment. The gardens were mostly within botanical gardens and non-profit organizations, though two universities, two arboretums and two parks contributed to the sample. In the initial design process, stakeholder involvement was fairly consistent, with 80% or greater including horticulturists, landscape architects and educators. Youth involvement was greatest for children ages six to twelve (60% of gardens), in alignment with the middle childhood focus of this study. Children's participation has potential benefits for this age group in terms of cognitive, affective and evaluative development in natural space development and interaction (Heft and Chawla, 2003; Kellert, 2002). Furthermore, all gardens indicated "environmental education and interaction" as an important mission statement theme, with approximately equal amounts of "participatory design" "accessibility and inclusiveness" and "children's health" mission statement themes. Not all themes were equally represented across differing garden types, ages, sizes and design stakeholders. In response to this, analysis of mission statement themes in design and participation was necessary to connect qualitative descriptions of garden characteristics with quantitative findings of mission statement, design and participation.

Aim 2: Examine whether children's garden ***mission statement themes*** *are reflected in participation (design, implementation and organization) and design features (direct natural elements, affordance diversity and usability) for* ***environmental competence****.*

Research aim 2 assessed the relationship between mission statements and participation and design features. The following discussion is divided by the predetermined research questions.

Research Question 2a: *Do children's gardens with mission statements* ***including participatory design and empowerment themes*** *have greater* ***children's participation*** *and design features including* ***direct natural elements*** ***(****e.g. ponds)?*

The most important finding for research question 2a was that gardens with the "participatory design and empowerment" mission statement theme had higher means among all three participation categories of design, implementation and organization. The strongest of these was initial design participation, which was associated with a higher mean direct natural element average than gardens without participation. This finding is consistent with child-nature studies of children's preference for natural elements in play spaces (Moore, 1989; Eberbach, 1988; Lekies et al., 2008). Past studies, including case studies of the Michigan 4-H children's garden, indicate that even without extensive knowledge of gardening, children have preferences for flowers, fruits, vegetables, water and trees when they themselves are involved in design (Whiren, 1995; Heffernan, 2004). While the findings are in the predicted direction, the small sample size and high standard deviation suggest no statistically significant findings.

The participation findings may be inconclusive given garden personnel both rated their mission statement and child participation in the same survey. To verify this, additional participation data from secondary sources (e.g. objective studies by Whiren, 1995, Garibay, 2001 and garden websites) provided mission statements and a second rater was utilized to assess the four themes. Unfortunately, the inter-rater agreement was low (Kappa test, .143 – discussed further in limitations), therefore the strength of the main effect of participatory design, implementation and organization for the mission statement theme of "participatory design and empowerment" is also low.

Research Question 2b*: Do children's gardens with mission statement themes including* ***<u>accessibility and inclusiveness</u>*** *have greater* ***<u>usability elements (e.g. scale, accessibility, legibility and safety elements)?</u>***

Some trends were observed in analysis of research question 2b for gardens that had "accessibility and inclusiveness" in their mission statements. Only three out of seven subconstructs were in the predicted direction for gardens with accessibility and inclusiveness in the mission statement. Specifically, external accessibility (transportation options), internal accessibility (universal design) and child-scaled items had higher mean element counts for gardens with this mission statement, though none were statistically significant. The inter-rater agreement for this mission statement was also low (Kappa score, .118), indicating weak measurement reliability which weakens the study's internal validity, suggesting a small chance of a main effect between "accessibility and inclusiveness" and the measured outcomes for usability.

In a qualitative sense, interviews suggest an interest in creating spaces that are universally accessible for children and families, and the literature supports this. "*Access and mobility to engage affordances*" was theorized by Heft and Chawla (2003) as an important requirement for children's environmental competence, and this may be reflected in children's garden accessibility and scale features. Past studies on universal design for children's outdoor space also suggest this, such as Moore & Ringhaert's (2005) post-occupancy evalutation which points to low ramps, winding paved paths, multi-level interactive space (like raised beds) to be most successful with children of all ability levels. In other design studies, child-scaled environments have been shown to enhance children's sense of control, thereby encouraging greater interaction with spaces (Moore et al., 1997; Eberbach, 1988).

Research Question 2c: *Do children's gardens with mission statement themes including* ***children's health*** *have design features with a* ***diversity of affordances?***

Of all the mission statement themes, design and behavior outcomes of research question 2c concerning "children's health" were the most ambiguous. It was predicted that the diversity of affordances (environmental supports) would be greater (indicated by a lower diversity index number) for gardens that included this factor in mission statements. The reasoning behind this was that for sustained physical and social play, a diversity of fine and gross motor functions should be supported by features in the environment (Moore et al., 1992). The data showed a reverse finding, with a higher affordance diversity index among gardens with children's health in the mission statement. Due to the small sample size, however, only two of the ten gardens that had on-site garden design analysis responded positively for the mission statement theme of "children's health", making the diversity measure inconclusive. The inter-rater agreement was the lowest for this mission statement (Kappa score, 0) suggesting a chance agreement, which may point to both an ill-defined concept of children's health, and an incomplete measure in design affordances.

Research Question 2d: *Do children's gardens with mission statements including **environmental education and interaction** have design features including **direct natural elements?***

Research question 2d, as stated earlier, was not analyzed in detail because there was no variation across gardens for the mission statement theme "environmental education and interaction". This is an important finding in itself because of the emphasis all gardens placed on this value. The inter-rater agreement for this mission statement was perfect (Kappa score, 1), suggesting that future studies should focus on this issue when assessing the success of design for environmental competence.

*Aim 3: Understand the relationship between children's garden **design features and children's use of gardens**.*

Research aim 3 assessed the relationship between design features and children's use of gardens with measures of behavioral density and behavioral diversity. The aim was addressed by answering two questions:

*Research Question 3a: Is the **proportion of direct natural elements** in design reflected in children's **preference for direct natural contact (behavioral density)?***

The most important finding for the research question 3a was a greater average percentage of children's direct natural contact and indirect natural contact (69%) than symbolic and non-natural elements (31%) suggesting a preference for these design features; even when their actual presence was lower across gardens (50% on average). In addition, a significant correlation between children's symbolic natural contact and symbolic natural elements matches hypothesized design and behavior outcomes, indicating a well functioning aspect of children's gardens. This may indicate that a good way to engage kids in children's garden design and use is by integrating familiar cues (say, symbolic animal statues or storybook creatures) with interactive experiences of nature (indirect and direct natural elements), which makes garden features more approachable and allows for children to build on complex concepts like environmental knowledge (Whiren, 1995).

*Research Question 3b: Is the **affordance diversity** in design reflected in **diversity of children's play (behavioral diversity)?***

In regard to research question 3b, analysis of affordance diversity and behavior diversity data provided several findings with implications for physical and social development. Amounts of behavioral diversity did seem to align slightly with the affordance diversity index, providing some correlation between design and use. Moreover, a significant correlation was found between the direct natural element average and behavioral diversity measure, where negative correlation is in the hypothesized direction) across all gardens. This may indicate that an even better measure of the physical and social supports in gardens is the amount of natural elements observed, rather than recording affordances themselves. The implications for children's health, suggesting natural areas support a diverse balance of fine motor and gross motor play important to children's health (Fjortoft & Sageie, 1999).

Limitations

External Validity

There were several limitations to this study which weaken the external validity, or generalizability, of the findings to other settings or gardens. This is not surprising, however; it is the nature of post-occupancy evaluations which evaluate specific settings rather than attempting to study a representative sample of settings. Thus, only a limited number of gardens could be visited and analyzed in depth, reducing the statistical power of the findings. To analyze children's use of garden spaces, a brief behavior mapping method was chosen consisting of one day observation periods and limited time sampling snapshots. Only five gardens were chosen for this method based on permission and existence of a map of the garden.

A convenience sampling method resulted in unequal populations at each garden (a range of 9 to 16) and variation in the numbers of girls, boys and age groups. All of these issues have effects on the type of play observed. It was not the objective to do a developmental study, however, so the sample was chosen for garden level study which explored the way these spaces are designed and used.

There was variation in the types of physical environments due to many alternatives variables (number of element choices, proportion of elements, locational factors). These variables may have affected the external validity of the findings from this study. Garden locations ranging from New York City to rural Michigan had varying amounts of space and funding, impacting their use and design. Still, describing the differences and similarities within and between children's gardens may inform designers, horticulturists and educators to the common successes and challenges faced within their unique environments.

Internal Validity

Limitations to internal validity can be defined as alternative explanations for the results of a study, which are often based on measurement issues. Some internal validity limitations included the instrumentation used to measure the variation in garden design between mission statement groups. For instance, self-report in both manager surveys and on-site inventories provided limited objective data. A tested measurement tool, was not used to assess true square foot percentage of each element type, and therefore all elements were considered equal in proportion to the whole garden. The design inventory checklist provided a substitute measure, and was based on my expertise in children's environments research. A second method or second observer would have been ideal to test the reliability of the design inventory and to prevent mono-method bias.

To deal with internal validity issues in the children's garden survey, a check on self-report of mission statements was performed for each garden with an objective rater. I was unable to get exact mission statements from all gardens, so substitute descriptions were used from published materials, which may explain the inconsistency in garden reported and rater reported mission themes.

Table 16: Kappa scores.

Theme	Kappa Score	Agreement
PDE	0.1430	Poor Agreement
AI	0.1180	Poor Agreement
CH	0.0000	Chance Agreement
EE	1.0000	Perfect Agreement
Total	0.4640	Fair Agreement

*PDE – Participatory Design and Empowerment; AI – Accessibility and Inclusiveness; CH – Children's Health; EE- Environmental Education and Interaction

Cohen's kappa coefficient (Cohen, 1960) provides a measure of inter-rater agreement for dichotomous items. Kappa scores range from -1.0 to 1.0, with 0 equivalent to chance. The Kappa test was used to assess the validity of the self-reported children's garden mission themes by comparing garden managers' reports with assessments of an objective rater presented with the published mission statements. The overall agreement between the garden manager and the rater was fair (k=.464), however kappas for individual mission statement themes were mostly quite poor (.143, .118, .00, and 1.00 for themes 1 -4 respectively), as shown in Table 15 . The exception is the environmental education theme which shown perfect agreement between garden managers and the rater.

Given these results, future studies might examine the most effective ways to accurately measure garden mission statement themes in a reliable and valid manner. Using an outside rater avoids "mono-method" bias, a threat to internal validity, but it is not clear whether an outsider raters' assessments of mission statement themes are accurate. More valid measurement would prevent any skewed data resulting from garden managers expected responses to participation and accessibility questions given responses to the mission statement question.

All methods used experimental applications of theorized methods. The affordance taxonomy has been used in previous analyses of children's environments (Kytta, 2002), but only in interview coding, not design checklists. Furthermore, the types of natural elements were developed from theorized categories (Kellert, 2002) for the purpose of this study, with no established validity and reliability. The behavior observation method, while using a reliable behavior schedule (Hart & Madorell, 2003), was tested for the first time in a behavior mapping application, verses its original use as a behavior tracking method.

Implications

The most important findings of this study involve the relation between child participation and design for natural contact, as well as the influence of universal design in children's gardens. Of the three gardens with the highest level of design participation, children's suggested elements (as documented in garden publications) involved in a number of highly interactive and accessible natural elements. The following table shows this breakdown of elements that children suggested in initial design, and those that children were observed engaging with in gardens (Table 16).

Table 16: Children's suggested, implemented and used elements.

*PD – Participatory Design; AI- Accessibility and Inclusiveness; EE – Environmental Education and Interaction.

Children's Garden Name	*Mission Statements	Design Stakeholder Ages	Child Suggested and Implemented Elements (Whiren, 1995; Heffernan, 2004; Ithaca Children's Garden Youth Design Session, 1998)	Children's Use of Elements
Cleveland Botanical Garden – Hershey Children's Garden	EE	6 to 12	Ponds, Bird Areas, Butterfly Area, Waterfall, Apple Trees, Flowers, Tree houses, Corstalks, Picket Fences, Berries, Vegetables	Bird Blind, SandPits/Digging Area, Tree house, Vegetable/Fruit Plots, Water Fountain, Wildlife Area(Wetland), Hand Pumps
Ithaca Children's Garden	PD, EE	6 to 12	Living Sculptures, Fish and Turtles, Pond with Water Lilies, Swing, Learning Areas, Flowers, Apple Trees, Berries, Treehouse, Compost, Child Murals	Hideaways/Enclosure, Sand Pits/Digging Areas, Sculpture/Ornament, Sustainability Features (GreenBuilding)/Playhouse, Vegetable/Fruit Plots (Programmed Activities), Wildlife Areas(Wetland), Bench Swing, Trees
Michigan 4-H Children's Garden	PD, AI, EE	2 to 5 and 6 to 12	Flowers, Trees, Grass, Fruits, Vegetables, Bright Colors, Storybook Characters, Mud, Rocks, Sand, Scarecrow, Shovels, Playhouse, Climbing Areas, Animals (Fish, Birds, Butterflies, Caterpillars, Dinosaurs).	Flowerbeds, Maze, Sundial, Dance Chimes, Playground Equipment, Treehouse, Pond, Water Fountain, International Garden, Sculpture/Ornament

As can be seen from the Table 13, there are some repeated elements both suggested and used by children across the gardens. For instance, ponds and wildlife areas (such as wetlands) were frequently mentioned in youth design sessions, and were repeatedly used throughout observations. Furthermore, vegetable and fruit plots were suggested by children and engaged with when adult supervision was present in the gardens. Sand, mud and water, of course, were consistently favored for their loose parts and opportunities for construction. Clearly, direct and indirect natural elements were preferred in participatory design gardens and the actual use by children, supporting the mission statement themes of "participatory design" and "environmental education". Of symbolic natural and non-natural elements, sculpture and art representing nature, such as the living sculptures at Ithaca Children's Garden and animal sculpture at the 4-H Children's Garden, were popular child suggestions and observations as well. Furthermore, playhouses or treehouses were frequently mentioned and used by children in both designs and play observations. These built features included accessible ramps and child scaled design, exemplifying the "accessibility and inclusiveness" mission statement theme.

In the behavioral study, the most successful element categories had a high correlation between symbolic natural elements and symbolic natural contact and the overall preference for direct and indirect natural contact. Participatory designed gardens often integrated such symbolic and direct natural elements for educational goals (Ithaca Children's Garden, the Hershey Children's Garden and the Michigan 4-H Children's Garden). For instance, child suggested elements like a large turtle mound calendar, a frog fountain and sheep statue were used to represent lessons about Native American harvest cycles, pond ecosystems, and Midwest agriculture.

Children's participation may be beneficial in and of itself for children's empowerment and competence, as well as having useful input on successful elements for accessibility, environmental education and children's health. Gardening programs that combined design participation and gardening education (such as the Ithaca Children's Garden Salad Gardens) both empower children to work on a project as well as teach them how that project is beneficial to themselves and the environment. In addition, incorporating and locating child preferred symbolic and interactive elements that work well together for natural play (water, digging areas and symbolic natural elements) and separating out those that may detract from learning goals (such as gross motor play areas) may help to achieve a balance between a garden's purpose of meeting children's play needs and teaching them about the natural and horticultural worlds.

Recommendations

To address how this research relates specific elements with relevant development stages and missions, the following typology provides children's garden stakeholders with best practice examples. These are grouped by direct natural, indirect natural, symbolic natural and non-natural categories as defined by the benefits to children's environmental competence.

Direct Natural Elements

One focus of this thesis was direct natural elements and how they were beneficial to children's cognitive and physical development. The most relevant mission statement themes associated with direct natural elements in the literature were "participatory design", "children's health" and "environmental education". Direct natural elements represent unprogrammed space that allows for immersion in some form of wild environment, or a restored natural setting, and can include plants and animals that function without human intervention. Examples include a forest, meadow or stream that involves **exploration, restoration, and diversity of environmental**

play supports. These spaces may appeal to children from six to twelve (Kellert, 2002) all the way into adolescence if care is made for purposeful construction, interaction, manipulation and discovery. These activities may lead to increased self-confidence, adaptability and moralistic viewpoints about natural settings (Kellert, 2002). The following gardens had successful elements representing these aspects:

Ithaca Children's Garden - Wetland

Gaffield Children's Garden – Wilderness Trail and Nature Art Garden

Hershey Children's Garden – Pond and Woodland

Sister's Children's Garden – Woodland, Wetland and Secret Garden

Brooklyn Botanic Discovery Garden – Woodland and Bamboo Waterway

Indirect Natural Elements

Indirect natural elements were another category of design features in children's gardens related to mission statement themes of participatory design, children's health and environmental education in the literature. This type of "everyday nature" does not need to be inherently wild, but allows access to plants and animals which represent human intervention in the natural world. Characterized by involvement of children throughout the age spectrum, these spaces are usually facilitated by programmed activity, verses free play. This category includes elements for **socialization, facilitated participation and interpretation**. The purpose of these spaces is to introduce fact-based understanding of cause and effect through themed garden areas, as well as cultivated garden plots. The following gardens had areas devoted to this type of natural contact:

Michigan 4-H Children's Garden – Garden Program Plots, Themed Gardens

Ithaca Children's Garden – Growing Gardens

Leila Arboretum Children's Garden – Themed Gardens

Hershey Children's Garden – Vegetable Patch, Orchard, Theme Gardens

Gaffield Children's Garden - Growing Gardens

Sister's Children's Garden – Country Garden

Symbolic and Non-Natural Elements

In addition to direct and indirect natural elements, symbolic and non-natural garden elements cater to the younger children's ages three to six years old (Kellert, 2002). In the literature, these types of elements were associated with mission statement themes of "accessibility" and "children's health". Symbolic and non-natural design features involved limited direct contact with wild nature, but a greater amount of **control, legibility, accessibility and safety** within a familiar type of environment. This may include play environments encouraging safe interaction with elements like symbolic art, animal sculpture, learning exhibits and other familiar elements, as seen in examples below:

Erie Country Botanical Garden Children's Garden - Entire Garden

Morton Arboretum Children's Garden – Backyard Garden

4-H Children's Garden – Music Garden, Sundial, Alice in Wonderland Maze

Ithaca Children's Garden - Gaia the Turtle

Lena Meijjer Children's Garden – Senses Garden

Hershey Children's Garden – Four Seasons Entry, Treehouse

Future Research

There are several areas for future research. Future studies might move beyond the post-occupancy evaluation methodology used in this project to study a larger, more representative sample of gardens. The survey could be sent to a larger number of children's gardens (of at least 30) throughout the U.S. A larger population could be assessed on which types of elements are included in design, as well as more in depth information on the content of educational programming that goes along with these spaces. In this way, the survey would focus on linking spaces to programming purposes, not just mission statements. Understanding what programs go on in certain areas of gardens would be an important next step in analyzing participation, health and environmental education goals. Furthermore, a nationwide study, versus this regional study, would get at the larger children's gardens trends, and allow for an analysis of the M. Miller (2005) checklist given the element categories established in this thesis. In this way, a large survey sample could be statistically analyzed with stronger internal validity to assess links between programmatic goals and types of elements.

Another gap in this research was the lack of child interviews to gather data about what are the most successful children's garden elements. To address this, future researchers could utilize the photo documentation of elements from this thesis in a children's garden design game. A prototype of this game was developed for the Ithaca Children's Garden Urban 4-H program, and used a circular chalk pathway for kids to enter different garden spaces (the four natural element categories). Using dice to determine which square to move to, kids were asked questions about the element from one of the four types. If they guessed right, kids could then turn over the question to discover a picture of one of the elements from the study, and give it a "green thumbs up" or a "green thumb down" sticker to identify whether they like to play and learn with this element or not. A researcher could use this game to compare before and after opinions of elements used in a gardening program. Schools, parks and botanic gardens could also use this method to get input from kids on initial or expanded garden designs.

In response to mono-method and self-report bias in the methods, more objective measures could be used in the future. For example, Geographic Information System (GIS) analysis could be used to understand contextual "accessibility" of gardens to surrounding areas. For usability elements to be further analyzed, targeted user groups (such as parents and children with physical challenges, Moore & Ringaert, 2005) should be interviewed and data on the success of transportation and universal design features should be collected.

A better measure of physical affordances for health is another area where improvement is needed. Gardens that provide programming in food and nutrition, such as the Ithaca Children's Garden Brooklyn Botanic Garden, Michigan 4-H Children's Garden and New York Botanic Garden, could be measured for percentage of children's gardening plots and amount of programming. Furthermore, objective assessment of green space and built space within gardens (such as through aerial GIS analysis) may improve validity of checklist measures of natural element categories.

Conclusion

With future research and application of this post-occupancy evaluation approach, we can better understand the implications of children's gardens for participation, accessibility, health and education. These spaces may provide a natural step towards health and sustainable behaviors for the next generation.

APPENDIX

Appendix A: Garden Manager Information Sheet and Survey

Appendix B: Parent Information Sheet, Consent Form and Interview

Appendix C: Behavior Schedule and Sample Behavior Map

Appendix D: Observation Data Sheet and Inventory

Appendix A: Garden Manager Information Sheet and Survey (Consent Letter)

Cornell University

Dear ……………,

My name is Ashley Miller, and I'm a graduate student in the Design and Environmental Analysis Department at Cornell University. I am in the process of completing an MS thesis examining children's garden design that I hope will contribute to our understanding of how children's garden elements encourage natural play and learning, which is often found to be lacking in conventional play grounds. I would be very appreciative if you would contribute to my research efforts by completing the attached survey. The questions address issues such as the age and size of the garden, and the kinds of elements that exist in the children's garden where you work. The survey will take approximately 10-15 minutes to complete.

If you would like a copy of the study, please indicate so by e-mail and I will send you an electronic copy when my work is complete. **Please return this survey and an additional map of the garden (if available) within two weeks (May 14th)**. As a participant, you will be included in a raffle for a **$50 gift certificate to a garden supply store** of your choice.

If you have any questions about this research, you can contact me at (607) 664-6333 or email me at alm252@cornell.edu. If you have further questions about your rights as a research participant, contact Susan Lewis, IRB Administrator, Cornell University, (607)-255-5138, rbhp-mailbox@cornell.edu. Concerns may also be reported anonymously through Ethicspoint or by calling toll free at 1-866-293-3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

Thank you very much for your contribution to this research project.

Sincerely,

Ashley Miller

CHILDREN'S GARDEN SURVEY

1) Garden Name: ______________________________

2) Your Position /Title: ______________________________

3) Would you be interested in a behavioral study of your garde? ___Yes ___No

4) Can you provide a map of the garden space to use in a behavior study (if YES, please attach to the original e-mail sent to you)? ___Yes ___No

5) What dates do you have regularly scheduled classes or events with children's groups (if any) in May and June?
____
____

6) How many square feet is the garden? ______________________________

7) In what context is the children's garden located (check all that apply):
___botanical garden ___community garden ___educational facility ___park
___arboretum ___other (please describe): ______________________

8) In what year was the garden opened? ______________________________

9) What are the external accessibility amenities (check all that apply)?:
___Bus ___Walking/Biking ___Mass transit ___Car
Other: ______________________________

10) What are the internal accessibility amenities (check all that apply)?
___Paved Pathway ___Ramps/ADA Approved Elevation ___Accessible Raised Beds
Other: ______________________________

11) Who manages the garden (check all that apply)?:
___University ___Private Institution ___Non-Profit __Public
Other: ______________________________

12) Which of the following are mentioned in the garden mission statement, vision or objectives:
__ Participatory Design/Empowerment __ Accessibility/Inclusiveness
__ Children's Health __ Environmental Education

13) Who was involved in the design process? :
__Landscape architects __Researchers _Horticulturists __Educators
__Students(College) __Students(6^{th}-12^{th} _ _Students (K-5th)
__Preschoolers
Other: ______________________________

14) In your view, what are the three most successful elements/areas in the garden (see list of garden elements on the next page for reference)?
____

15) What are the three elements you would change about the garden, if you could (see list of garden elements on the next page for reference)
____

Was any youth participation involved in the design of the children's garden? Please indicate the amount of the following participation activities:

	Low		**Moderate**		**High**	
The children/youth participate in discussions regarding the project	1	2	3	4	5	N/A
They are informed about the issues facing the project	1	2	3	4	5	N/A
They participate in project planning	1	2	3	4	5	N/A
They participate in project decision making	1	2	3	4	5	N/A
They contribute to problem solving	1	2	3	4	5	N/A
They serve in leadership roles	1	2	3	4	5	N/A
They carry out project activities						
They take initiative in carrying out project activities	1	2	3	4	5	N/A
They make financial decisions about the project	1	2	3	4	5	N/A
They participate in advisory committees	1	2	3	4	5	N/A
They assume responsibility for carrying out the ongoing tasks of the project	1	2	3	4	5	N/A
They develop publicity about the project	1	2	3	4	5	N/A
They share information with other community groups about the project	1	2	3	4	5	N/A
They prepare written reports about project activities	1	2	3	4	5	N/A
They train new participants	1	2	3	4	5	N/A
They evaluate project activities	1	2	3	4	5	N/A
They report to project funders	1	2	3	4	5	N/A

(Participation questions from *Engaging Children Survey*, Lekies et. al., 2006)

Please indicate in the following checklist which elements are present (yes) or not present (no) in your children's garden.   Additional elements not listed here should be written at the end.

ELEMENTS	YES	NO
Adventure Playground/ Playground Structures		
Art		
Bathrooms/Buildings		
Bulletin Board		
Butterfly Garden		
Bright Colors		
Elevation (Varying)		
Entrances		
Fences		
Flower Beds (annuals, perennials)		
Game Settings		
Gathering/ Meeting Areas		
Greenhouse/ Cold Frame		
Herb Garden		
Hideaways / Enclosure/ Refuge		
Hen House/ Birdhouse/ Animal Areas		
Lawn/ Grass Area		
Orchard		
Pathways/ Walks/ Stepping Stones		
Patio/ Terrace		
Performance Area		
Plant Label/ Stake		
Lighting		
Plant Structures		
Playhouse		
Raised Beds		
Sand Pits/ Digging Areas		
Scarecrows/ Pinwheels/Sundial (functional garden decoration)		
Sculpture/ Ornament		
Seating/ Benches (Child Sized)		
Security/ Emergency Telephone/ First Aid		

	YES	NO
Sensory Elements (tactile, interactive)		
Signage / Wayfinding		
Storage Area/Tool Shed		
Stroller/ Wheelchair Amenities		
Sustainability Feature (solar panels, water saving, green building)		
Swing		
Tables (kid size)		
Teaching Area/Learning Stations		
Theme Gardens		
Topiary		
Tree House		
Trees/ Woodland		
Vegetable / Fruit Plots		
Vertical Structure/ Landmarks		
Vistas		
Water Fountain		
Weather Station		
Wildflower Meadow		
Wildlife Area (wetland, stream, native plants)		
Water Feature (fountain, pond etc.)		

*Checklist adapted from Mark Miller (2005), *An Exploration of Children's Gardens: Reported Benefits, Recommended Elements, and Preferred Visitor Autonomy*

Additional elements:
____
____
____
____
____
____
____
____
____
____

Appendix B: Parent Information Sheet, Consent Form and Interview

I'd like to introduce myself. My name is Ashley Miller, and I'm a graduate student in the Design and Environmental Analysis Department at Cornell University. For my thesis research, I'm observing how children use this gardening space to plan better outdoor spaces for children. This will take approximately 15 minutes. With your help, I'd like to understand how children's garden spaces encourage social and natural play, which is found to be lacking in conventional play grounds.

If you have any questions about this research, you can contact me at (607) 664-6333 or email me at alm252@cornell.edu, or my advisor, Nancy M. Wells at nmw2@cornell.edu. If you have further questions about your rights as a research participant, Susan Lewis, IRB Administrator, Cornell University, (607)-255-5138, rbhp-mailbox@cornell.edu. Concerns may also be reported anonymously through Ethicspoint or by calling toll free at 1-866-293-3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

Thank you for your participation in the study. I will give you a copy of this form to take with you.

_________________________ ________ ___________________________ _____

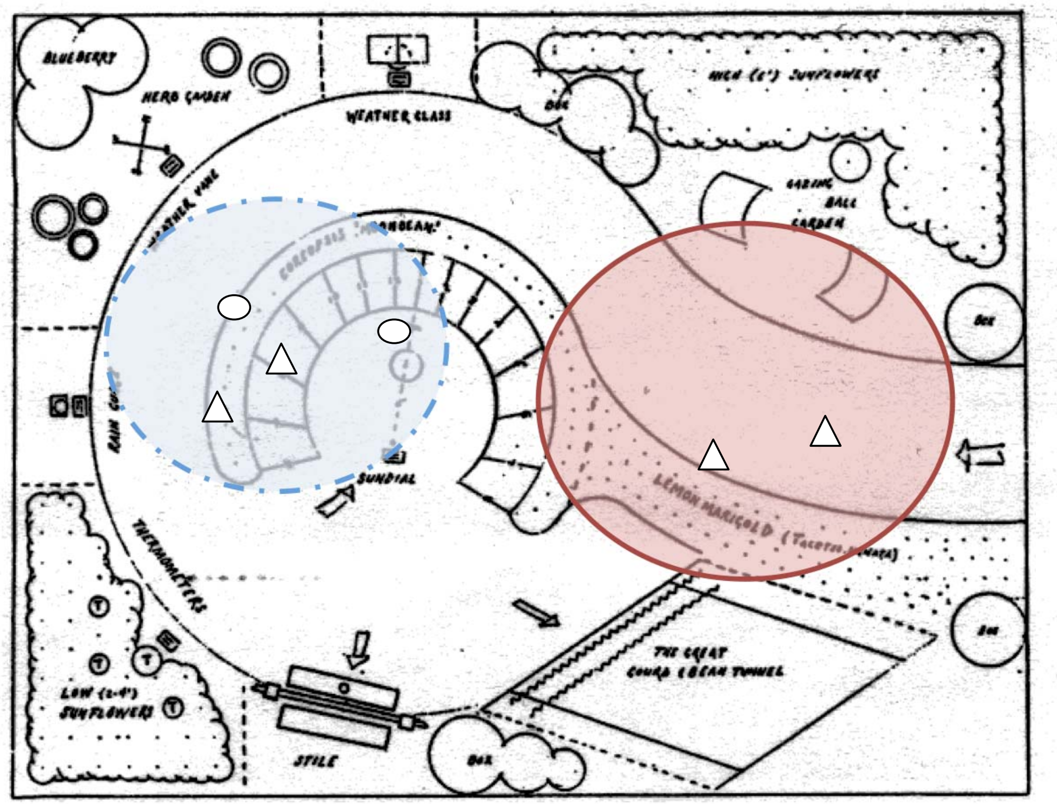
Participant's signature **Date** **Investigator's signature** **Date**

Age of your child ________

Gender of child____________

Appendix C: Behavior Schedule and Sample Behavior Map

Activities (Gross Motor)	***Activities (Cognitive/Sensory)***	***Affordances***
-Crawling	-Manipulating/Digging	-Direct natural contact (with wild natural habitats and materials)
-Rough and tumble	-Constructing	-Indirect natural contact (with domesticated nature, i.e. vegetable gardens)
-Jumping / Tumbling	-Dismantling	-Symbolic natural contact (statues, models, signage representing nature)
-Balancing	-Games sedentary	-Non-natural contact (man-made built structure, toys, etc.)
-Climbing	-Reading / Writing	
-Chasing / Racing	-Watching	
-Hiding	-Seeking	
-Riding bikes, trikes	-Water play	
-See – sawing	***Activities (Other)***	
-Swinging	-Personal needs	
-Throwing	-Waiting	
-Splashing	-Unfocused activity	
-Dancing	-Blocked View	
-Locomotion (Walk/run)	-Carried Locomotion	
-Locomotion (Wheelchair)		
-Games active		



Sample Behavior Map:
Dashed Circle= Direct Natural Contact
Solid circle = Indirect Natural Contact
Triangle = Active Play
Circle = Passive Sensory Play

Sheet)

Environmental Competence Design Features->	Natural Contact Element Categories				Affordance Diversity Features											Control	Safety		Accessibility	Legibility	
Date:	4) Direct Natural Contact	3) Indirect Natural Contact	2) Symbolic Natural Contact	1) Non-Natural Contact	1) Flat, relatively smooth surfaces	2) Relatively smooth slopes	3) Graspable, detached objects	4) Attached objects	5) Non-rigid, attached object	6) Climbable feature	7) Aperture	8) Shelter or refuge	9) Mouldable material	10) Water	11) Social Interaction Space	Child Scale	Surveillance	Usability (Health and Safety Amenities)	Internal Access for Universal Design	Interpretive Elements	Wayfinding Elements
Weather:																					
Number of Children Present:																					
Garden:																					
Adventure Playground/ Playground Structures																					
Art (Child)																					
Bathrooms/Drinking Fountain																					
Bridge																					
Buildings																					
Bulletin Board																					
Butterfly Garden																					
Bright Colors																					
Compost Area																					
Elevation (Varying)																					
Entrances																					
Fences																					
Flower Beds (annuals, perrenials)																					
Game Settings																					
Gathering/ Meeting Areas																					
Greenhouse/ Cold Frame																					
Herb Garden																					
Hideaways / Enclosure/ Refuge																					
Hen House/ Birdhouse/ Bird Blind																					
Animal Areas																					
Lawn/ Grass Area																					
Maze																					
Orchard																					
Pathways/ Walks/ Stepping Stones																					
Patio/ Terrace (adult area)																					
Performance Area																					
Plant Label/ Stake																					
Lighting																					
Potted Plants																					
Plant Structures (Arbor, Bean Pole, Teepee)																					
Playhouse																					
Raised Beds																					
Root View Cabinet																					
Rocks																					
Sand Pits/ Digging Areas																					
Sundial (Functional Decoration)																					
Sculpture/ Ornament																					
Seating / Benches (Child)																					
Security/ Emergency Telephone/ First Aid																					
Multi-sensory Elements (sound, smell, etc.)																					
Signage / Wayfinding																					
Storage area																					
Stroller/ Wheelchair Amenities																					
Sustainability Feature (solar panels, water saving, green building)																					
Swing																					
Tables (Child)																					
Teaching Area																					
Topiary																					
Train																					
Tree House																					
Trees/ Woodland																					
Vegetable / Fruit Plots																					
Vertical Structure/ Landmarks																					
Water Fountain																					
Water Feature/Pond																					
Weather Station																					
Wildflower Meadow																					
Wildlife Area (wetland, stream, native plants)																					
Windmill																					
Unique Areas (Theme Gardens):																					

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